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# Returns to higher education subjects and tiers in China: Evidence from the China Family Panel Studies

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## Abstract

Using the China Family Panel Studies, we identify the subjects studied by vocational college and university graduates, with the latter group further divided into ordinary and key universities. While the returns are around 8-10% to attending colleges and ordinary universities, there are higher returns of 12-16% per annum to attending the more prestigious key universities. The recent massive expansion of the higher education sector resulted in reduced returns to all HE types, except for graduates who studied subjects other than LEM (law, economics, and management) or STEM (sciences, technology, engineering and math/medicine) at key universities.

We further account for selection on observables into subjects and tiers using the doubly robust Inverse Probability Weighted Regression Adjustment method (IPWRA) approach. While these results are tentative, they suggest that pooled OLS and random-effect models substantially underestimate the effect of attending universities that are more prestigious for graduates of both genders in LEM.

**JEL code**: I23, I26

**Keywords**: Returns to university tier and subjects; China; Inverse Probability Weighted Regression Adjustment; Higher Education expansion

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## 1. Introduction

Various studies have highlighted the key role that the expansion of the education system, in particular the higher education (HE) system, has played in China's remarkable economic growth over the last 4 decades, accounting for at least 10–15% of per capita GDP growth (Wang and Yao (2003), Zhu (2012) and Whalley and Zhao (2013)).

Whether and to what extent returns to HE vary by subjects and tiers of prestige are of enormous interest to policy makers and the general public in China, yet there is surprisingly little empirical evidence in the literature. Using a nationally representative sample of working age (20-60) employees with at least upper secondary education, we address two specific research questions in this paper. First, to what extent, if any, do the returns to HE in China vary by the subject studied and tiers of prestige of the institution attended? Essentially we are testing the implicit assumption in the returns to schooling studies that returns do not vary by university subjects, conditional on tiers. On the other hand, one would expect higher returns to attending more selective universities, which admit more able students and are better resourced. Second, how does the recent substantial HE expansion, affect the returns to HE differentially by subject and tiers? A textbook economic model of labour demand and supply would predict overall declines in the returns, with larger decreases for vocational colleges which have expanded disproportionately.

We make at least three contributions to the literature on returns to college selectivity and university subject choice. Firstly, according to our review of the literature, this is the first attempt to estimate the treatment effects of HE subjects and tiers of prestige on earnings in China. While the returns to attending 3-year colleges and 4-year Ordinary Universities are approximately 8-10% per year for both genders, the returns to attending the more selective Key Universities are substantially higher, at

12-16% per annum. On the other hand, within each tier of prestige, the difference in returns to studying different subjects is not statistically significant for either men or women. Secondly, our results indicate that after more than 10 years' of massive HE expansion which started in 1999, returns to HE have declined across HE types, except for those studying subjects other than STEM ((sciences, technology, engineering and math/medicine) or LEM (law, economics and management) at the most prestigious universities. Finally, we have attempted to account for the simultenous choice of university subjects and tiers, using the doubly robust Inverse Probability Weighted Regression Adjustment method (IPWRA) approach, which is a generalisation of propensity score matching by allowing for multiple treatments (Wooldridge 2007, 2010; and Imbens and Wooldridge 2009). While these results are tentative, they suggest that pooled OLS and random-effect models substantially underestimate the effect of attending universities that are more prestigious for graduates of both genders in LEM.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature, with special reference to China. Section 3 discusses the institutional background. Section 4 introduces the data. Section 5 briefly outlines the analytical methods. The empirical results are presented and discussed in Section 6. Finally, Section 7 concludes.

## 2. Literature Review

The economic literature on returns to HE types can be classified into two strands. The first strand concerns returns to subjects (or majors, in the US literature) while typically holding the prestige tier constant, and the second concerns returns to prestige tier (a.k.a. selectivity) while typically treating subjects as given. Both strands are dominated by descriptive analyses. In this brief review, we focus on the studies that have attempted to estimate the causal effect of the subject or prestige type.

Altonji et al. (2012) survey the empirical literature on the demand for and returns to college major, allowing for the effects of high school curriculum, and observe that most of the studies are from the US and the UK, presumably due to data availability.

Paglin and Rufolo (1990) highlight the importance of mathematical ability in determining field choice for US college students, which is consistent with earnings maximization by major. They observe that graduates with above average Graduate Record Exam quantitative scores for their undergraduate field tend to switch to fields requiring higher average scores. Using a dynamic model of college and major choice that allows for switching and dropout, Arcidiacono (2004) focuses on ability sorting across majors in the National Longitudinal Study of the Class of 1972 (NLS72). Although individuals appear to make the initial choice about college and major according to the course-specific expected earnings, they update their decisions by dropping out or changing the course, based on new information about their preferences and ability while in college. Moreover, he finds large earnings premiums for natural science and business majors even after controlling for endogenous selection of majors. By contrast, Hamermesh and Donald (2008) demonstrate that overlooking non-response bias in survey data leads to overestimation of the earnings differentials across college majors in the US.

