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ABSTRACT

Does Vocational Education Pay Better, or Worse, Than Academic Education?*

In this paper, we use the Chinese General Social Survey data to analyse the returns to upper secondary vocational education in China. To address possible endogeneity of vocational training due to omitted heterogeneity, we construct a novel instrumental variable using the proportion of tertiary education graduates relative to the entire population by year. Our main finding is that, although returns to vocational upper secondary education appear higher than returns to academic upper secondary education according to the Mincerian equation, the results from the instrumental variable method tell the opposite story: vocational upper secondary graduates face a wage penalty compared to academic upper secondary graduates. The wage penalty is confirmed by an alternative and more recent IV method - the Lewbel method (Lewbel, 2012). Our findings highlight the importance of properly accounting for endogeneity when estimating the returns to vocational education.

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

Keywords: vocational education, academic education, upper secondary, China, Lewbel

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* The survey data in this paper is from the research project "Chinese General Social Survey (CGSS)" of the National Survey Research Center (NSRC), Renmin University of China.

1 Introduction

The vocational education and training sector has been at the heart of recent economic reforms 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 the 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). To alleviate this 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 likely reason is the culture of degrading vocational graduates persists, discouraging parents from sending their child to vocational institutes in the first place. The other likely reason is the return 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 vocational education in China.

This paper adds to the literature in the following five aspects. First, we apply a novel instrument, which is the proportion of university graduates relative to the entire population per year. Second, we compare the results using this novel IV with results using three other sets of IVs: the enrolment ratio used in Dai and Martins (2020), the classical parental education instruments, and a dummy instrument used in Guo and Wang (2020). Third, we replicate the enrolment ratio IV as is used in Dai and Martins (2020) and find similar "wage premium" enjoyed by vocational graduates as opposed to academic graduates. Fourth, using our novel IV, we find the opposite that vocational graduates actually suffer a wage penalty. Five, we utilise a heteroskedasticity-based instrumental method to check the robustness of our IV results (Lewbel, 2012). In the end, we find that vocational upper secondary education pays worse than academic upper secondary education.

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. Using 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 Isreal, 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 in 1999 escalates the supply of university graduates, from both academic track and vocational track (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 competitions soar and graduates from academic track have to compete with those from vocational track. 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.

In the existing education literature in China (and neighbour 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 developing countries including China (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 Becker-Mincerian equation 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 return, 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.[1]. 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 1 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 the academic-track and the vocational-track students. An academic-track 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-track 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

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

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 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.[2] 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%.

[2]Manually calculated by the author from the MoE documents.

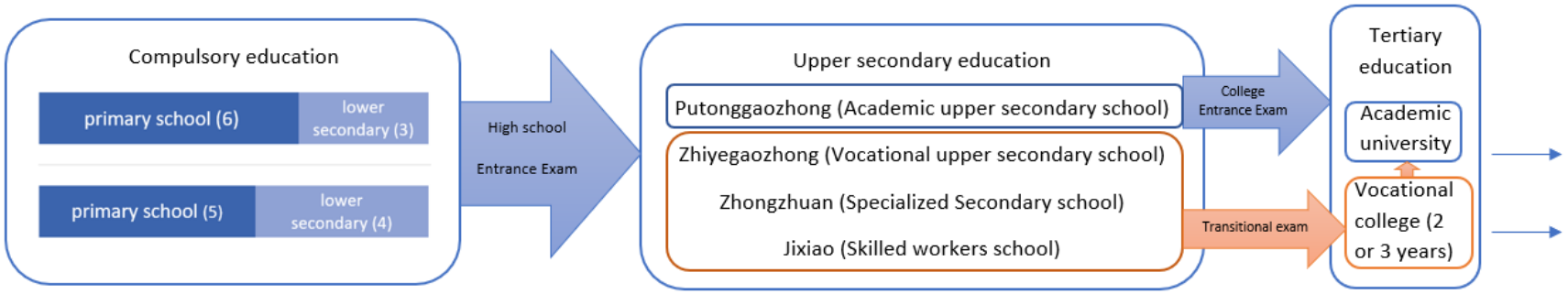

Figure 1: Education system in China

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.[3] 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 Education[4]. In our econometric analysis, we treat the education qualifications as dummies. The actual years of education is of little concern in our paper since we mainly focus on the two types of upper secondary education, both of which typically last three years.

