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Dynamics of returns to vocational education in China: 2010-2017

Jie Chen*, Francesco Pastore†

Abstract

In this paper, we use the Chinese General Social Survey data (2010-2017) to analyse the returns to different education qualifications. We additionally compare the returns to vocational education with returns to academic education, at both the upper secondary level and the tertiary level. Compared to those who only complete compulsory education, upper secondary graduates earn about 20% more, vocational college graduates earn 50%, and academic university graduates earn 75% more. At tertiary level, academic education pays better than vocational education, although the difference shrinks over the years. At upper secondary level, the evidence is indeterminate, depending on different econometric techniques (i.e., OLS, IV, Lewbel method, or PSM). These findings add to the limited quantitative evidence on returns to vocational education. The dynamics emerged from the findings echo the discussion on labor market mismatch and overeducation in China, which has important policy implications.

Keywords: dynamic; vocational education; academic education; upper secondary; tertiary; China

JEL Classification: I26, I25, J24, J31, C36

Declarations

Conflicts of interest: None.

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1 Introduction

The vocational education and training sector has been at the heart of recent economic reforms all over the world (Chappell, 2003; Tran, 2021). As the economy develops, more high value-added industries will substitute low value-added industries (Loyalka et al., 2015). Consequently, the demand for high-skilled workers grows. The positive relationship between economic development and demand for skilled workers has been observed in many developing countries in recent years. To better prepare future graduates for the job market, a country’s education system has to evolve accordingly. Vocational education thus plays a vital role in a country’s education system (Tran, 2021; Patrinos et al., 2021).

As one of the world’s largest and most vibrant economic entities, China is no exception in upgrading its vocational education and training system. China’s rapid economic growth sees a dramatic increase in the demand of high-skilled workers Heckman and Yi (2012). However, as a result of a long-standing tradition of degrading vocational graduates, lower secondary graduates are reluctant to pursue a vocational degree unless their academic performance is too poor for an academic degree (Hansen and Woronov, 2013). Figure 1 presents the share of individuals with different education qualifications in China over the period 2010-2017. From Figure 1(a), we see that the largest proportion of individuals only completed lower secondary education; around 14% completed academic upper secondary education while only around 9% completed vocational upper secondary education; from 2010-2013 to 2015-2017, there is a shift from lower education qualifications to higher education qualifications, reflecting an overall improvement in the quality of labor supply. Figure 1(b) shows that the story is similar when we zoom into the young cohort. Notably though, in 2015-2017, the share of academic university graduates surpasses the share of lower secondary graduates. This seemingly surprising result is a clear signal of the consequence of higher education massification¹.

Despite the upsurge in the supply of academic university graduates, employers in China still face a supply shortage of skilled labors. This is for two reasons. On the one hand, curricula of academic universities are theory-oriented and do not really prepare students for skill-intensive jobs. On the other hand, academic university graduates prefer “white-collar” jobs and are reluctant to do “blue-collar” jobs. Consequently, the supply and demand of labor constantly mismatch. To alleviate the shortage of supply of skilled workers, the Chinese government has been actively promoting vocational education since the 1990s. Yet, skilled workers are still under-supplied in the labor market (Fudan University, 2016). Two reasons likely have contributed to this perpetuating supply shortage. One reason is that the culture of degrading vocational graduates persists, discouraging parents from sending their child to vocational institutes in the first place. The other reason is that the returns to vocational education in the labor market is not high enough to attract sufficient students. In this paper, we speak to the second reason by looking at returns to different education qualifications, especially vocational education ones, in China.

¹See Meng (2012); Mok and Marginson (2021); Dai and Martins (2020) for discussions on the higher education massification in China.

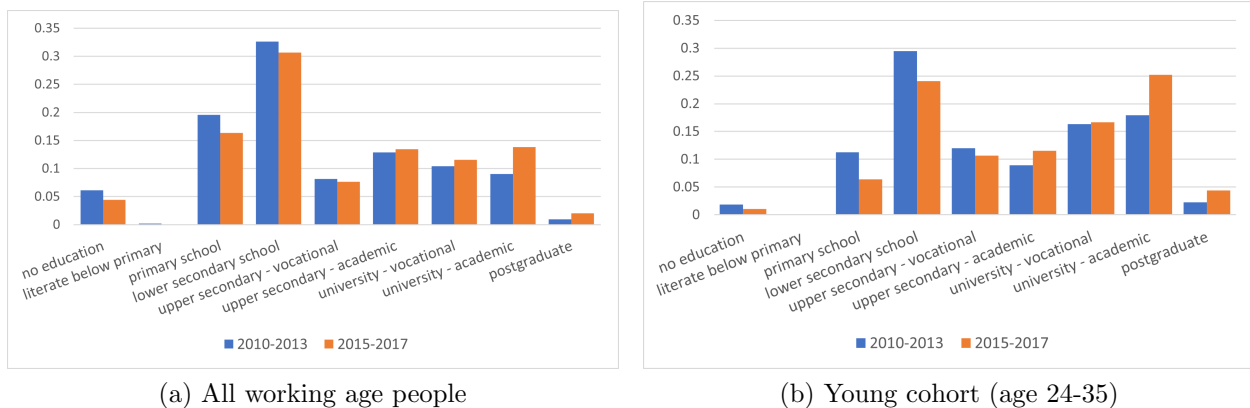


Figure 1: Share of graduates by education qualifications

This paper adds to the literature in the following aspects. First, we estimate the returns to different education qualifications in China during 2010-2017, focusing on vocational education qualifications. Second, rigorous econometric techniques (i.e., conventional IV, heteroskedasticity-based Lewbel (Lewbel, 2012) IV) are applied to compare the returns to vocational education and academic education, both at the upper secondary level and at the tertiary level. Third, and related to the second aspect, we apply a novel instrument, which is the proportion of university graduates relative to the entire population per year, in the IV estimations. Additionally, we replicate the enrolment ratio IV as is used in Dai and Martins (2020). We find similar “wage premium” enjoyed by vocational graduates as opposed to academic graduates using the same instrument, however the “premium” disappeared when more rigorous econometric techniques are used to check the robustness of the result. Last but not least, we tie the discussion of the dynamics in the returns to different education qualifications with the ongoing vocational education reforms in China, providing international readers with an enriched picture of vocational education in China.

This paper is structured as follows. In Section 2, we summarize the related literature. In Section 3, we provide the research context of the education system in China and describe the data. In Section 4, the methodology is discussed. Section 5 presents the results. We conclude in Section 6.

2 Literature review

Vocational education has attracted much attention in recent decades, especially after the massification of higher education in developed countries and recently in some developing countries (Meng, 2012; Mok and Marginson, 2021).

Brunello and Rocco (2017) classify vocational and academic education in four groups, similar as our classification, namely vocational upper secondary, academic upper secondary, vocational tertiary, and academic tertiary education. Note that although Brunello and Rocco (2017) do not differentiate college from university, in our classification, we treat vocational colleges differently from academic universities, for reasons we will explain in Section 3.2. Us-

ing Inverse Probability Weighted Regression Adjusted method, they find that, at secondary or post-secondary level (ISCED 3 and 4), vocational education accrues slightly (1.3% for males and 4.8% for females) lower hourly returns compared to academic education. Meanwhile, they find that the difference in return between vocational and academic education becomes much substantial at the tertiary level (ISCED 5) - around 20%.

Using the 2017 Household Labour Force Survey in Turkey, Patrinos et al. (2021) find that returns to academic upper secondary education pays better than vocational upper secondary education in Turkey, whereas Psacharopoulos and Patrinos (2018) find the opposite. Choi et al. (2019) find that employers in one Vietnamese city appreciate work experience more than they do the level of education, whereas employers in a different city put higher weight on the level of education. Using Mincerian equation and census data from 1983 in Israel, Neuman and Ziderman (1991) find that vocational education, when matched with occupation, relates to a 10% increase in earnings compared to academic education. Patrinos et al. (2021) find that private returns to vocational secondary graduates are higher than those to academic graduates. Although studies on returns to education are abound, country-specific studies are essential and cannot be substituted (Psacharopoulos and Patrinos, 2018).

China has a long tradition of discriminating vocational graduates (Schulte, 2013). Even parents in rural areas are reluctant to send a child to a vocational institute unless getting into an academic upper secondary school is impossible (Hansen and Woronov, 2013). As a result of the tradition, good students try to avoid vocational education if they can, which further lowers the quality of vocational graduates and perpetuates the vicious cycle.

The Chinese government and China's industries demand specialised, technically adept workers, meaning that vocational graduates face favorable policies (Schulte, 2013). The 1978 Reform and Opening-up created countless job opportunities requiring skilled workers which were in short supply back then. The Chinese government have thus been encouraging establishments of both upper secondary vocational schools and vocational universities, the former being solely application-oriented and the latter bearing a higher proportion of theory. However, the massification of higher education since 1999 escalates the supply of university graduates, both academic ones and vocational ones (Dai and Martins, 2020). Both kinds of university graduates then have to compete in the same job market. As the increasing rates of university graduates are much higher than those of positions requiring skilled workers, job market competition has soared and academic graduates have had to compete with vocational graduates. On the one hand, we see high-quality vocational workers are in short supply. On the other hand, we see high-quality vocational workers are in great demand. To cope with this dilemma in the job market, the government has been pouring in policies and financial supports to boost the supply of vocational workers (examples of related policies can be found in Section 3.1).

