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The Wage Effects of Polytechnic Degrees: Evidence from the 1999 China Higher Education Expansion*

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Abstract

While the wage effects of vocational versus academic secondary education are well documented, there is little evidence on how polytechnics degrees pay off compared to university degrees. In this paper, we estimate the polytechnic degree wage effect in China, drawing on an unprecedented higher education expansion initially focused on universities and only later covering polytechnics. We find a large polytechnic wage penalty, of 35%, larger than what could be driven by the shorter duration of these degrees. While this result is robust to several checks, the penalty is found to be more pronounced for workers of lower earnings potential, when using IV-QR methods. Our results are consistent with a significant human capital gap of polytechnic degrees compared to university degrees.

Keywords: Returns to education, Polytechnics, Higher Education Expansion, China.

JEL Codes: I23, I26, J24.

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1 Introduction

Both secondary and tertiary education have important academic and vocational streams. However, in contrast to the case of secondary education, the effects of vocational *tertiary* education are still poorly understood. This research gap is particularly concerning as many countries are investing significantly in higher education supply (Psacharopoulos and Patrinos, 2018; Emran et al., 2020) but have little evidence to guide their decisions regarding the academic and vocational streams. In this context, understanding the wage returns to polytechnic degrees compared to their university counterparts is particularly useful in developing the evidence base to support these policy decisions.

In this paper, we contribute to the measurement of the wage effects of polytechnic degrees in China, a major example of rapid higher education expansion. Moreover, we draw on an important policy shock in the country - a sudden expansion of tertiary education in 1999 as a response to the Asian financial crisis. This expansion sought to tackle the economic slowdown and rising youth unemployment in that period, among other objectives (Fengyan Dai and Zhu, 2022; Huang et al., 2022). This unexpected expansion of tertiary education led to a 42% increase in tertiary enrolment in 1999 alone.¹ However, in the first three years of the expansion, the increase in enrolment was focused on tertiary academic education, with an average annual growth rate of 47.5%, and only 19.6% for tertiary vocational education – Figure 1. This led to significant exogenous variations in the opportunity for potential students to enter tertiary academic or vocational education, given the intense competition regarding tertiary education for upper secondary education graduates.²

(Figure 1 here)

We exploit this large and academic-education-biased policy shock to estimate the impact of tertiary vocational education degrees on wages, compared to the case of the more standard higher education academic degrees. Empirical evidence suggests that, when compared to

¹In comparison, the rate of increase in 1998 was 8%. Moreover, in 2000 and 2001, the increases in tertiary enrolment were still strong, at 38% and 22%, respectively. The growth rates subsequently remained at lower, even if still two-digit rates for nearly a decade.

²Students wishing to enter either tertiary academic or vocational education need to sit national college entrance exams. The places in tertiary education were limited compared to the number of upper secondary graduates who hoped to enter tertiary education. According to Ministry of Education of the People's Republic of China, in 1998 there were 3.2 million upper secondary graduates sitting national college entrance exams, with 1.08 million admitted in tertiary education institutions - a progression rate of only 33.75%. In contrast, in 1999, 1.6 of 2.88 million (55.56%) students were admitted in tertiary education institutions.

secondary academic education, secondary vocational education provides early-career wage premiums and facilitates quicker school-to-job transitions (Brunello and Rocco, 2015; Jäger, 2016; Dai and Martins, 2020; Ferreira and Martins, 2023). Moreover, new secondary vocational graduates tend to be more resilient to economic downturns (Eichhorst et al., 2015). However, in contrast to the abundance of evidence on the average earnings effect of education tracks at the secondary level, little is known about the earnings effect of completing tertiary vocational rather than tertiary academic education (Saltiel, 2021).³

To the best of our knowledge, nine papers compared the wage effects of vocational and academic education at the tertiary level, with only two focusing on developing countries. Using data from Europe, Hanushek et al. (2017) and Brunello and Rocco (2017a,b) estimated the return to the type of short-cycle tertiary education (ISCED-5) and found vocational wage penalties at the start of working careers. Backes-Gellner and Geel (2014) used parental education attainments to instrument individual tertiary education track choice and found higher returns to tertiary vocational degrees at career entry in the case of Switzerland. The findings were confirmed by Saltiel (2021), which further showed that the returns were higher for those with higher cognitive ability. In another study that examining the heterogeneous wage effects of vocational education, Balestra and Backes-Gellner (2017) showed an observational wage penalty to vocational (secondary and tertiary) education in the same country both at the mean and across upper conditional wage quantiles. In another observational study, Lin et al. (2003) found that attending vocational programs in Canadian universities improved labour market outcomes.

Of the two studies on developing countries, Ferreyra et al. (2022) used exogenous variations in enrolment to estimate the wage effects of short-cycle tertiary vocational programs compared to the next best alternative (bachelor’s programs or no higher education), finding a vocational wage penalty of 24%. The study closest to ours is Wang and Wang (2023), which found a large wage penalty of more than 50% to polytechnic graduates compared to comparable university graduates in China. They used individual and family characteristics in a propensity score matching (PSM) design.

³In contrast to the scarcity of empirical evidence, the relationship between tertiary education and earnings can be argued to be more direct and relevant than in the case of secondary education. Unlike secondary education, in which vocational education prepares students for jobs, whereas academic education prepares students for advanced studies, most academic and vocational tertiary education graduates enter directly into the labour market. We also note that tertiary education tends to deliver the highest returns across the education system (Psacharopoulos and Patrinos, 2018) and important social returns (Cui and Martins, 2021).