O'Leary and Sloane (2005) conduct one of the first UK studies that focuses on the heterogeneous returns to broad and narrowly defined subjects by using the Labour Force Survey. Their results highlight the substantial variation in returns across degree subjects and by gender in the UK. Using a survey of a cohort of young UK graduates linked to administrative records of academic attainment and family background, Chevalier (2011) documents large heterogeneity in mean wages between subjects and an even larger variation by unobserved individual characteristics within subjects.

As for the causal studies on the effect of college selectivity on earnings, most studies have used matching methods that assume selection on observables only (see for example, Chevalier and Conlon (2003) and Hussain et al. (2009) for the UK, both of whom observe a modest return to attending universities that are more selective of approximately 6% for one standard deviation increase in HEI quality). Dale and Krueger (2002) is the first attempt to allow for selection on unobservables. By matching students who were accepted with students who also applied to but were rejected by the same set of colleges, they conclude that there is little evidence of higher returns to attending colleges that are more prestigious in the US for students with the same ability, except for children from low-income families. Following the Dale and Krueger method, Broecke (2012) compares UK students who satisfied the conditional offers for their first-choice to students who applied to the same universities but attended their second-choice universities due to not fulfilling the conditions of their preferred offer. He finds that one standard deviation in selectivity leads to a 7% increase in earnings in the UK.

Walker and Zhu (2018) attempt to estimate the treatment effect of university subjects and prestige tiers for the UK. Using the IPWRA approach to allow for selection on observables into subjects and institution types, they find that much of the variation in relative wages across courses is due to the quality of students enrolled. Similarly, Belfield et al. (2018) apply the IPWRA method to the new Longitudinal Education Outcomes administrative dataset to account for variation in course selectivity and student characteristics in estimating the labor market returns to different degrees in the UK.

This paper follows the same IPWRA methodology, which is discussed in details in the Online Appendix. Compared with the more conventional matching method, which can only be applied to a binary treatment, the main advantage of the IPWRA method is that it allows for robust estimation of treatment effects when the number of treatments outnumber the number of potential instruments.

The recent HE expansion in China has been the topic of a growing body of literature, mostly published in Chinese. The literature review by Feng (2012) concludes that most of studies from the perspective of education or sociology show that inequality has exacerbated following the expansion. In particular, students from disadvantaged (e.g., rural) backgrounds enroll disproportionately in lower tier HEIs and/or less-popular (lucrative) subjects. Allowing for complementariness among workers of different ages and qualifications, Li et al. (2017) show that the HE expansion has increased the college premium of older cohorts of graduates at the expense of younger cohorts. Using the discontinuity in the months of births induced by the HE expansion, Dai et al. (2018) show that each additional year of university education induced by the 1999 HE expansion increases monthly wage income by 21%, compared with an OLS estimate of 8%. However, this seemingly large return could be explained by the relaxation of severe constraint on HE supply when less than 3% of the cohort enrolled in HE before the expansion and a large positive demand shock for high skills following China's WTO accession in 2001. It is far from clear that the high return to HE will persist after sustained expansion which saw annual enrolment into HE growing from 1.08 million in 1998 to 6.08 million in 2008 (Ministry of Education, 2018).

Few Chinese studies have examined the choice of university subjects and tiers in China or the differential returns to such choices. Using a sample of 488 monozygotic twin pairs from urban China, Li et al. (2012) present measurement error corrected within-twin estimates of about 22% for vocational colleges and 38% for universities, relative to having no more than junior high school. Interestingly, they find a close to zero return to the exam-oriented (senior) high school, which they argue is mainly serving as selection mechanism for colleges. Unfortunately, they are unable to control for subject studied and the data is not nationally representative. Another study is Sheng (2017), who shows that although there is little difference in subject choice across social class, secondary school students from high-income families in Beijing are more likely to enter national Key Universities, which is the most prestigious tier in the Chinese education hierarchy.

## 3. Institutional Background

In 1986, China introduced 9-year compulsory education starting at age 6, with 6 years of primary education and 3 years of junior high schools. Students who continue with their education after completing compulsory schooling, enter vocational schools or Senior High Schools, which have a duration of 3 years. Students in the Senior High Schools are streamed into the science or arts tracks for the last 2 years of upper secondary education (OECD 2016). Students in both tracks take Chinese, English, and political science, but arts students take geography, history, and basic mathematics, whereas science students take physics, chemistry, biology, and advanced mathematics (Li et al. 2012).