In the existing education literature in China (and neighbouring countries such as Japan and Korea), the focus has been largely on academic stream education but not vocational stream education (Hansen and Woronov, 2013). However, very limited evidence explores the returns to vocational education, especially vocational upper secondary education in devel-

oping countries including China (exceptions are Li et al. (2012); Loyalka et al. (2015)). The lack of relevant evidence is partly due to data unavailability (Guo and Wang, 2020).

Using the 2003-2015 Chinese General Social Survey data on all workers, Dai and Martins (2020) compare returns to upper secondary vocational education versus returns to upper secondary academic education in China. In the baseline estimations, the authors adopt the Mincerian equation (Mincer, 1974) with a dummy indicating whether an individual attended vocational or academic upper secondary education. They further investigate heterogeneous effects of vocational education using the instrumental variable quantile regression method. The instrument was the quota of upper secondary enrolment relative to that of low secondary enrolment, which is determined by the Chinese government and varies across locations and years. They find that, although secondary vocational graduates do not enjoy wage premia over secondary vocational graduates on average in OLS regressions, secondary vocational education does result in more than 30% wage premia for individuals with average earnings potential when estimated by instrumental variable quantile regressions.

Using CGSS survey data from 2008, Guo and Wang (2020) take propensity score approach and find that vocational upper secondary education attracts significantly higher private returns, especially for academically low-performing students, compared to academic upper secondary education. The overall premium of attending vocational education is around 8-8.4%. To account for endogeneity due to potential unobservable factors, the authors also adopted an instrumental variable method in their estimation. The instrument was a dummy which equals one if an individual's enrolment year is after 1985 and zero otherwise. This instrument results from a policy shock that supposedly increased the likelihood of an individual getting enrolled into vocational upper secondary education.

Loyalka et al. (2015) carried out a two-wave longitudinal study involving 10,071 first-year computer-majored students among 259 upper secondary schools in two provinces in China. To investigate the effect of attending vocational upper secondary schools, the authors primarily rely on OLS regressions and instrumental variable analyses. The instrument is a student's High School Entrance Exam score relative to the county-level cutoff score for entrance to an academic upper secondary school. As a robustness check, the authors also adopt Coarsened Exact Matching (CEM) analyses. They find that attending vocational upper secondary school negatively affects a student's general skill by 0.30-0.44 SDs (as measured by math score) and does not significantly improve a student's specific skills (as measured by computer skills). If anything, attending a vocational high school seems to detract a student from accumulating human capital. In the same vein, the authors also find that students in vocational schools are significantly more likely to drop out compared to students in academic schools, with a particularly high drop-out rate among low-income and low-ability students. A similar paper with a two-wave longitudinal study involving more than 12,000 students in one Chinese province has similar findings Yi et al. (2018).

Using data of twins in urban China, Li et al. (2012) find that returns to upper secondary vocational education is around 22%, whereas return to academic upper secondary education is not statistically different from return of compulsory education. Their finding is in drastic

contrast with the most recent findings from Dai and Martins (2020). The difference in these two studies can be attributed to several reasons. First, it signals a potential shift in the supply and demand of vocational graduates due to the massive expansion and promotion of vocational education in the recent decades. In any case, these differences call upon further investigation regarding returns to vocational education, a gap that our research aims to fill in.

3 Research context

3.1 The education system in China

The current education system in China mainly consists of two stages. The first stage is compulsory and lasts 9 years - 6-year primary education plus 3-year lower secondary education.² The *Compulsory Education Law of the People's Republic of China* was enacted in 1986. The *law* urged all provinces to implement the 9-year compulsory education according to local economic and cultural development. In 2006, the *law* was revised and mandated 9-year compulsory education nationwide. The second stage is competitive and thus non-compulsory, including upper secondary level education and those above.

Figure 2 illustrates the major progression paths in the Chinese education system. As can be seen, a student normally sits in the High-school Entrance Exam (HEE) after completing the compulsory education. Depending on his performance in the exam, he may enter an academic upper secondary school or a vocational upper secondary school. The upper secondary education normally lasts three years, after which students compete to enter tertiary level education or directly enter the job market. The path to tertiary education is different for academic students and vocational students. An academic upper secondary graduate has to attend the College Entrance Examination to enter tertiary education. Depending on her performance, she may end up in an academic university or a vocational college. Meanwhile, a vocational upper secondary graduate only needs to attend a transitional exam, which is normally carried out by individual vocational colleges, to progress to a vocational college. Although the latter path to tertiary education seems easier, it is less attractive to students for two reasons. First, the latter path eliminates the possibility of directly entering an academic university which is more highly valued in the current job market. Second, the latter path makes it hard to continue pursuing postgraduate degrees. According to the current education policy, a vocational college graduate cannot directly attend the Graduate Entrance Exam, a necessary path for general undergraduates to progress to postgraduate education. To qualify for the Graduate Entrance Exam, the vocational college graduate has to either work two years after graduation or take a specific test - *zhuanshengben* (vocational-to-academic test) - to pursue an academic university degree with one or two additional years.

In China, vocational education and vocational training are different. Vocational education is school-based and earns a degree whereas vocational training is work-based and does not earn a degree. Our focus is on the former, which is a kind of education qualifications. The

²In some places, the primary education takes 5 years and the lower secondary education takes 4 years, still summing up to 9 years in total

Chinese government has specific requirements regarding the design of vocational education programs. First, a total of 19 areas (corresponding to 1349 majors), which cover all sectors of the economy, are set by the *Professional Catalogue of Vocational Education* issued by the Ministry of Education. Design of vocational majors should be within the catalogue. Second, individual curricula should be designed following the national guidelines. Third, practical training should be no less than 50% of the total credit hours of the vocational education degree.

In 1996, the Chinese government enacted the *Vocational Education Law of the People's Republic of China*, setting out official standards for vocational education in China. Since then, vocational education has received much attention and resources from the government. In 2005, the Chinese government announced *Decision of the State Council on Vigorously Developing Vocational Education*, which stimulated a rapid growth period of vocational education. For example, from 2005 to 2017 the national financial funds for vocational education reached 2.7 trillion yuan.³ As of 2017, the total investment in vocational education was about 434 billion yuan, nearly five times that of 93.9 billion yuan in 2005, with an average annual growth rate of 14%.

³Manually calculated by the authors from the MoE documents.

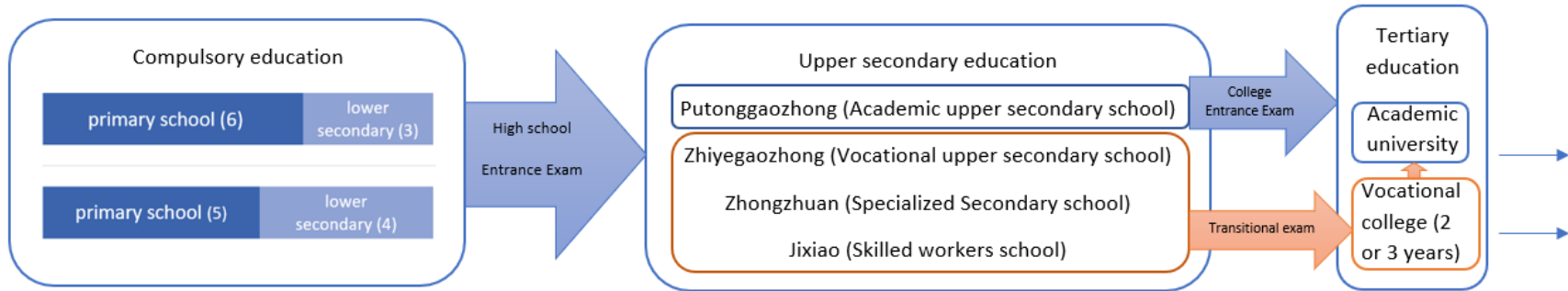


Figure 2: Education system in China

Note: 1. Although three types of vocational schools exist at the upper secondary level, they are generally grouped together in empirical analysis. We follow this convention in our paper. 2. To enter *Dazhuan* (vocational college) after completing the compulsory education, a student may sit in the High-school Entrance Exam or attend selective tests prepared by individual vocational colleges.

3.2 Data description

The Chinese General Social Survey (CGSS), one of the nationally representative surveys in China, is a repeated cross-sectional survey project that was launched in 2003. The survey adopts a multi-stage stratified sampling method, covering households from all 31 mainland provinces.⁴ Starting in 2010, a modified sampling method is adopted to collect a more representative sample nationwide. In this paper, we analyze six annual survey datasets collected from 2010 to 2017 (except for 2014 and 2016, due to data unavailability). The 2017 data was released in 2020, and is the latest dataset available. After dropping observations without annual wage entries, we are left with a total of 27,545 observations. Table 1 summarizes the main variables of interest. The average hourly wage across all six years is 15.391 yuan, consistent with existing literature (Asadullah and Xiao, 2020; Dai and Martins, 2020).