The average years of 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 provinces. [5]

[3] A detailed description of the sampling method used can be found here.

[4] The 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.

[5] The geographical classification of locations is according to the National Bureau of Statistics in China.

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					
Eratio_{vus}	0.236	0.090	0.490	0.044	6471
Eratio_{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).

4 Methodology

4.1 Baseline estimation

Our baseline estimation strategy is the extended Mincerian equation (Duraisamy, 2002; Psacharopoulos, 1994). The classical semi-logrithmic 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 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 ith 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 2 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

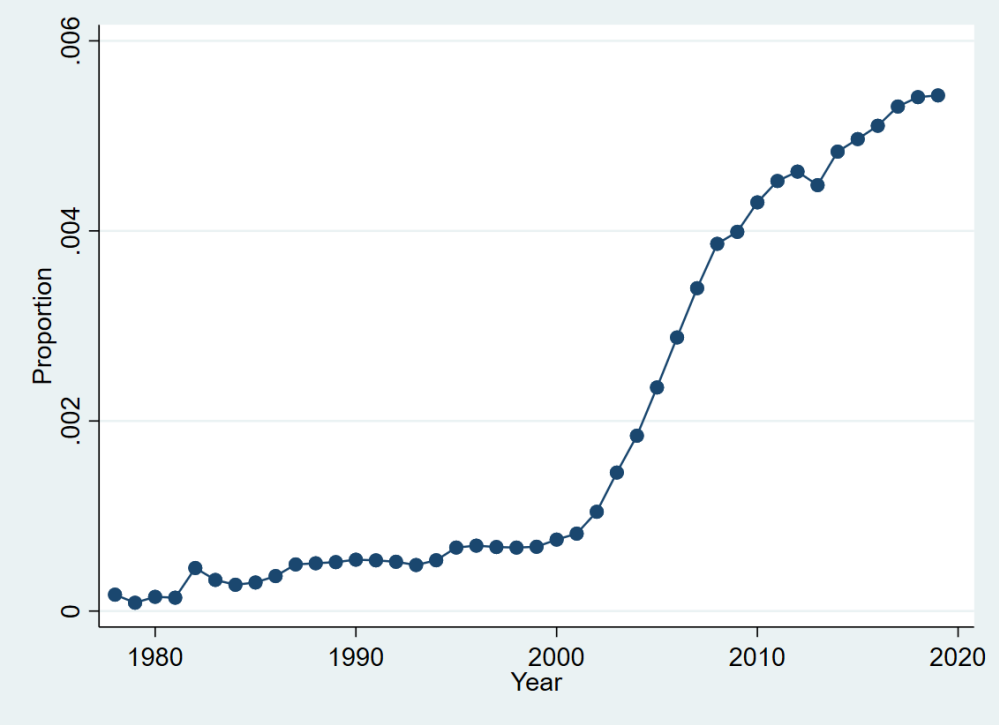

Figure 2: Proportion of university graduates relative to total population

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 track 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 raio 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 3. As a robustness check, we have also replicated Figure 7 in Dai and Martins (2020), which can be found in Figure 4 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 track, the vocational track 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 track 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).