After 12 years of schooling, secondary school graduates can apply to colleges and universities through a centralized admissions system that proceeds sequentially in tiers based on the scores in the standardized National College Entrance Examinations, known as *gaokao* (Zhu 2014). Colleges and universities in China can be classified into three tiers in descending order of prestige and entry requirements: Key Universities (mostly research intensive National Project 985 and Project 211 universities), Ordinary Universities, and vocational training colleges. The duration of study for the Key Universities and Ordinary Universities is typically 4 years, leading to a bachelor's degree. The duration of study for the vocational training colleges is 3 years, leading to a college diploma.

There are nearly 2,600 regular HEIs in China employing 1.6 million academic staff as of 2016 (Ministry of Education 2018). The system of Key Universities in China originated from the 1950s, with an aim 'to cultivate high quality management and scientific research personnel' (Tan and Wang 2016). By 2009, there are only 112 Project 211 universities which are predominantly former Key Universities.

Admissions in the second tier universities start only after the assignments in the first tiers are finalized, and so forth. Each applicant submits a lexicographic list to the provincial student placement office that indicates their HEI (i.e., colleges and universities) preferences and then their preference regarding subjects within each HEI. Important for this analysis, university applicants must consider the tier of the HEI and the subject at a given HEI simultaneously, which defines a university course. These considerations are an important feature of the Chinese educational system that must be considered in the econometric analysis.

Another unique institutional feature of China is the *hukou*, or household registration system, which classifies people into rural and urban status at birth, usually according to the mother's *hukou* status. Education resources at the primary and secondary level are highly unequal and in favor of urban residents in China, who have better access to HEIs than their rural counterparts, especially to the most prestigious universities and colleges.[1]

Intuitively, *hukou* status at age 12 is likely to determine whether the respondent attended an urban or rural secondary school, with systematic differences in the quality that might also be subject specific (e.g., rural secondary schools might struggle to recruit competent English teachers). Therefore, in addition to family background variables such as mother's education, we also control for *hukou* status at age 12 as a key determinant of the choice of HE types in the formal analysis.

Figure 1 shows the annual enrolment of Senior High Schools and HE Institutions in China over the period 1990-2015. From 2000 onwards, we can further break down HE into colleges and universities. The massive expansion of the HE sector starting in 1999 (marked by the vertical bar) is totally unprecedented among major economies, with annual enrolment growing from 1.08 million in 1998 to 6.08 million in 2008 (see Che and Zhang 2018). Figure 1 also indicates within the HE sector 3-year colleges have expanded disproportionately, relative to 4-year universities.

Before the expansion, the HE system in China could only be characterized as elitist, as the HE participation rate was well below 5%. A decade later, roughly a quarter of a birth cohort particapted in HE. Given the phenomenal transition from elitist to mass HE (see Trow 2007) over such a short time period, it would be of interest to investigate whether the returns to HE has been depressed, and if so whether the negative effect of the expansion differs by subject and tiers.

[Figure 1 near here]

[1] Using the 2008 Chinese General Social Survey (CGSS), Hao *et al.* 2014 find a cumulative penalty of rural *hukou* and rural school, which increases with educational stage. They interpret these as evidence in support of the Maximally Maintained Inequality (MMI) and Inequality Reproduction hypotheses.

## 4. Data

This study is based on the China Family Panel Studies (CFPS), a biennial longitudinal nationally representative survey of Chinese families, with interviews of around 15,000 households and 30,000 individuals the first wave in 2010, conducted by the Institute of Social Science Survey of Peking University of China. The survey collects information on employment, income, education, and health at individual, family, and community levels (Xie and Hu, 2014). Important for the purpose of this paper, the survey contains detailed information on the respondent's subjects of study at each level of post-secondary education, including the Senior High School, college, undergraduate and postgraduate levels. For university graduates, the CFPS also asks about the tier of prestige, i.e. national key, key or ordinary, in the first wave.

Our sample consists of all individuals aged 20–60 years whose highest qualification is Senior High School, College, or University in the first wave of the CFPS. We exclude individuals whose highest qualification is Junior High School or below, because HE choice is irrelevant to them. We also exclude the small number of respondents with a Master's or PhD level qualification because there might be important unobservables that distinguish them from the rest of the graduates. Implicitly, we want to model the choice of a Senior High School graduate between entering HE, or entering the labor market straight away, and if choosing the former option, between different HE subjects and different tiers of prestige or selectivity of the HEIs. Due to sample size limitations, we use a 3 by 3 grouping of HE types, namely, three subjects consisting of STEM, LEM, and Other Subjects,[2] and three institution tiers consisting of colleges, Ordinary Universities, and Key Universities.