In the summary statistics, the years of education is constructed by mapping the Chinese education system onto the International Standard Classification of Education⁵. Note that because it typically takes three years to complete vocational education at tertiary level and four years to complete academic education at tertiary level in China, the years corresponding to vocational education are one year shorter than those of academic education. Following the convention in the literature (Kang et al., 2021), vocational tertiary education is referred to as *vocational college* and academic tertiary education is referred to as *academic university* throughout this paper. In our econometric analysis, we treat the education qualifications as dummies. The actual years of education is irrelevant when we focus on the two types of upper secondary education, both of which typically last three years. The years of education is controlled when we investigate other education qualifications.

The average years of work experience for a waged worker are 29.08. Female composes about 41.2% of the sample. Ethnically, only less than 9% are from a minority group. 60.3% of the sample have an agricultural *hukou*. 15.0% of the sample are union members, whereas 11.6% are communist party members. The average years of education are 5.72 for father and 3.97 for mothers. 82.6% of the sampled are married and 10.5% remain single. As for education qualifications, more than 56.3% of the sample only attended compulsory or less education. 8.0% finished vocational upper secondary education, whereas 13.1% finished academic upper secondary education. Roughly the same proportion - around 10.7% - of vocational college graduates and academic university graduates are observed in the sample. Only 1.3 out of 100 completed postgraduate and above level of education. In terms of occupation sector, more than 33.9% of the sampled subjects are in the agricultural sector. More than 38.3% work in privately owned enterprise. 20.2% work in state owned enterprise, followed by collectively owned enterprise, foreign funded enterprise, and Hong Kong, Macau or Taiwan funded enterprise. Location-wise, 37.6% are from the eastern provinces, 26.5% are from the western ones, 23.1% are from the central, and 12.8% are from the northeast

⁴A detailed description of the sampling method used can be found [here](#).

⁵The mapping follows Chen and Pastore (2021). Specifically, compulsory education = 9 years, upper secondary education = 12 years, vocational college = 15 years, academic university=16 years, master's education and above = 19 years.

provinces.⁶

Figure 3 shows the relationship between change in employment rate and the share of individuals with certain degree. Each dot corresponds to an industrial sector categorized following ISCO2008 two-digit codes.⁷ In all four figures, the vertical axis represents the sector-wise change in employment from 2010 to 2017. The horizontal axis captures the share of tertiary graduates (in figures (a) and (c)) or upper secondary graduates (in figures (b) and (d)). Figure 3(a) and Figure 3(b) are for all the working age subjects, whereas (c) and (d) are for the young cohort aged 24-35. Comparing the figures horizontally, we see that the majority of sectors cluster around the left end in (a) and the distribution spreads more evenly in (b). In other words, in most of the sectors, upper-secondary degree holders are relatively common whereas university degree holders are rare (mostly occupying less than 10% of the population in a sector). Comparing the figures vertically, the share of tertiary graduates are less clustered for the young cohort as opposed to the entire working age group, indicating that workers with tertiary degrees are more common in most sectors; the share of upper secondary graduates are more clustered on the right end for the young cohort as opposed to the entire working age group, indicating upper-secondary degree holders also become more common. Additionally, the figures manifest one constantly expanding sector (i.e., 52 - Sales Workers) and one constantly shrinking sector (i.e., 1 - rural agriculture). The expansion of the sales sector echos the massive growth of Chinese market, especially the housing market, in the past decade. The compression of the rural agriculture sector corroborates the well-known rural-urban migration in China.

⁶The geographical classification of locations is according to the National Bureau of Statistics in China.

⁷except sector number 1, which correspond to *rural agriculture*, distinct from the commonly understood agriculture, as a result of the Chinese *hukou* system. *hukou* is a registration system in China that separates its population into rural and urban populations, restricting the former's mobility and access to state-sponsored benefits and welfare.

Table 1: Summary statistics of waged workers, 2010-2017

| Variable | Mean | SD | Max. | Min. | N |
|--|--------|--------|---------|--------|-------|
| Hourly wage | 15.391 | 26.064 | 400.641 | 0.003 | 27545 |
| Ln hourly wage | 2.028 | 1.219 | 5.993 | -5.966 | 27545 |
| Years of education | 10.075 | 4.171 | 19 | 0 | 27533 |
| Years of experience | 29.084 | 12.508 | 62 | 0 | 27533 |
| Age | 40.198 | 10.170 | 60 | 18 | 27545 |
| Gender (female=1) | 0.412 | 0.492 | 1 | 0 | 27545 |
| Ethnicity (minority=1) | 0.087 | 0.282 | 1 | 0 | 27545 |
| Hukou (agricultural=1) | 0.603 | 0.489 | 1 | 0 | 27545 |
| Union (yes=1) | 0.150 | 0.358 | 1 | 0 | 27307 |
| Party member (yes=1) | 0.116 | 0.320 | 1 | 0 | 27468 |
| Father education | 5.719 | 4.619 | 19 | 0 | 26653 |
| Mother education | 3.967 | 4.412 | 19 | 0 | 26939 |
| Marital status | | | | | |
| Single | 0.105 | 0.306 | 1 | 0 | 27545 |
| De facto | 0.009 | 0.094 | 1 | 0 | 27545 |
| Married | 0.826 | 0.379 | 1 | 0 | 27545 |
| Re-married | 0.016 | 0.126 | 1 | 0 | 27545 |
| Separated | 0.007 | 0.083 | 1 | 0 | 27545 |
| Divorced | 0.023 | 0.151 | 1 | 0 | 27545 |
| Widowed | 0.014 | 0.117 | 1 | 0 | 27545 |
| Education qualification | | | | | |
| Compulsory education and below (baseline) | 0.563 | 0.496 | 1 | 0 | 27533 |
| Upper secondary - vocational | 0.080 | 0.271 | 1 | 0 | 27533 |
| Upper secondary - academic | 0.131 | 0.337 | 1 | 0 | 27533 |
| Vocational college | 0.108 | 0.310 | 1 | 0 | 27533 |
| Academic university | 0.106 | 0.308 | 1 | 0 | 27533 |
| Postgraduate and above | 0.013 | 0.112 | 1 | 0 | 27533 |
| Occupation | | | | | |
| Agricultural job (baseline) | 0.339 | 0.473 | 1 | 0 | 20920 |
| State owned enterprise | 0.202 | 0.402 | 1 | 0 | 20920 |
| Collectively owned enterprise | 0.052 | 0.223 | 1 | 0 | 20920 |
| Privately owned enterprise | 0.383 | 0.486 | 1 | 0 | 20920 |
| Hong Kong, Macau or Taiwan funded enterprise | 0.005 | 0.070 | 1 | 0 | 20920 |
| Foreign funded enterprise | 0.018 | 0.133 | 1 | 0 | 20920 |
| Location | | | | | |
| Eastern | 0.376 | 0.484 | 1 | 0 | 27545 |
| Central | 0.231 | 0.421 | 1 | 0 | 27545 |
| Western | 0.265 | 0.441 | 1 | 0 | 27545 |
| Northeast | 0.128 | 0.335 | 1 | 0 | 27545 |
| Instruments | | | | | |
| $E_{ratio_{vus}}$ | 0.236 | 0.090 | 0.490 | 0.044 | 6471 |
| $E_{ratio_{aus}}$ | 0.343 | 0.129 | 0.678 | 0.137 | 6471 |
| Lost parent at age 14 | 0.077 | 0.266 | 1 | 0 | 24501 |

Notes: the data include waged workers from the Chinese General Social Survey in 2010, 2011, 2012, 2013, 2015, and 2017. ‘Years of experience’ equals age minus the sum of years of education and 6 (the legal school entry age in China).