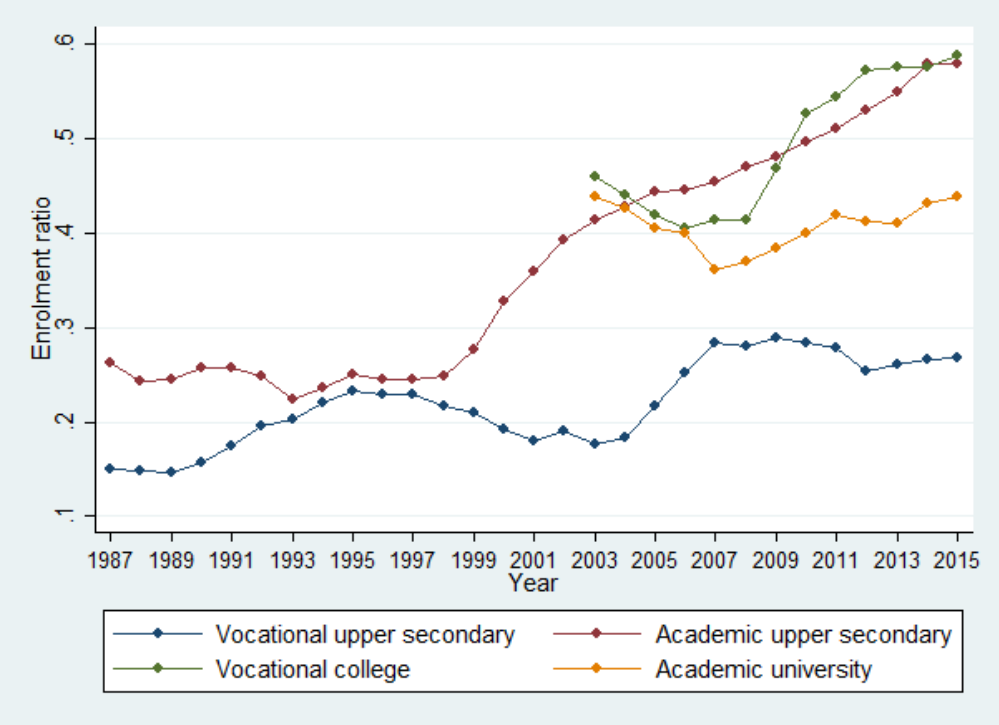

Figure 3: Enrolment ratio

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 four 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 rational 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 heteroskedasiticity-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 endogeneous 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.

5 Results

Table 2 presents the OLS estimates of the extended Mincerian equation. At first glance, we see that returns to vocational upper secondary education (24.2%) is higher than returns to academic upper secondary education (19.5%). As for whether the difference is statistically significant, we relegate the comparison to Table 3. Looking through the six years, returns to academic upper secondary education seem to increase more fastly than returns to vocational upper secondary education. Looking at the coefficients corresponding to marital status, we see there is almost a pseudo "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. 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.