[2] This is derived from the 11 subjects reported: sciences, engineering, agriculture, medicine are grouped into STEM; law, economics and management are grouped into LEM; and philosophy, education, literature, history are grouped into Other Subjects.

After excluding individuals with missing values on key variables including the outcome variable of monthly earnings and a handful of graduates with degrees from abroad, the sample consists of 2,813 distinct individuals, of which 1,173 (41.7%) are women. We take full advantage of the panel nature of the CFPS by including Waves 2 and 3 (conducted in 2012 and 2014, respectively). However, only earnings, age, survey years, and survey months are time-varying in our analysis.[3]

Table 1A shows the relative frequencies by gender. Notably 46.7% of males in the sample are graduates, and 54.6% of females hold a college or university degree. The variation in the relative frequencies partly reflect the popularity of a certain subject–tier combination, with Key-University Other Subjects and Key-University STEM being the least common combination for men and women, respectively.

Table 1B reports the summary statistics for key variables in Wave 1 by gender. The mean real monthly earnings in January 2009 constant price are RMB 2,443 and 1,849 for men and women, respectively. Compared with men, women are almost 3 years younger and more likely to have had an advantageous background as proxied by a non-agricultural *hukou* at age 12 and mother's education level. Although women are more likely to live in urban areas than men, there is no difference in the probability of living in the East Region, which is the most economically developed region of China.

[Table 1 near here]

Table 2 presents the mean log real monthly salaries by HE types and gender for the wage panel. The raw graduate wage premium is 0.36 log points for men and women.[4] Male college graduates earn 0.29 log points more than their Senior High

[3] The age-earnings profiles shown in Figure A1 in the Online Appendix suggest that people with higher qualifications not only have higher earnings at given age, but also have higher earnings growth at the beginning of their career, compared to their lower qualification counterparts.

[4] For simplicity, we interpret a slope coefficient $b$ in the log wage equation in terms of log points, which approximate a $100b$ percentage point change.

School counterparts and 0.11 log points less than male Ordinary University graduates. Although Key Universities and Ordinary Universities take the same time to complete, we observe a staggering 0.25 log points' earnings difference among male university graduates. Female college graduates earn 0.25 log points more than their Senior High School counterparts and 0.19 log points less than male Ordinary University graduates. The earnings premium for attending Key Universities for women is 0.22 log points. Notably, STEM graduates have the lowest earnings at college level, but the highest earnings at Key University level for both genders, implying a higher return to selectivity to study those subjects. Finally, the gender difference in earnings is more or less constant across all education levels and types: approximately 0.20 log points.

[Table 2 near here]

Due to potentially different employment patterns, we will undertake empirical analysis for men and women separately whenever the sample sizes are sufficiently large. However, when we need to split the sample with regard to the massive expansion, it is necessary to pool gender and even report statistical significance at the 10% rather than 5% level.[5]

## 5. Analytical Methods

We will start our analysis with Pooled Ordinary Least Squares (POLS), which serves as a benchmark. However, controlling survey year dummies only does not take full advantage of the CFPS panel. Therefore, we also estimate the popular Random-effects (RE) model which accounts for the serial correlation in the error term (Wooldridge

[5] Moreover, the minimum sample size required is quite sensitive to the number of treatments. In order to detect an effect size of 0.1 in our case with 14 control variables, the required minimum sample size almost doubles from 779 to 1558, when the number of treatments increases from 1 to 9, assuming a 0.05 significance level and a power of 0.8.

2010). Note that a fixed-effects (FE) model is not feasible, as education (types) is effectively time-invariant.

We further explore the "doubly robust" IPWRA estimator (see Wooldridge 2007, 2010; and Imbens and Wooldridge 2009). Compared to the more conventional propensity score matching (PSM) method which only allows a single treatment, the IPWRA estimates the average treatment effect (ATE) of multiple HE types and allows for selection into a particular HE type by using multinomial logit model in the first step. In the second step, this estimator then estimates an OLS regression of log earnings by using the reweighted data, using the inverse of the predicted probabilities from the first step as the weights to account for the selection bias. Assuming that there is only selection on observables, this weighting method can yield causal estimates of the ATEs.

Due to the space constraint, a more detailed discussion of the methodology is left to the Online Appendix.