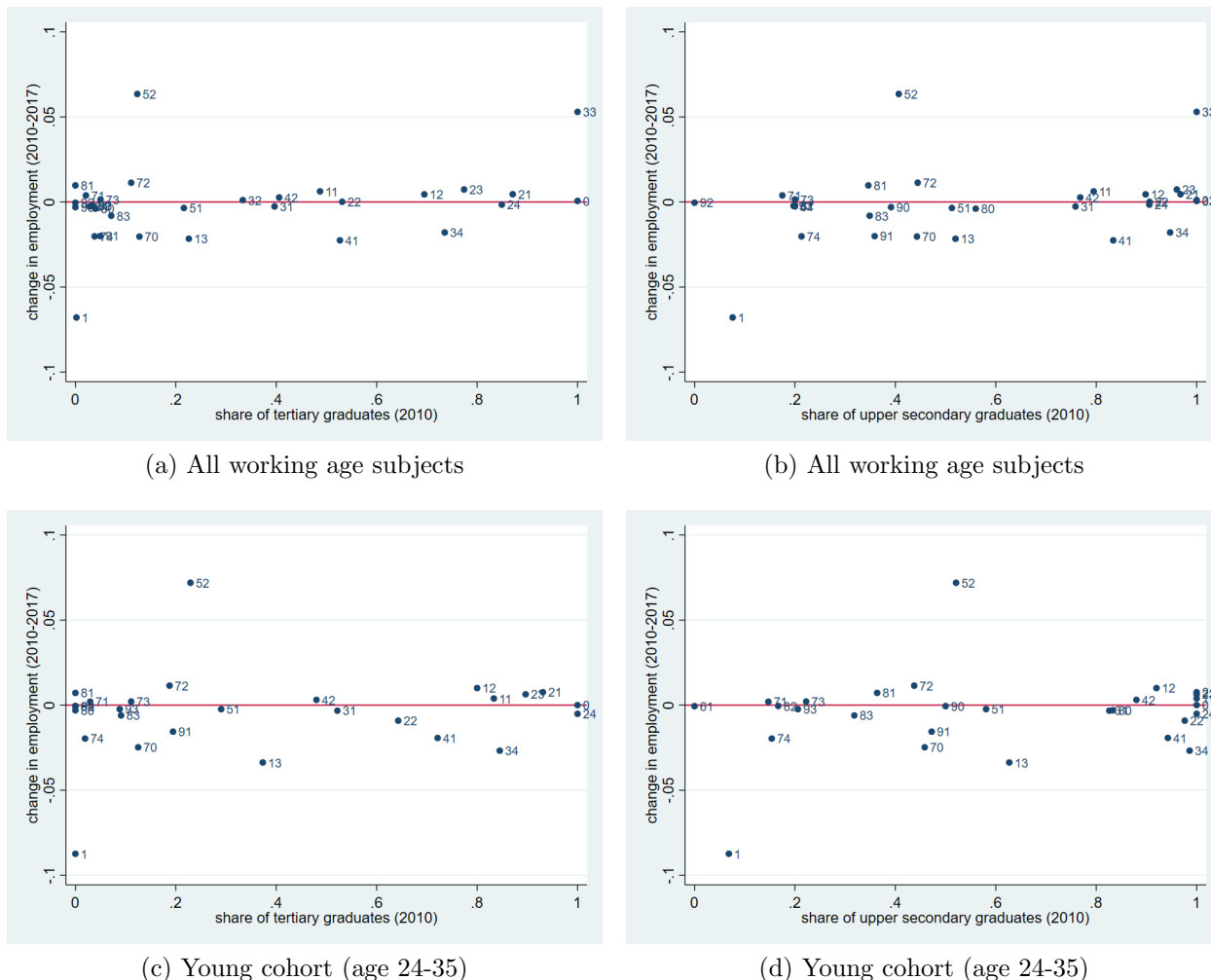


Figure 3: Change in employment rate vs. share of workers with university/higher-secondary degree

Notes: The sector classifications are according to International Standard Classification of Occupations (2008 edition) developed by International Labor Office, except Sector 1 (please see footnote 7 for detailed explanation). 0-Armed Forces Occupations; 1-rural agriculture; 11-Chief Executives, Senior Officials and Legislators; 12-Administrative and Commercial Managers; 13-Production and Specialized Services Managers; 20-Professionals; 21-Science and Engineering Professionals; 22-Health Professionals; 23-Teaching Professionals; 24-Business and Administration Professionals; 30-Technicians and Associate Professionals; 31-Science and Engineering Associate Professionals; 32- Health Associate Professionals; 33-Business and Administration Associate Professionals; 34-Legal, Social, Cultural and Related Associate Professionals; 40-Clerical Support Workers; 41-General and Keyboard Clerks; 42-Customer Services Clerks; 50-Services and Sales Workers; 51-Personal Services Workers; 52-Sales Workers; 61-Market-oriented Skilled Agricultural Workers; 63-Subsistence Farmers, Fishers, Hunters and Gatherers; 70-Craft and Related Trades Workers; 71-Building and Related Trades Workers (excluding Electricians); 72-Metal, Machinery and Related Trades Workers; 73-Handicraft and Printing Workers; 74-Electrical and Electronic Trades Workers; 80-Plant and Machine Operators and Assemblers; 81-Stationary Plant and Machine Operators; 82-Assemblers; 83-Drivers and Mobile Plant Operators; 90-Elementary Occupations; 91-Cleaners and Helpers; 92-Agricultural, Forestry and Fishery Labourers; 93-Labourers in Mining, Construction, Manufacturing and Transport. Employment rate in year $t = \frac{\text{number of subjects in sector } i}{\text{labor force in year } t}$

4 Methodology

To estimate the returns to different education qualifications, we apply baseline estimation strategy as explained in Section 4.1. Because we are also interested in comparing the returns to same-level academic and vocational education, we apply various other techniques to address endogeneity problem and identify causality in the comparison, which simultaneously serve as robustness checks of the baseline comparison. These additional techniques are explained in Section 4.2 to Section 4.4.

4.1 Baseline estimation

Our baseline estimation strategy is the extended Mincerian equation (Mincer, 1974; Duraisamy, 2002; Psacharopoulos, 1994). The classical semi-logarithmic functional form is as follows.

$$Y = \alpha + \beta_i edu_i + \gamma X + \epsilon$$

where Y is the natural logarithm of hourly working income. edu_i is a vector of dummies corresponding to different education qualifications, with the baseline group being those who have completed the 9-year compulsory education at most. X is a list of controlled covariates including years of work experience, experience-squared, gender, marital status, ethnicity, *hukou* status, union membership, party membership, the occupation sector, and the province/location in which one completed the survey. Specifically, province fixed effect is controlled in the OLS regression. In all later regressions, provinces are grouped into four regions to avoid over-controlling dummies. We also control for the interaction between marital status and gender, as existing literature has demonstrated marital status affects men and women’s earnings differently (Antonovics and Town, 2004; Juhn and McCue, 2017; Chen and Pastore, 2021). We additionally control for parents’ years of education, as Card (1999) noted that family background measures such as parental education typically positively affect earnings.

When education qualifications are controlled as dummies, scholars typically utilise the following formula in calculating the yearly returns corresponding to a specific education qualification (Duraisamy, 2002).

$$r_i = \frac{\beta_i - \beta_{i-1}}{t_i - t_{i-1}}$$

where r_i represents the yearly return rate to education qualification edu_i . β_i and β_{i-1} are the returns to education qualification at the i th and $i - 1$ th level. t and $t - 1$ are the years of schooling corresponding to their respective qualifications. In our case, both the vocational and the academic upper secondary education typically last three years. Both types of upper secondary education also share the same baseline group (i.e., compulsory and below level of education). Thus, comparing the statistical difference between r_i and r_{i-1} is equivalent to comparing β_i and β_{i-1} directly. Clearly, if one is to obtain the yearly returns, one still needs to convert β_i to r_i .

4.2 Instrumental variables

The Durbin and Wu–Hausman test weakly rejects the hypothesis that the choice of vocational upper secondary education against academic upper secondary education is exogenous. Thus utilising Instrumental Variable (IV) method is necessary.

IV method is often susceptible to the choice of IVs. To provide robust IV estimates, we try several seemingly feasible IVs in this paper and compare their estimates. The first IV is the proportion of university (including colleges) graduates over the total population by year. Figure 4 plots the proportion of university graduates over the total population from year 1978 to 2019. We see that the proportion of university graduates increased slowly before 2000 and surged after that. The dramatic change is due the higher education expansion in 1999 (Meng, 2012; Meng et al., 2013; Zhong, 2011). This variable is *exogenous* in that any

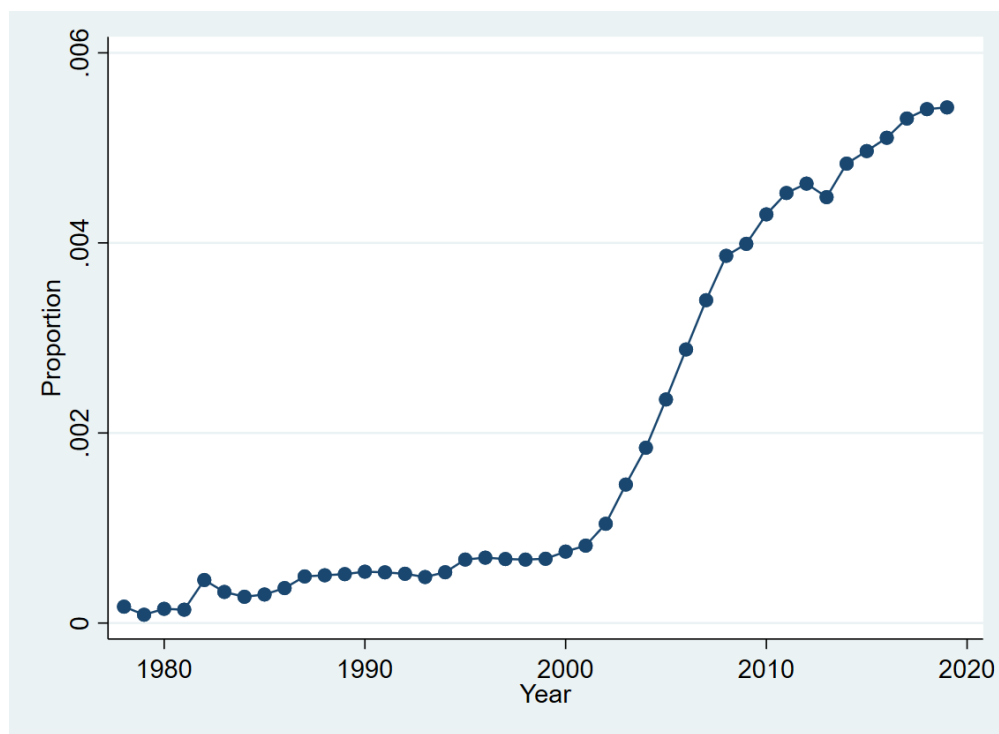


Figure 4: Proportion of university graduates relative to total population

Note: Data are manually extracted by the authors from China State Statistical Bureau.

individual decision cannot affect the proportions over the years. This is particularly true if we think about the year in which the expansion policy is announced: the change in proportions is mainly out of a policy shock. The variable is *relevant* in that the changes in the proportion of university graduates will relate to the changes in upper secondary graduates. Hence, the proportion of university graduates over the total population is a valid instrument.