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							
Vocational upper secondary	0.242***	0.224***	0.206***	0.199***	0.244***	0.263***	0.283***
	(0.024)	(0.057)	(0.080)	(0.048)	(0.049)	(0.070)	(0.066)
Academic upper secondary	0.195***	0.173***	0.157**	0.124***	0.208***	0.200***	0.323***
	(0.021)	(0.047)	(0.072)	(0.042)	(0.046)	(0.061)	(0.060)
Vocational college	0.513***	0.499***	0.369***	0.438***	0.521***	0.624***	0.637***
	(0.024)	(0.058)	(0.084)	(0.050)	(0.049)	(0.066)	(0.060)
Academic university	0.751***	0.780***	0.640***	0.697***	0.755***	0.769***	0.870***
	(0.027)	(0.070)	(0.087)	(0.059)	(0.056)	(0.071)	(0.062)
Postgraduate and above	1.082***	1.181***	0.754**	0.847***	1.244***	0.938***	1.381***
	(0.055)	(0.130)	(0.315)	(0.129)	(0.138)	(0.124)	(0.100)
Experience	0.030***	0.019***	0.022**	0.042***	0.040***	0.043***	0.032***
	(0.003)	(0.007)	(0.010)	(0.006)	(0.006)	(0.007)	(0.006)
Experience squared	-0.001***	-0.000***	-0.000***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female (yes=1)	-0.165***	-0.261***	-0.076	-0.274***	-0.017	-0.204**	-0.056
	(0.038)	(0.095)	(0.126)	(0.096)	(0.074)	(0.093)	(0.080)
Union (yes=1)	0.098***	0.152***	0.156***	0.116***	0.121***	0.000	0.005
	(0.016)	(0.040)	(0.060)	(0.036)	(0.034)	(0.046)	(0.040)
hukou (agricultural=1)	-0.068***	-0.123***	-0.120**	0.004	-0.011	-0.017	-0.162***
	(0.017)	(0.043)	(0.057)	(0.035)	(0.037)	(0.043)	(0.040)
Ethnicity (minority=1)	0.018	-0.022	-0.061	0.045	0.080	0.071	-0.045
	(0.029)	(0.059)	(0.097)	(0.063)	(0.072)	(0.083)	(0.075)
Party member (yes=1)	0.075***	0.067	0.109	0.064	0.124***	0.029	0.056
	(0.019)	(0.045)	(0.067)	(0.040)	(0.043)	(0.054)	(0.048)
Mother education	0.010***	0.012**	0.014**	0.013***	0.009**	-0.003	0.007
	(0.002)	(0.005)	(0.007)	(0.004)	(0.004)	(0.006)	(0.005)
Father education	0.010***	0.009**	0.011*	0.014***	0.007	0.019***	0.006
	(0.002)	(0.004)	(0.006)	(0.004)	(0.004)	(0.006)	(0.005)
Marital status							
De facto	0.270***	0.167	-1.112**	0.292**	0.091	0.586*	0.656***
	(0.091)	(0.354)	(0.546)	(0.126)	(0.186)	(0.345)	(0.170)
Married	0.280***	0.234***	0.302***	0.302***	0.236***	0.240***	0.305***
	(0.028)	(0.067)	(0.090)	(0.071)	(0.055)	(0.070)	(0.065)
Re-married	0.370***	0.070	0.489*	0.450***	0.355*	0.393**	0.244**
	(0.080)	(0.288)	(0.258)	(0.175)	(0.208)	(0.158)	(0.119)
Separated	0.091	0.141	-1.783***	0.131	0.443	-0.512	0.130
	(0.102)	(0.148)	(0.175)	(0.231)	(0.344)	(0.466)	(0.179)
Divorced	0.149**	0.004	0.052	0.233*	0.338**	-0.148	0.051
	(0.066)	(0.180)	(0.198)	(0.127)	(0.137)	(0.199)	(0.159)
Widowed	0.216**		0.285	0.512***	-0.094	0.144	0.288
	(0.105)		(0.237)	(0.198)	(0.222)	(0.210)	(0.297)
Female x De facto	-0.150	1.058	0.458	-0.141	-0.265	-0.351	-0.417*
	(0.134)	(1.656)	(0.722)	(0.189)	(0.268)	(0.376)	(0.229)
Female x Married	-0.210***	-0.081	-0.356***	-0.130	-0.344***	-0.206**	-0.285***
	(0.040)	(0.100)	(0.133)	(0.100)	(0.080)	(0.101)	(0.088)
Female x Re-married	-0.269**	-0.096	-0.645*	-0.214	-0.348	-0.300	0.035
	(0.120)	(0.446)	(0.334)	(0.254)	(0.293)	(0.250)	(0.258)
Female x Separated	0.095	0.142	1.693***	-0.418	0.859	-0.047	0.128
	(0.156)	(0.203)	(0.375)	(0.345)	(1.248)	(0.584)	(0.387)
Female x Divorced	0.027	0.116	0.187	0.008	-0.425**	0.324	0.123
	(0.094)	(0.228)	(0.335)	(0.177)	(0.194)	(0.251)	(0.230)
Female x Widowed	-0.145		-0.101	-0.398	0.225	-0.067	-0.616*
	(0.139)		(0.326)	(0.252)	(0.310)	(0.311)	(0.347)
State owned enterprise	0.571***	0.599***	0.542***	0.678***	0.555***	0.400***	0.584***
	(0.025)	(0.058)	(0.081)	(0.050)	(0.053)	(0.073)	(0.066)
Collectively owned enterprise	0.447***	0.454***	0.226*	0.532***	0.411***	0.304***	0.538***
	(0.030)	(0.069)	(0.117)	(0.059)	(0.057)	(0.094)	(0.084)
Privately owned enterprise	0.502***	0.474***	0.434***	0.562***	0.551***	0.367***	0.534***
	(0.021)	(0.049)	(0.062)	(0.042)	(0.049)	(0.063)	(0.060)
Hong Kong, Macau or Taiwan funded enterprise	0.585***	0.665***	0.548***	0.727***	0.605***	0.476**	0.337***
	(0.071)	(0.199)	(0.201)	(0.139)	(0.140)	(0.221)	(0.126)
Foreign funded enterprise	0.677***	0.756***	0.701***	0.656***	0.681***	0.567***	0.671***
	(0.044)	(0.101)	(0.145)	(0.114)	(0.089)	(0.114)	(0.103)
N	19852	4093	2198	4652	3457	2537	2915
Adj R-squared	0.514	0.452	0.440	0.479	0.536	0.437	0.514
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