## 6. Empirical Results

### *6.1. Main results*

Table 3 presents the Pooled OLS (POLS) and Random-effects (RE) estimates of the effect of various HE types on log real monthly earnings for each gender separately, controlling for age, age squared, and living in urban areas or in the more developed East Region, as well as survey years. There is no information in our survey on social class, a concept which is controversial in China. However, we control for parental education and one's own *hukou* status, which have been identified as key determinants of HE accesses in the relevant social stratification literature (see e.g. Feng 2012 and Sheng 2017). We deliberately choose this parsimonious specification, which later facilitates estimating the IPWRA model.[6] Notably, we are estimating the absolute returns to different HE types, using the same Senior High School graduates with no HE credentials as the control group in all specifications while allowing for nine treatment groups.

[Table 3 near here]

The RE and POLS estimates are largely indistinguishable for both genders. Thus, in the following, we comment on the RE results. For men, attending a 3-year college yields a return between 24%–30%, with STEM subjects having the lowest returns and LEM having the highest returns. However, the differences are statistically insignificant across subjects. Men attending 4-year Ordinary Universities have a return between 33% and 41%, again with the lowest returns for STEM. This implies that the returns to either college or ordinary universities is about 8-10% per year, which is consistent with existing studies (e.g, Liu et al. (2012) report an OLS return of 8.5%).

However, men attending the most prestigious Key Universities have a return between 49% and 64%, with substantially lower returns for graduates studying Other Subjects than STEM or LEM. Thus, we observe that returns to attending HEIs that are more prestigious are substantially higher, in the range of 12-16% per annum. A model that fails to allow for both HE tier and subject groups would fail to capture the heterogeneity in returns across HE types.

Formal tests fail to reject the null hypothese that the returns per year of schooling are the same across subjects within each HE tier regardless of gender, at the conventional level of significance. However, the null of identical returns across all 9

[6] Table A1 in the Appendix shows that controlling for occupations would compress the returns to HE types somewhat, but the overall pattern remains similar. However, we choose not to control for any post-education choices such as occupation due to concerns for endogeneity. Moreover, controlling for mother's year of birth makes little difference to the returns to HE types and the coefficient is statistically insignificant for women.

HE types are rejected at the 5% significance level for both genders, due to the higher returns to attending key universities.

For women, we observed returns similar to those for men, except for Ordinary University STEM graduates and Key-University Other Subjects graduates, which are substantially higher.

For men, having a non-agricultural *hukou* at age 12 is associated with 7% higher returns; living in urban areas is associated with approximately 14% higher monthly earnings compared with living in rural areas; and living in the more developed East Region is associated with approximately 36% higher earnings than living in the central or western regions. For women, we observe no significant link between *hukou* status at 12, but the wage premiums for living in urban areas or the East Region are even higher than for men.

### *6.2. Heterogeneous effect of the HE expansion*

We move on to explore the heterogeneous effect of the HE expansion by HE tiers and subjects to address the second research question. The HE sector in China experienced an unprecedented expansion from 1999–2018, with an annual enrollment that increased from approximately 1 million to 6 million. The most dramatic growth occurred between 1999 and 2001: approximately 40% annual growth per year.

[Table 4 near here]

We classified people born in August 1979 or before as the pre-expansion cohort and people born in September 1979 or later as post-expansion.[7] Approximately 30% of the sample are post-expansion. Due to the small sample sizes, we pool gender in Table

[7] This is consistent with Wu and Zhao (2010), who show that high school students account for a small majority of 19-year-olds even among full-time students in the various censuses.

4, which presents RE and IPWRA for pre- and post-expansion cohorts separately. We also drop the survey month dummies from the controls.

Although the RE estimates are remarkably similar to those in Table 3 for the pre-expansion cohorts, they are very different for the post-expansion cohorts. Moreover, a formal test overwhelmingly rejects the null hypothesis that the returns to the 9 HE types are pairwise equal across sample periods at the significance level of 0.000. Indeed, the results suggest that the HE expansion has had a very heterogeneous effect on the returns to HE, depending on the subject and tier of prestige. Figure 2 visualizes the changes in returns by HE types resulting from the HE expansion. The hollow squares represent the pre-expansion point estimates, and the solid circles indicate the post-expansion point estimates. The solid and dashed spikes with caps represent the corresponding 90% confidence intervals. Although the returns to all types of HE are significantly positive before the expansion, we can no longer reject the null of a zero return at 10% significance for vocational colleges which have expanded disproportionately, except for LEM graduates. Notably, all but Key University grduates in Other (than LEM or STEM) Subjects experience a decline in returns after the expansion. In particular, the declines in returns to STEM subjects are statistically significant at the 10% level at all tiers of selectivity. Moreover, the decline in returns to LEM at the college level is also significant at the 10% level.