The second instrument is the upper secondary enrolment ratio, the number of vocational upper secondary students enrolled over the number of lower secondary graduates, by

province. Enrolment ratio has been used as instrument in Dai and Martins (2020); Chen and Pastore (2021). To construct the enrolment ratio, we first extract the number of lower secondary graduates and the number of students enrolled in vocational upper secondary schools from the Educational Statistics Yearbook of China from 1987 to 2015. Then we calculate $Eratio_{vus}$, which is the average of province-level enrolment ratios each year. A province-level enrolment ratio is defined as the number of students enrolled in vocational upper secondary schools in year t in a province divided by the number of lower secondary graduates in year t in the same province. A graphical representation of the $Eratio_{vus}$ can be found in Figure 5. As a robustness check, we have also replicated Figure 7 in Dai and Martins (2020), which can be found in Figure 6 in the Appendix. Note that the two figures are slightly different, because the two sets of ratios are calculated differently. Instead of directly calculating the ratio at a national level which is done in Dai and Martins (2020), we choose to calculate province-level ratios first and then take the average of the ratios. This is because individual data are generally more precise than aggregate data and thus are preferred over aggregate data (Firebaugh, 1978). Compared to the enrolment ratio for academic upper secondary schools, the vocational enrolment ratio remains rather steady with slow increase. One interesting thing to note is that the enrolment ratio for higher education overlaps largely with the enrolment ratio for academic upper secondary education. The quota is *relevant* in that it can predict the probability of a student entering the vocational upper secondary education in a specific province in a given year. The quota is *exogenous* because there are strong reasons to believe that enrolment ratio does not affect one's income several years later (Chen and Pastore, 2021).

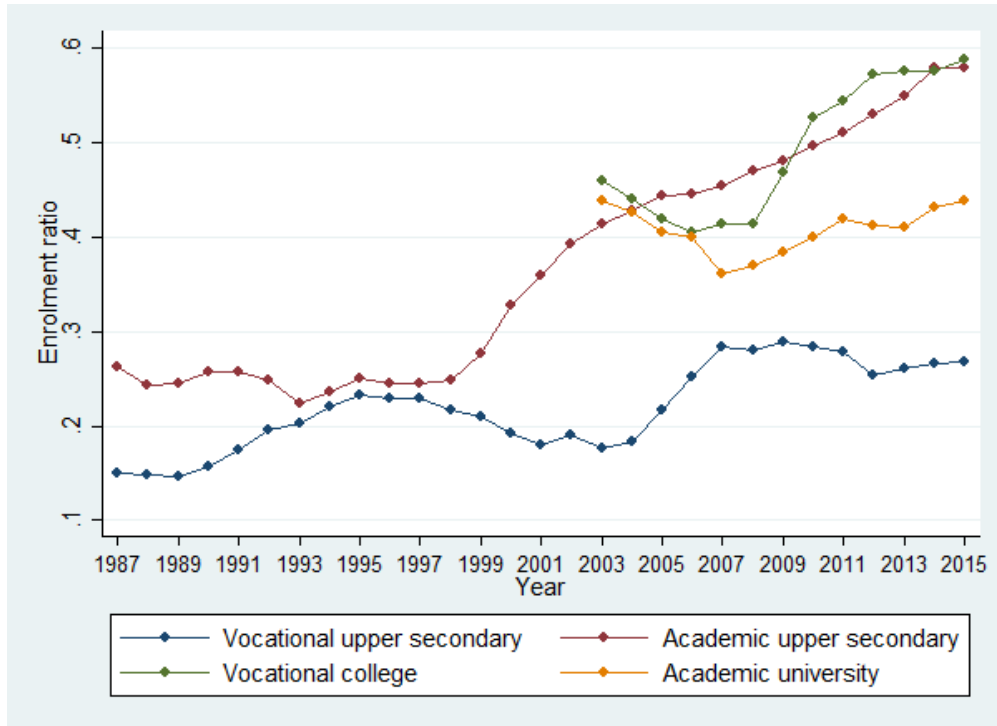


Figure 5: Enrolment ratio

Note: Each enrolment ratio is an average of the province-level enrolment ratios. A province-level vocational / academic upper secondary education ratio equals the number of students enrolled in vocational / academic upper secondary education in a year in a province over the number of lower secondary graduates in the same year and the same province. Vocational college (academic university) enrolment ratio equals the number of students enrolled in vocational colleges (academic universities) in a year over the number of upper secondary graduates in the same year. Data are compiled by the authors from China Educational Yearbook (1987-2015).

In the third IV specification, we apply the conventionally used parental education and compare the results across three specifications. The purpose of doing this is to benchmark our results to more conventional specifications and facilitate understanding of our results. Similarly, the fourth IV is a dummy which equals one if the enrolment year to upper secondary education is after 1985 and zero otherwise. This IV is identical to that in Guo and Wang (2020). The rationale of this IV is that a policy shock that supposedly boosts enrolment to vocational upper secondary education is announced in 1985. The IV is included for comparison purpose as well.

4.3 Lewbel method

In addition to the conventional IV method, we also apply a heteroskedasticity-based instrumental method introduced in Lewbel (2012); Baum and Lewbel (2019). This method can utilise the heteroskedasticity in the error term of the reduced form equation to construct instruments when no external instruments are available. It can also serve as a robustness check and validity test of external instruments (Baum and Lewbel, 2019).

This method has three key assumptions. Although the method may still work when these assumptions do not hold, it is more likely to be appropriate if there is evidence that these assumptions (should) hold (Baum and Lewbel, 2019). The first assumption essentially states that the endogeneity of the instrumented variable comes from an error component that appears in both the structural form and the reduced form equations. In the case of returns to education, the error component can be unobserved ability which affects both wages and education (Baum and Lewbel, 2019). The second assumption says that if the structural model is correctly specified, then the remaining errors are idiosyncratic. Since we largely follow the convention of extended Mincerian equations in our model specifications, it is reasonable to expect that the second assumption holds. The third assumption, if satisfied, ensures that the constructed instruments are indeed correlated with the endogenous variable. Providing that the second assumption holds, the third assumption essentially says that the error term of the reduced form is heteroskedastic. This assumption is testable via a Breusch-Pagan test.

4.4 Propensity score matching

When comparing the returns to vocational upper secondary and academic upper secondary education, one challenge is that students from those two tracks may differ in various characteristics before they enter the upper secondary education. For example, boys may prefer vocational education while girls may prefer academic education, or rural students may prefer vocational education while urban students prefer academic education. To maximize the possibility of comparing the like with the like, we also apply propensity score matching (PSM) method. The PSM method assigns observations into the treatment group and the control group, then it estimates propensity scores for each observation based on pre-treatment characteristics, and comparisons are done between observations with closely matched propensity scores. In this paper, nearest neighbor matching is used, meaning for each treatment observation, one control observation with the closest propensity score is chosen for comparison. In our case, subjects are matched based on experience, gender, ethnicity,

hukou, parental education, union membership, and party membership.

5 Results

5.1 Returns to different education qualifications

Table 2 presents the OLS estimates of the extended Mincerian equation. Noting that we have controlled for a rich set of variables, we perform the multicollinearity test using the Variance Inflation Factor. No multicollinearity is detected. Overall, compared to the baseline group who only complete compulsory education, those who complete vocational upper secondary education earns 24.5% more, those who complete academic upper secondary education earns 19.5% more, those who complete vocational college education earns 51.4% more, those who complete academic university earns 75.3% more, and those who complete postgraduate and above level of education earns 108.7%. Clearly, the returns to education increases with the level of education qualifications. From 2010 to 2017, returns to all types of education are increasing. Yet, returns to upper secondary education increase more substantially (vocational: 25.1%⁸, academic: 77.5%) than returns to tertiary and above levels of education (vocational: 24.1%, academic: 10.0%, postgraduate and above: 16.0%).

Comparing vocational education with academic education, we see that, returns to vocational upper secondary education (24.2%) are higher than returns to academic upper secondary education (19.5%). As for whether the difference is statistically significant, we relegate the comparison to Section 5.2. Looking through the six years, returns to academic upper secondary education seem to increase faster than returns to vocational upper secondary education. From the coefficients corresponding to marital status, we see there is almost a “wage transfer” from married females to married males. Specifically, if one is married and male then he gets a 28% increase in wages compared to a single male, whereas a married female gets a 21% decrease in wages compared to a married male. From 2010 to 2017, males seem to enjoy an increasing marriage premium from 23.2% to 30.9%, grown by more than a third. This implies that males are potentially even more highly valued in the Chinese labor market nowadays than ten years ago, a strong signal of workplace gender inequality. This finding is in line with a recent meta analysis on gender wage gap in China (Iwasaki and Ma, 2020), which states that in recent years the gender wage gap in China has grown rapidly.