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). The difference between the original estimates and the transformed coefficients get larger with the coefficient increasing. In Table 3 we report the transformed coefficients, along with the difference tests of the transformed coefficients. The coefficient difference is calculated as follows.

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

Table 3 confirms our observation in Table 2. The returns to vocational upper secondary education is indeed statistically significantly different from the returns to academic upper secondary. Looking through the six years, albeit not significant, five coefficients remain positive. 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. Table 4 presents the IV estimates using the four sets of instrument variables

Table 3: Coefficient difference comparison

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	All years	2010	2011	2012	2013	2015	2017
β^*_{vus}	0.274***	0.250***	0.229**	0.220***	0.276***	0.301***	0.327***
	(0.031)	(0.071)	(0.098)	(0.059)	(0.063)	(0.091)	(0.088)
β^*_{aus}	0.215***	0.189***	0.170**	0.131***	0.231***	0.221***	0.382***
	(0.026)	(0.056)	(0.085)	(0.047)	(0.057)	(0.075)	(0.083)
$\beta^*_{vus} - \beta^*_{aus}$	0.059*	0.061	0.059	0.089	0.045	0.080	-0.055
	(0.032)	(0.073)	(0.107)	(0.060)	(0.064)	(0.093)	(0.093)

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

discussed in Section 4. 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 instrument is identical with the one in Guo and Wang (2020), which is included for comparison purpose as well.

To facilitate interpretation, we exclusively focus on the upper secondary graduates in the IV regressions. In other words, the edu_i variable now equals zero for academic graduates and equals one for vocational graduates. Odd-numbered columns provide the F statistic of

the first stage. Even-numbered columns present the coefficient of 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 convincing evidence that vocational graduates are actually paid less well compared to academic graduates. Our IV estimates above contradicts the OLS estimates, indicating that the OLS estimation

Table 4: IV estimates of the returns to vocational education

	Model 1		Model 2		Model 3		Model 4	
	(1) first	(2) second	(3) first	(4) second	(5) first	(6) second	(7) first	(8) second
F statistic	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

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

may suffer from severe endogeneity bias. To further address this endogeneity issue and to check the robustness of our IV estimates, we utilise the Lewbel method. Results from the Lewbel regressions are reported in 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.

Table 5: Lewbel regression results

	Model 1		Model 2		Model 3		Model 4	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
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

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

6 Discussion and Policy implications

In this paper, we utilise a novel instrument to account for endogeneity in the choice of vocational education against academic education at the upper secondary level. We find that vocational upper secondary graduates suffer a wage penalty of around 20% compared to academic upper secondary graduates. This finding is in line with the negative findings in Brunello and Rocco (2015) and Dearden et al. (2002).