[Figure 2 near here]

One possible explanation of our finding is that although the HE expansion has improved the overall access to colleges and universities, it might have intensified the competition to the most prestigious HEIs (see e.g. Feng 2012). Moreover, students from more socioeconomically advantaged backgrounds might have benefited disproportionately from the expansion.

However, caution should be exercised regarding the interpretation of the post-expansion results. In particular, the RE results are rather imprecise for post-expansion cohorts due to small sample size. This could be partly due to the narrow age range for each subset, especially for the post-expansion cohorts. Notably, graduates who entered HE in 1999 or later had been observed only for a maximum of 7 years at the time of the 2010 survey.

### *6.3. IPWRA*

Table 5 focuses on the IPWRA estimates of the ATEs of the HE types relative to Senior High School graduates.[8] The choice of HE types is estimated using a multinomial logit on the respondent's school cohort and *hukou* status at age 12, as well as his/her mother's age and educational qualification. Table A4 in the Appendix shows how HE types vary by family background, as proxied by mother's education. These family background variables have been widely used in the economics of education literature as key determinants of educational choices (see e.g., Berger 1988). The small differences in sample sizes (less than 2% for both genders) between IPWRA and the corresponding RE estimates in Table 4 reflect that observations off *common-support* are dropped from the final outcome (wage) equations in IPWRA.

While we cannot completely rule out the possibility of some residual selection of HE on unobservables, the ability to control for *hukou* status and mother's education should go a long way in capturing the endogenous selection of HE type. Here the main concern is a lack of an ability measure which might be expected to have an effect even conditioning on *hukou* status and mother's education. To the extent that ability is positively correlated with earnings, our IPWRA estimates could be regarded as an upper

[8] The estimation was implemented using the Stata 15 routine *teffects ipwra*. See Online Appendix Figures A2/A3 for the overlap plots and Tables A2/A3 for full sets of the IPWRA results.

bound estimate of the true effect. Importantly, they should be much less biased than the corresponding POLS or RE estimates which completely overlooks the self-selection into the various HE types.

[Table 5 near here]

Compared with the RE estimates, the IPWRA returns to LEM graduates are much higher, by 0.29 and 0.25 log points for men and women, respectively, but only if they attend the most prestigious Key Universities. This result implies that ignoring the endogeneity of HE types is likely to lead to underestimation of the returns to attending more selective universities, especially the most prestigious Key Universities in China. One possible mechanism is that university degrees in these subjects from the most selective HE institutions might have become an increasingly important determinant for accessing the most lucrative occupations in the age of massification of HE.

## 7. Concluding Remarks

According to our review of the literature, no previous study has attempted to estimate the treatment effects of ***combinations of*** higher education subjects and tiers of prestige in China. Using the first three waves of the CFPS, we identify the subjects studied and tiers of HE prestige. We take advantage of the rich information on the respondent's school cohort, *hukou* status at age 12, and the mother's age and education to estimate the ***simultaneous*** choice of subject and tier of prestige of HEIs by Senior High School graduates. These factors are significant determinants of HE types defined by the 3 by 3 combinations of subjects and tiers.

By allowing for all possible combinations of university tiers and subjects in the students' HE choice set (despite our modest sample size limiting the number of groups we could accommodate in practice), we do not impose arbitrary restrictions on the sequencing or interactions of choices of university subjects and tiers of prestige. This modelling strategy also fits well with the Chinese college admissions system, under which students list preferences for university courses, as defined by subject at specific institutions.

Consistent with existing studies, we find that returns to attending 3-year college and 4-year ordinary universities are approximately 8-10% per year for both genders in POLS and RE estimations. On the other hand, the returns to the more selective Key Universities are substantially higher, at 12-16% per annum. Moreover, we show that the recent substantial expansion of the HE sector in China have reduced returns for all HE types, with the exception of graduates from Key Universities studying subjects other than STEM or LEM.

Using the doubly robust IPWRA method to account for selection on observables in subjects and tiers, we present tentative evidence that POLS and RE substantially underestimate the treatment effect of attending universities that are most prestigious for graduates of both genders in Law, Economics and Management (LEM).

This study has limitations worth highlighting. First, the sample size is still relatively small, especially for the post-expansion analysis. Secondly, the absence of measures of prior educational attainment from secondary schools, such as the actual academic tracks and subjects chosen, calls for extra caution in the causal interpretation of the IPWRA results which assumes selection on observables only.

Nevertheless, this study represents a first attempt in estimating the differential returns to HE tiers and subjects, which have important policy implications and are of wide public interest in China. Further causal studies are required before an enhanced understanding of this important topic is possible.