Looking further down the table, we find that union membership no longer brings additional returns starting from 2015. Those with agricultural *hukou* tend to suffer a certain level of wage penalty. The minority ethnic groups are paid comparably to the *Han* ethnic group, indicating no ethnical discrimination. Party membership is related to a lower wage premium of 7% only when all the years are pooled together. Returns are generally positively related to parental education, in line with the mainstream literature. Compared to the baseline agricultural jobs, all five types of enterprises pay substantially higher wages across all the years, implying that the payment situation in agriculture has not improved much over the years. Probably, this is also why the Chinese government initiated the “rural revitalization (*xiangcunzhenxing*)” strategy in late 2017.

⁸As an example, the ratio is calculated as the following: $\frac{0.289-0.231}{0.231} = 25.1\%$.

Technically, because our OLS estimation is essentially a log-linear transformation of an exponential function, we can interpret the coefficients as semi-elasticity. In other words, the coefficients measure the percentage change in the hourly wage in response to any unit change in the independent variable (Pastore and Verashchagina, 2006). Because the education qualifications are dummies, the semi-elasticity interpretation can be more precise when transformed via $(e^\beta - 1) \times 100$ (Halvorsen et al., 1980). By its nature, the difference between the original estimates and the transformed coefficients gets larger with the coefficients increasing. The transformed coefficients are reported in Table 3. By and large, all the values based on the original semi-elasticity interpretation hold. However, we note the imprecision in the original estimates. As expected, the larger the coefficients, the more imprecise the semi-elastic measures are. For example, the returns to postgraduate and above level education is 108.7% in Table 2 but almost doubled to 196.6% in Table 3, underlying the importance of noting this caveat in future research.

Table 2: OLS estimates of ln hourly wage on education qualifications

| VARIABLES | (1) All years | (2) 2010 | (3) 2011 | (4) 2012 | (5) 2013 | (6) 2015 | (7) 2017 |
|--|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Education qualifications (Baseline: compulsory education and below) | | | | | | | |
| Vocational upper secondary | 0.245*** (0.024) | 0.231*** (0.057) | 0.210*** (0.079) | 0.202*** (0.048) | 0.244*** (0.049) | 0.264*** (0.070) | 0.289*** (0.066) |
| Academic upper secondary | 0.195*** (0.021) | 0.178*** (0.046) | 0.158** (0.072) | 0.126*** (0.042) | 0.209*** (0.046) | 0.200*** (0.061) | 0.316*** (0.060) |
| Vocational college | 0.514*** (0.024) | 0.506*** (0.058) | 0.371*** (0.084) | 0.439*** (0.050) | 0.522*** (0.049) | 0.625*** (0.065) | 0.628*** (0.060) |
| Academic university | 0.753*** (0.027) | 0.788*** (0.070) | 0.646*** (0.087) | 0.697*** (0.059) | 0.762*** (0.056) | 0.770*** (0.071) | 0.867*** (0.062) |
| Postgraduate and above | 1.087*** (0.055) | 1.190*** (0.130) | 0.763** (0.312) | 0.876*** (0.129) | 1.246*** (0.138) | 0.936*** (0.124) | 1.380*** (0.100) |
| Experience | 0.030*** (0.003) | 0.020*** (0.007) | 0.021** (0.010) | 0.042*** (0.006) | 0.040*** (0.006) | 0.041*** (0.007) | 0.032*** (0.006) |
| Experience squared | -0.001*** (0.000) | -0.000*** (0.000) | -0.000*** (0.000) | -0.001*** (0.000) | -0.001*** (0.000) | -0.001*** (0.000) | -0.001*** (0.000) |
| Female (yes=1) | -0.164*** (0.037) | -0.262*** (0.095) | -0.088 (0.123) | -0.274*** (0.096) | -0.020 (0.074) | -0.198** (0.092) | -0.049 (0.079) |
| Marital status (Baseline: single) | | | | | | | |
| De facto | 0.265*** (0.090) | 0.167 (0.356) | -0.906** (0.452) | 0.293** (0.126) | 0.090 (0.185) | 0.593* (0.345) | 0.659*** (0.170) |
| Married | 0.283*** (0.028) | 0.232*** (0.067) | 0.294*** (0.089) | 0.303*** (0.071) | 0.237*** (0.055) | 0.253*** (0.070) | 0.309*** (0.065) |
| Re-married | 0.365*** (0.080) | 0.022 (0.269) | 0.481* (0.257) | 0.452*** (0.175) | 0.355* (0.207) | 0.410*** (0.158) | 0.246** (0.119) |
| Separated | 0.092 (0.101) | 0.140 (0.148) | -1.782*** (0.178) | 0.130 (0.232) | 0.447 (0.344) | -0.501 (0.471) | 0.128 (0.179) |
| Divorced | 0.151** (0.066) | 0.005 (0.180) | 0.044 (0.197) | 0.232* (0.127) | 0.337** (0.137) | -0.124 (0.193) | 0.049 (0.159) |
| Widowed | 0.216** (0.104) | | 0.264 (0.226) | 0.512*** (0.198) | -0.094 (0.222) | 0.154 (0.210) | 0.291 (0.297) |
| Female x De facto | -0.146 (0.134) | 1.055 (1.657) | 0.254 (0.653) | -0.143 (0.190) | -0.261 (0.267) | -0.360 (0.376) | -0.424* (0.229) |
| Female x Married | -0.214*** (0.040) | -0.082 (0.100) | -0.344*** (0.130) | -0.131 (0.100) | -0.347*** (0.080) | -0.213** (0.100) | -0.298*** (0.087) |
| Female x Re-married | -0.282** (0.120) | -0.334 (0.470) | -0.630* (0.333) | -0.215 (0.254) | -0.347 (0.293) | -0.307 (0.250) | 0.027 (0.257) |
| Female x Separated | 0.093 (0.156) | 0.140 (0.203) | 1.700*** (0.376) | -0.416 (0.345) | 0.853 (1.252) | -0.052 (0.589) | 0.124 (0.388) |
| Female x Divorced | 0.008 (0.094) | 0.080 (0.229) | 0.112 (0.336) | 0.006 (0.177) | -0.421** (0.194) | 0.307 (0.246) | 0.118 (0.230) |
| Female x Widowed | -0.146 (0.138) | | -0.079 (0.317) | -0.398 (0.252) | 0.229 (0.310) | -0.071 (0.310) | -0.626* (0.347) |
| Union (yes=1) | 0.098*** (0.016) | 0.152*** (0.040) | 0.165*** (0.060) | 0.113*** (0.036) | 0.122*** (0.034) | -0.002 (0.046) | 0.003 (0.040) |
| hukou (agricultural=1) | -0.068*** (0.017) | -0.122*** (0.043) | -0.120** (0.057) | 0.003 (0.034) | -0.011 (0.037) | -0.015 (0.043) | -0.156*** (0.039) |
| Ethnicity (minority=1) | 0.016 (0.029) | -0.029 (0.058) | -0.062 (0.095) | 0.045 (0.063) | 0.087 (0.072) | 0.050 (0.082) | -0.050 (0.073) |
| Party member (yes=1) | 0.071*** (0.019) | 0.060 (0.045) | 0.108 (0.067) | 0.062 (0.040) | 0.120*** (0.043) | 0.022 (0.054) | 0.053 (0.048) |
| Mother education | 0.010*** (0.002) | 0.013*** (0.005) | 0.013** (0.007) | 0.013*** (0.004) | 0.009** (0.004) | -0.002 (0.006) | 0.006 (0.005) |
| Father education | 0.010*** (0.002) | 0.008* (0.004) | 0.010* (0.006) | 0.014*** (0.004) | 0.006 (0.004) | 0.018*** (0.006) | 0.006 (0.005) |
| Occupation - enterprise ownership (Baseline: agricultural job) | | | | | | | |
| State owned enterprise | 0.572*** (0.025) | 0.600*** (0.058) | 0.532*** (0.081) | 0.676*** (0.050) | 0.556*** (0.053) | 0.408*** (0.073) | 0.592*** (0.066) |
| Collectively owned enterprise | 0.450*** (0.030) | 0.457*** (0.068) | 0.221* (0.117) | 0.530*** (0.059) | 0.412*** (0.057) | 0.312*** (0.093) | 0.548*** (0.083) |
| Privately owned enterprise | 0.503*** (0.021) | 0.475*** (0.048) | 0.432*** (0.061) | 0.560*** (0.042) | 0.555*** (0.049) | 0.372*** (0.063) | 0.540*** (0.060) |
| Hong Kong, Macau or Taiwan funded enterprise | 0.587*** (0.071) | 0.671*** (0.198) | 0.541*** (0.201) | 0.724*** (0.139) | 0.604*** (0.140) | 0.482** (0.222) | 0.345*** (0.127) |
| Foreign funded enterprise | 0.687*** (0.044) | 0.761*** (0.101) | 0.694*** (0.144) | 0.676*** (0.112) | 0.682*** (0.089) | 0.604*** (0.116) | 0.678*** (0.103) |
| N | 20014 | 4130 | 2226 | 4669 | 3479 | 2557 | 2953 |
| Adj R-squared | 0.515 | 0.454 | 0.439 | 0.480 | 0.537 | 0.439 | 0.513 |
| Province FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Notes: the baseline category for *Education qualifications* is compulsory education and below. The baseline category for *Marital status* is 'single'. The baseline ethnicity group is 'Han'. †: The pooled OLS regression in column (1) also controls for yearly fixed effects.