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.

Limited quantitative evidence exists regarding returns to vocational education in devel-

oping countries (Guo and Wang, 2020). In this paper, we construct a novel instrument - the proportion of university graduates relative the the entire population over the years. 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). The IV results is robust to the heteroskedasticity-based instrumental method introduced by Lewbel (2012). Our main finding is that, although vocational education appears to pay better than academic education according to the Mincerian equation, further investigation shows that vocational upper secondary graduates actually suffer a significant wage penalty. In other words, vocational upper secondary graduates face a significant wage penalty compared to academic graduates. This finding complements the results from Dai and Martins (2020).

Our finding further confirms the importance of validating an instrument and checking robustness of the IV results. Looking at Table 4 again, had we not perform the F-test or the endogeneity test, we would have not known which estimates to trust. With the validity tests and robustness checks, we confidently conclude that vocational upper secondary graduates face a 20% wage penalty compared to academic upper secondary graduates.

Future research may investigate the returns to vocational higher education and compare vocational and academic education at the tertiary level. One may also compare the returns to vocational education at the upper secondary level against that at the tertiary level. The latter comparison is particularly interesting given the notable over-education phenomenon observed in China (Wu and Wang, 2018). If over-education also happens in the vocational track, then the payment to vocational higher education may not necessarily be higher than vocational upper secondary education.

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

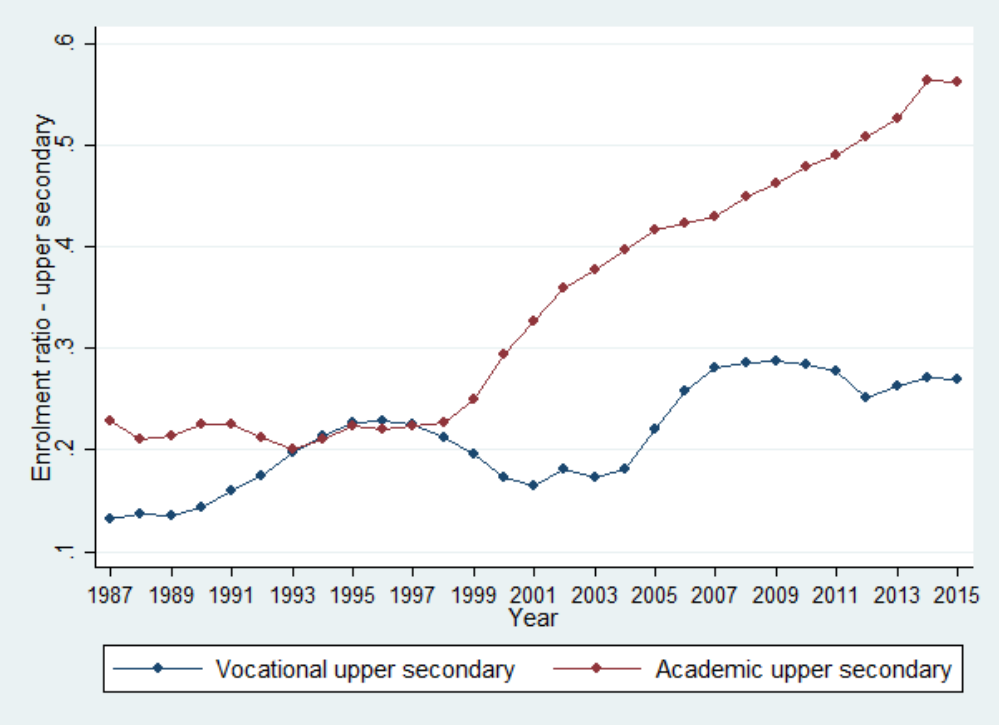

Figure 4: Enrolment ratio (replication of Figure 7 in Dai and Martins (2020))

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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