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## Tables

### Table 1A: Relative frequencies by gender

| HE types | Men | Women | Total |
|---|---|---|---|
| Senior High School | 53.35 | 45.44 | 50.05 |
| All HE, of which | 46.65 | 54.56 | 49.95 |
| College STEM | 11.04 | 9.12 | 10.24 |
| College LEM | 12.74 | 16.20 | 14.18 |
| College Other | 4.57 | 7.16 | 5.65 |
| OrdinUG STEM | 4.70 | 4.01 | 4.41 |
| OrdinUG LEM | 4.21 | 4.60 | 4.37 |
| OrdinUG Other | 2.62 | 5.46 | 3.80 |
| KeyUG STEM | 3.41 | 1.88 | 2.77 |
| KeyUG LEM | 2.01 | 3.07 | 2.45 |
| KeyUG Other | 1.34 | 3.07 | 2.06 |
| Total | 100.00 | 100.00 | 100.00 |
| Obs | 1,640 | 1,173 | 2,813 |

### Table 1B: Summary statistics by gender

| | Men | Women | Total |
|---|---|---|---|
| Real monthly salary (Jan 2009 price) | 2443 | 1849 | 2196 |
| Age | 37.3 | 34.6 | 36.2 |
| School cohort | 1972.1 | 1974.8 | 1973.2 |
| Non-agricultural *hukou* at age 12 | 0.449 | 0.500 | 0.471 |
| Mother's year of birth | 1945.6 | 1948.4 | 1946.8 |
| Mother's education Level (1-6) | 2.13 | 2.42 | 2.25 |
| Urban | 0.802 | 0.872 | 0.831 |
| East Region | 0.441 | 0.443 | 0.442 |

Note: Distinct individuals in Wave 1. OrdinUG and KeyUG stand for Ordinary and Key Universities, respectively.

**Table 2: Mean log real monthly salaries by HE types and gender**

| HE types | Men | Women | Gender difference |
|---|---|---|---|
| Senior High School | 7.44 | 7.22 | 0.22*** |
| All HE, of which | 7.81 | 7.58 | 0.23*** |
| *All Colleges* | *7.73* | *7.47* | *0.26**** |
| College STEM | 7.70 | 7.40 | 0.29*** |
| College LEM | 7.77 | 7.50 | 0.27*** |
| College Other | 7.71 | 7.48 | 0.23*** |
| *All Ordinary Universities* | *7.84* | *7.66* | *0.18**** |
| OrdinUG STEM | 7.81 | 7.76 | 0.05 |
| OrdinUG LEM | 7.87 | 7.62 | 0.25* |
| OrdinUG Other | 7.84 | 7.62 | 0.23** |
| *All Key Universities* | *8.09* | *7.88* | *0.21**** |
| KeyUG STEM | 8.17 | 7.96 | 0.21 |
| KeyUG LEM | 8.05 | 7.91 | 0.13 |
| KeyUG Other | 7.95 | 7.81 | 0.14 |
| Total | 7.62 | 7.42 | 0.19*** |

Note: Unweighted wage panel. OrdinUG and KeyUG stand for Ordinary and Key Universities, respectively. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