*** p < 0.01, ** p < 0.05, * p < 0.1

Table 3: Returns to different education qualifications - transformed coefficients

| VARIABLES | (1) All years | (2) 2010 | (3) 2011 | (4) 2012 | (5) 2013 | (6) 2015 | (7) 2017 |
|----------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| β_{vus}^* | 0.278*** (0.031) | 0.260*** (0.072) | 0.233** (0.097) | 0.224*** (0.059) | 0.277*** (0.063) | 0.302*** (0.092) | 0.336*** (0.088) |
| β_{aus}^* | 0.216*** (0.026) | 0.195*** (0.055) | 0.171** (0.085) | 0.134*** (0.047) | 0.233*** (0.057) | 0.222*** (0.075) | 0.371*** (0.082) |
| β_{vcol}^* | 0.671*** (0.040) | 0.659*** (0.096) | 0.449*** (0.121) | 0.550*** (0.078) | 0.685*** (0.083) | 0.868*** (0.122) | 0.874*** (0.112) |
| β_{auni}^* | 1.124*** (0.057) | 1.199*** (0.153) | 0.908*** (0.166) | 1.008*** (0.118) | 1.142*** (0.121) | 1.160*** (0.154) | 1.380*** (0.148) |
| $\beta_{postgrad}^*$ | 1.966*** (0.163) | 2.288*** (0.427) | 1.146* (0.670) | 1.401*** (0.311) | 2.477*** (0.481) | 1.550*** (0.315) | 2.974*** (0.396) |

Notes: *** p< 0.01, ** p< 0.05, * p< 0.1

5.2 Comparison of returns to vocational and academic education

In this section, we do pairwise comparison of the returns to vocational education and those to academic education, both at the upper secondary level and at the tertiary level. Table 4 presents the coefficient difference test results of the transformed OLS coefficients, based on delta method. The coefficient difference is calculated as follows.

$$\beta_{vus}^* - \beta_{aus}^* = [(e_{vus}^\beta - 1) \times 100] - [(e_{aus}^\beta - 1) \times 100] = (e_{vus}^\beta - e_{aus}^\beta) \times 100$$

From Panel A, we see that returns to vocational upper secondary education are 6.2% higher than returns to academic upper secondary education. The positive difference is in line with Dai and Martins (2020) in which a 20% wage premium is captured among vocational upper secondary graduates as opposed to academic graduates. Yet our estimated difference is much smaller in magnitude (6%) than that in Dai and Martins (2020). This is partly due to the fact that we use transformed coefficients for the education qualification dummies, which presumably generates a more precise measure of the difference. Since both vocational and academic upper secondary education typically last three years, the yearly difference is around 2.1%. Panel B shows that the difference in returns to vocational college and academic university is much more substantial, vocational college graduates earning 45.3% less than academic university graduates. As explained before, most vocational college programs last three years and academic university programs last four years. When comparing the yearly difference, different denominators need to be used. The yearly difference is around 6% for the entire sample, comparable in magnitude to the benefit of obtaining an additional vocational upper secondary degree. Because the difference is both economically and statistically strongly significant, it is unsurprising that the pattern remains stable across the

years. Notably though, the yearly return difference between vocational college education and academic university education keeps shrinking from 2010 to 2017. This again matches the higher education massification over the past two decades and the labor market mismatch in China - academic university degree is losing its additional charm slowly in the labor market and vocational college degree is catching up.

Table 4: Coefficient difference comparison

| VARIABLES | (1) All years | (2) 2010 | (3) 2011 | (4) 2012 | (5) 2013 | (6) 2015 | (7) 2017 |
|--|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Panel A: vocational upper secondary vs. academic upper secondary | | | | | | | |
| $\beta_{vus}^* - \beta_{aus}^*$ | 0.062** (0.032) | 0.065 (0.073) | 0.062 (0.107) | 0.090 (0.060) | 0.044 (0.064) | 0.081 (0.093) | -0.036 (0.092) |
| $\beta_{vus}^*/3 - \beta_{aus}^*/3$ | 0.021** (0.011) | 0.022 (0.024) | 0.021 (0.036) | 0.030 (0.020) | 0.015 (0.021) | 0.027 (0.031) | -0.012 (0.031) |
| Panel B: vocational college vs. academic university | | | | | | | |
| $\beta_{vcol}^* - \beta_{auni}^*$ | -0.453*** (0.043) | -0.540*** (0.119) | -0.459*** (0.136) | -0.457*** (0.094) | -0.457*** (0.090) | -0.292*** (0.112) | -0.506*** (0.108) |
| $\beta_{vcol}^*/3 - \beta_{auni}^*/4$ | -0.057*** (0.012) | -0.080*** (0.031) | -0.077** (0.037) | -0.068*** (0.025) | -0.057** (0.024) | -0.001 (0.031) | -0.054* (0.029) |

Notes: all the coefficients are transformed via the Halvorsen equation, as explained in Section 5.1. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Noting the robust and persistent difference at the tertiary level and the relatively weak difference at the upper secondary level, further econometric techniques are applied to verify the robustness of the difference between vocational upper secondary education and academic upper secondary education. Meanwhile, comparisons are done for the entire sample without looking into specific years, since the difference between the two types of upper secondary education is only significant when all the years are pooled together. Put differently, the rest of this section exclusively focuses on the two types of upper secondary education in the entire sample.

Panel A of Table 5 presents the IV estimates using the four sets of instrument variables discussed in Section 4. Because both types of upper secondary education programs last three years, we redefine the main treatment variable as a dummy which equals zero for academic graduates and equals one for vocational graduates. The first instrument is the proportion of university graduates by year, which is novelly constructed by the authors. The second instrument is the enrolment ratio, similar to the one in Dai and Martins (2020). The third set of instruments are parental education, which is conventionally used in the returns to education literature. The fourth set of instruments is identical with the one in Guo and Wang (2020), which is included for comparison purpose as well.⁹ Odd-numbered columns provide the F statistic of the first stage. Even-numbered columns present the coefficient of

⁹Actually, we tried another instrument based on the 2015 policy which aimed at developing vocational education vigorously. Yet, because that policy is rather recent and only a small proportion of the sample is affected, the estimates were too imprecise to be informative. Hence, the fifth IV is dropped.

interest estimated from the second stage. As a rule-of-thumb, an acceptable F statistic of the first stage should be greater than 10 (Staiger and Stock, 1997). As can be seen, only our novel instrument has an F statistic larger than 22, well above the conventional threshold of 10 for a qualified instrument. Interestingly, with the novel instrument, we find that vocational graduates suffer a wage penalty of close to 70% compared to academic graduates. With the other three sets of instruments, the estimated coefficients are positive. However, the weak first stage or failing to pass the Durbin test cast doubt on the validity of these positive estimates. In sum, the IV estimation instrumented by the proportion of university graduates provides evidence that vocational graduates are actually paid less well compared to academic graduates.

Table 5: Vocational vs. academic upper secondary education

| | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
|------------------------------|---------|------------|---------|---------|-----------|---------|-------------|---------|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Panel A: IV estimates | | | | | | | | |
| F statistic of first stage | 22.06 | | 1.083 | | 2.623 | | 196.2 | |
| Durbin p-value | 0.056 | | 0.332 | | 0.001 | | 0.827 | |
| β_{vus} | | -0.734* | | 1.420 | | 2.532* | | 0.031 |
| | | (0.412) | | (2.050) | | (1.351) | | (0.132) |
| N | | 3983 | | 1700 | | 4143 | | 4143 |
| Panel B: Lewbel estimates | | | | | | | | |
| Chi-sq of Breusch-Pagan test | 116.54 | | 9.97 | | 86.95 | | 139.08 | |
| p-value | 0.000 | | 0.002 | | 0.000 | | 0.000 | |
| β_{vus} | | -0.193** | | -0.031 | | 0.019 | | 0.047 |
| | | (0.089) | | (0.231) | | (0.103) | | (0.079) |
| N | | 4015 | | 1715 | | 4277 | | 4416 |
| Adj R-squared | | 0.276 | | 0.253 | | 0.280 | | 0.279 |
| Panel C: PSM estimates | | | | | | | | |
| | N.treat | N. control | | ATT | Std. Err. | | t-statistic | |
| | (1) | (2) | | (3) | (4) | | (5) | |
| | 2612 | 2103 | | -0.036 | 0.035 | | -1.009 | |

Notes: **Panel A and Panel B:** Model 1 is instrumented by the proportion of university graduates over year. Model 2 is instrumented by the enrolment ratio. Model 3 is instrumented by parental education. Model 4 is instrumented by a dummy which equals one if the enrolment year is after 1985 and zero otherwise. The control variables are the same for all four models, except that Model 3 does not directly control for parental education. **Panel C:** ATT stands for Average Treatment effect on the Treated. Bootstrapped standard errors with 200 repetitions are reported.