**Table 3: OLS and RE estimates by gender**

| | Men | | Women | |
|---|---|---|---|---|
| | Pooled OLS | RE | Pooled OLS | RE |
| | (1) | (2) | (3) | (4) |
| College STEM | 0.254*** | 0.239*** | 0.217*** | 0.221*** |
| | (0.049) | (0.048) | (0.064) | (0.061) |
| College LEM | 0.305*** | 0.295*** | 0.229*** | 0.228*** |
| | (0.044) | (0.045) | (0.047) | (0.046) |
| College Other | 0.295*** | 0.281*** | 0.289*** | 0.290*** |
| | (0.069) | (0.070) | (0.076) | (0.072) |
| OrdinUG STEM | 0.346*** | 0.333*** | 0.517*** | 0.516*** |
| | (0.093) | (0.086) | (0.088) | (0.086) |
| OrdinUG LEM | 0.391*** | 0.386*** | 0.398*** | 0.405*** |
| | (0.094) | (0.088) | (0.113) | (0.104) |
| OrdinUG Other | 0.434*** | 0.411*** | 0.449*** | 0.438*** |
| | (0.074) | (0.079) | (0.087) | (0.082) |
| KeyUG STEM | 0.621*** | 0.642*** | 0.606*** | 0.609*** |
| | (0.084) | (0.087) | (0.154) | (0.148) |
| KeyUG LEM | 0.608*** | 0.624*** | 0.579*** | 0.579*** |
| | (0.106) | (0.112) | (0.096) | (0.094) |
| KeyUG Other | 0.454*** | 0.485*** | 0.530*** | 0.534*** |
| | (0.120) | (0.122) | (0.077) | (0.079) |
| Age | 0.023* | 0.038*** | 0.028* | 0.036** |
| | (0.012) | (0.012) | (0.015) | (0.014) |
| Age sq | -0.000 | -0.000*** | -0.000 | -0.000* |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Non-agricultural *hukou* at | 0.080** | 0.073** | 0.002 | -0.000 |
| age 12 | (0.036) | (0.035) | (0.041) | (0.039) |
| Mother Primary Edu | 0.072* | 0.071* | 0.026 | 0.030 |
| | (0.039) | (0.038) | (0.052) | (0.050) |
| Mother Junior High Edu | 0.081 | 0.100** | 0.140*** | 0.142*** |
| | (0.052) | (0.049) | (0.052) | (0.051) |
| Mother Senior High Edu | -0.018 | -0.014 | 0.124* | 0.139** |
| | (0.055) | (0.054) | (0.064) | (0.062) |
| Mother College+ Edu | 0.209* | 0.240** | 0.192* | 0.212** |
| | (0.116) | (0.115) | (0.101) | (0.100) |
| Urban | 0.141*** | 0.141*** | 0.237*** | 0.228*** |
| | (0.046) | (0.045) | (0.071) | (0.067) |
| East | 0.357*** | 0.363*** | 0.444*** | 0.436*** |
| | (0.031) | (0.031) | (0.037) | (0.035) |
| Constant | 6.515*** | 6.243*** | 6.011*** | 5.895*** |
| | (0.231) | (0.222) | (0.269) | (0.247) |
| Observations (person-waves) | 3,402 | 3,402 | 2,395 | 2,395 |
| $R^2$ | 0.157 | | 0.195 | |

Note: Robust standard errors in parentheses. Clustering at the individual level for pooled OLS. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$. OrdinUG and KeyUG stand for Ordinary and Key Universities, respectively. Other controls include dummies for survey years.

**Table 4: RE estimates by time period, pooled gender**

| | Pre-expansion<br>(1) | Post-expansion<br>(2) |
|---|---|---|
| College STEM | 0.284*** | 0.063 |
| | (0.051) | (0.058) |
| College LEM | 0.307*** | 0.140** |
| | (0.039) | (0.065) |
| College Other | 0.381*** | 0.022 |
| | (0.062) | (0.084) |
| Ordinary STEM | 0.554*** | -0.013 |
| | (0.084) | (0.091) |
| Ordinary LEM | 0.423*** | 0.301*** |
| | (0.084) | (0.110) |
| Ordinary Other | 0.497*** | 0.157 |
| | (0.050) | (0.159) |
| KeyUG STEM | 0.804*** | 0.402*** |
| | (0.101) | (0.128) |
| KeyUG LEM | 0.681*** | 0.430*** |
| | (0.088) | (0.127) |
| KeyUG Other | 0.489*** | 0.609*** |
| | (0.077) | (0.117) |
| Female | -0.239*** | -0.216*** |
| | (0.029) | (0.042) |
| Observations (person-waves) | 4,025 | 1,772 |

Note: Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$. Same control variables as in Table 3.

**Table 5: IPWRA Average Treatment Effect, by gender**

| | Men | Women |
|---|---|---|
| | (1) | (2) |
| College STEM | 0.268*** | 0.241*** |
| | (0.044) | (0.051) |
| College LEM | 0.311*** | 0.226*** |
| | (0.041) | (0.037) |
| College Other | 0.289*** | 0.284*** |
| | (0.060) | (0.057) |
| OrdinUG STEM | 0.470*** | 0.600*** |
| | (0.051) | (0.069) |
| OrdinUG LEM | 0.483*** | 0.396** |
| | (0.079) | (0.154) |
| OrdinUG Other | 0.428*** | 0.385*** |
| | (0.068) | (0.099) |
| KeyUG STEM | 0.684*** | 0.720*** |
| | (0.058) | (0.121) |
| KeyUG LEM | 0.912*** | 0.832*** |
| | (0.107) | (0.055) |
| KeyUG Other | 0.616*** | 0.548*** |
| | (0.081) | (0.051) |
| Observations (person-waves) | 3,335 | 2,355 |

Note: Robust standard errors in parentheses. Clustering at the individual level for pooled OLS. * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$. OrdinUG and KeyUG stand for Ordinary and Key Universities, respectively. Same control variables as in Table 3. The full set of results in both the outcome and treatment equations (except for survey year dummies) are presented in Tables A2 and A3 in the Appendix.