*** p < 0.01, ** p < 0.05, * p < 0.1

The IV estimates above contradict the OLS estimates, indicating that the OLS estimation may suffer from endogeneity bias. To further address this endogeneity issue and to check the robustness of our IV estimates, we utilise the Lewbel method. The definition of the treatment variable and the external instruments are the same as those in the corresponding

IV specifications. Note that the Lewbel method additionally incorporates all the remaining control variables as internal instruments. Results from the Lewbel regressions are reported in Panel B of Table 5. We see that all four specifications pass the Breusch-Pagan test with strong statistical significance, validating the usage of the Lewbel method. As expected, the results instrumented by the proportion of university graduates (Model 1) remains negative and statistically significant. Yet, results in the other three specifications are insignificant. Notably, the results in Model 2 even changed sign: it was positive in the IV estimation and becomes negative in the Lewbel estimation. This raises further concern towards instrumenting vocational upper secondary graduates using its enrolment ratio. The weakness of the enrolment ratio instrument is likely due to the small sample size. Noting the sample size is reduced by more than a half in Model 2, enrolment ratio probably does not provide enough variation within the small sample. The dummy instrument in Model 4 is never significant in either the IV specification or the Lewbel method.

In Panel C of Table 5, the PSM estimates of average treatment effect on the treated is -0.036 , being statistically insignificant. The lack of statistical significance may result from the dramatic reduction in the number of observations, which in itself has interesting implications. This suggests that the overall samples are very different from each other. In other words, the difference in returns to education between vocational and academic education is essentially a matter of the different samples. This is in line with your idea that unfortunately people going into vocational education are the worst in terms of skills and talent. This adds to the story, is not in contrast with the story. Meanwhile, the PSM result is interesting when compared with the positive difference which was found in the OLS estimates. One possibility is that the alternative to vocational education for academically low performing students is academic upper secondary education, but they perform even worse in this case by moving to academic education. Without matching, we may have underestimated the returns to academic upper secondary education because a subgroup of academic students are the would-be low performing vocational students. With matching, we have a like for like comparison. Now that the three different econometric techniques generate three drastically different answers, we conclude that the return difference between vocational and academic upper secondary education cannot be determined as far as the current paper goes. On a related note, readers will benefit from reading this paper jointly with the paper by Dai and Martins (2020) for the following reasons. First, both studies use the same CGSS dataset, although ours additionally includes a new round. Second, the second IV specification in the current study is almost identical to the one in Dai and Martins (2020) (see Figure 6 for a reproduction of Figure 7 in Dai and Martins (2020)). Third, the OLS estimates in both studies show that vocational upper secondary graduates earn a wage premium over academic upper secondary graduates. Fourth, Dai and Martins (2020) find no difference via IV estimations whereas we find a negative difference using a stronger IV. Last but not least, we attempt Lewbel and PSM methods to further investigate the overall difference (albeit without obtaining a determinant answer) whereas Dai and Martins (2020) switch their focus onto local differences utilising quantile regressions.

To sum up, from the comparisons of vocational and academic education, we have the following main findings. First, academic university education degree pays around 45% better

than vocational college education degree, meaning each additional year of academic university education earns 6% more than each additional year of vocational college education. Second, from 2010 to 2017, the payment premium of academic university education shrinks constantly. After 2015, yearly returns to academic university education no longer strongly differ from those to vocational college education. Third, although OLS estimates show that vocational upper secondary graduates enjoy a 6% wage premium over academic upper secondary graduates, the difference does not survive alternative specifications (IV, Lewbel, PSM).

6 Discussion and Policy implications

In this paper, we investigate the returns to different education qualifications in China. We also compare the returns to vocational education and returns to academic education, both at the upper secondary level and at the tertiary level.

We have the following main findings. First, compared to the baseline group with compulsory education and below levels of education, upper secondary graduates enjoy a wage premium of around 20%, vocational college graduates enjoy around 50% premium, academic university graduates enjoy 75.3% premium, and those who complete postgraduate and above levels of education more than double their returns. Second, compared to academic upper secondary education, vocational education earns a wage premium of around 6% according to OLS estimates. Yet the difference does not survive various robustness checks. Third, compared to academic university education, vocational college education pays 45.3% less in returns, both economically and statistically strongly significant.

Alongside the new findings, novel econometric techniques are adopted to the relatively conventional returns-to-education topic. First, a novel instrument (i.e., the proportion of university graduates relative the entire population over the years) is introduced to account for endogeneity in the choice of vocational education against academic education at the upper secondary level. Evidence shows that this instrument outperforms the conventional parental education instruments, the enrolment ratio instrument which was used in Dai and Martins (2020), and the policy shock dummy in Guo and Wang (2020). Second, heteroskedasticity-based Lewbel method is used to fully utilise both the externally constructed instruments and internal instruments (i.e., the full set of control variables or a subset). Third, propensity score matching method is applied to match vocational students with academic students who have similar characteristics, so that self-selection bias can be partialled out to a certain extent. The paper has its limitations. One is our sample captures people across all the working age. People in different generations may face completely different social and economic conditions. Readers need to bear this caveat in mind when interpreting the results. Another is that our sample size is not so large relative to the 1.4 billion population in China.

Although we do not reach a definitive answer when comparing vocational and academic upper secondary education, it is undoubtful that vocational college graduates are paid significantly lower than academic university graduates. The payment disadvantage facing vocational graduates can be explained by the specific context in China. The Chinese government's

early effort in encouraging vocational education are countered by the country's long-standing tradition of degrading vocational graduates. This conflict puts vocational graduates into a seemingly vulnerable position compared to academic graduates. China gradually started its transition from low value-added industry to high value-added industry in recent years. In 2015, China's President Xi initiated the "supply-side reform", encouraging the industry to improve the quality of production and optimize its efficiency. Shortly after this, the "Made in China 2025" strategy was announced by Premier Li Keqiang in his Government Work Report. Traditionally, "Made in China" tends to be associated with cheap and low-quality goods. The "Made in China 2025" aims at transforming the Chinese industry so that products of China will be linked to technology-intensive and high quality goods. The introduction of the "supply-side reform" and the "Made in China 2025" strategy has seen an increasing demand of high-quality skilled workers, followed by heavy investment and extensive media coverage on vocational education institutions. In the foreseeable future, the Chinese education sector will give more attention to vocational education and training. Understanding how the returns to vocational education change as China transits its industry can better prepare other countries that face a similar situation.

A Appendix

A.1 Covariates

- age: =survey year– birth year
- Education qualifications:
- Years of education: no education (0), literacy (1), primary school(6), lower secondary school (9), upper secondary school (12), vocational college (15), academic university (16), postgraduate and above (19)
- experience: =age-edu-6. replace experience=0 if negative
- gender: 1=female, 0=male
- marital status: single (0), De facto (1), married (2), re-married (3), Separated (4), divorced (5), widowed (6)
- party membership: 1=Yes, 0=otherwise
- union membership: 1=Yes, 0=otherwise
- ethnicity: 0=Han, 1=minority
- *hukou*: 0=non-agricultural, 1=agricultural
- sector: 0=agricultural,1=state owned enterprise, 2=collectively owned, 3=privately owned, 4=HK Macau or Taiwan funded, 5=foreign funded

A.2 Figures

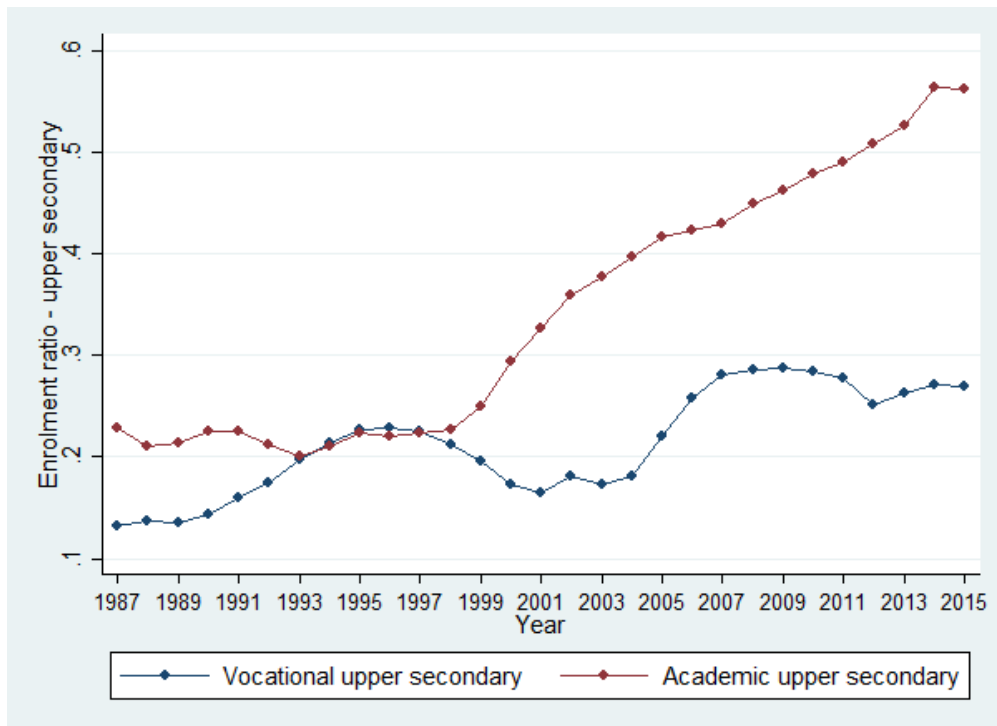


Figure 6: Enrolment ratio (replication of Figure 7 in Dai and Martins (2020))

Notes: Vocational / Academic upper secondary education ratio equals the number of students enrolled in vocational / academic upper secondary education nationwide in a year over the number of lower secondary graduates nationwide in the same year. Data are compiled by the authors from China Educational Yearbook (1987-2015).

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