Our paper complements these studies by being the first causal study on the mean and distributional wage effects of vocational versus academic education at the bachelor’s or equivalent level (ISCED-6) in a developing country. Our approach based on the policy shock above addresses the challenge in estimating the wage effects of tertiary vocational (versus academic) education tracks, as students are not randomly assigned to different tracks (Saltiel, 2021). Furthermore, selection into academic or vocational tertiary education may also result from institutional factors. According to OECD (2023), a quarter of students currently enrolled in the secondary vocational programs have no subsequent direct access to tertiary education.⁴

Our motivation for the case of China also follows from the sheer number of students entering tertiary education there: each year there are more than 10 million students enrolled in tertiary education. In addition, as in many other countries, in China there is a clearly defined orientation and comparability of tertiary education (ISCED-6) programs (Wang and Wang, 2023), of which vocational education is delivered in polytechnics and academic education in universities.⁵ From a causal inference perspective, the nationwide, academic-education-biased sudden expansion of higher education in China from 1999 creates a suitable quasi-experimental setting to identify the causality between tertiary education tracks and wages.

We also note that tertiary vocational education offered at polytechnics is likely to be more heterogeneous in its mix of general skills (Hanushek et al., 2017; Eichhorst et al., 2015). Since general skills like problem solving, teamwork and communication are key to employability, this heterogeneity in tertiary vocational education provision, coupled with individual unobserved heterogeneity (Cahuc and Hervein, 2024), may lead to substantial variation in labour market returns. This prompts us to also consider the distributional effects of tertiary vocational qualifications.

As to our results, based on the 2010 to 2017 waves of the China General Social Survey (CGSS), the 1999 higher education expansion, which focused on the academic stream, indeed increased an individual’s chance of being admitted to a university instead of a polytechnic.

⁴Another issue concerns the comparability between tertiary vocational and academic education. Although secondary vocational education delivery varies from school-based to dual (school-firm) vocational education (Eichhorst et al., 2015; Cahuc and Hervein, 2024), there is a clear division between academic and vocational routes. However, at the tertiary level, there is no internationally agreed definition of the orientation of educational programs (OECD, 2023). For example, there are short-cycle tertiary vocational programs that leads to two-year associate degrees or certificates (that can be completed in a few months or weeks), whereas higher education institutions of applied sciences in countries like Germany award vocational qualifications that are equivalent to bachelor’s and master’s degrees (EU, 2023).

⁵In China, post-secondary non-tertiary and short-cycle tertiary programs (ISCED-5) are also available, but the number of students in these programs is negligible compared to that in polytechnics and universities.

Moreover, using the instrumental variables derived from this policy shock, we found that, on average, tertiary vocational graduates were paid 35% less in annual wages, compared to their academic counterparts. Furthermore, this vocational wage penalty was more pronounced for workers who are female, younger, and that work in high-skill occupations. Drawing on instrumental variable quantile regression (IV-QR), we showed that the income gap between polytechnic and university graduates was reduced for the individuals at higher deciles of the conditional wage distribution.

The study contributes to three threads of literature. First, in the literature on educational income gap (Kemper and Renold, 2024; Brunner et al., 2022; Hartog et al., 2022; Stevens et al., 2019; Brunello and Rocco, 2017a; Hanushek et al., 2017), we show evidence of significant wage differentials from education tracking at the bachelor's or equivalent level (ISCED-6). Recent high growth rates in higher education attendance suggest that estimating the wage effect of education tracking at this level is particularly important to educational public policy.

Second, our study investigates the distributional wage effects of polytechnics across individuals with heterogeneous earnings potential. Although examining the mean wage effects of education track is useful, it may ignore important heterogeneity. This is especially relevant in the case of diversification in education provision, labour segmentation and individual heterogeneity (McIntosh and Morris, 2021; Cahuc and Hervelin, 2024).

Finally, our findings contribute to the literature on the relationship between public education provision and individual education attainment (Card, 1993; Duflo, 2001). We use the 1999 higher education expansion to show that such policy may encourage students to shift between different education tracks, beyond its effect on the quantity of schooling (Fengyan Dai and Zhu, 2022). This bears further implications with respect to adjusting labour and/or skill supply to navigate job mismatch and the econometric identification of education effects.

The remainder of the paper proceeds as follows. Section 2 provides a more detailed review of the literature. The research design and the data are described in Sections 3 and 4. The empirical results are presented and discussed in Section 5. The final section concludes.

2 Literature review

Since the ground-breaking work on human capital by Schultz (1961), and later works on return to education by Becker (1962) and Mincer (1974), a large body of literature around

the world estimated the relationship between education and income. Most studies focused on the level of education and estimated the marginal effect of schooling. Periodic reviews of these studies could be found in the works by George Psacharopoulos and Harry Patrinos, for example, in Psacharopoulos and Patrinos (2018). As education provision diversifies, more researchers shifted their focus to different tracks of education, most notably vocational and academic education.

Similar to estimating the marginal return to schooling, a challenge to estimating the return to different tracks of education is the substantial selection to different tracks. Meer (2007) use U.S. data and show that individuals with secondary vocational qualifications would earn 3.7% less if they had been on the academic track; and the income of academic graduates would be 18.0% less if they had taken the vocational track at the this level. This is also the case in Switzerland, where Saltiel (2021) showed that students sort into different tertiary education tracks based on latent ability. In the prevalence of ‘academisation’, merit-based education systems create substantial selection into education. The effects of educational provisions and policies intertwines with that of student ability and preferences (Griliches, 1977), which creates estimation challenges and may bias the public perception of the economic return to the type of education. A consensus of most studies is that individuals who opt for different tracks of education may have systematically different personal traits (Eichhorst et al., 2015) and/or face different circumstances (Ota and Moffatt, 2007), e.g., expectations of future outcomes (Wilson et al., 2005), or costs to parents of continuing their children’s education (Piachaud, 1975). If these factors also relate to the the person’s economic and social outcomes, simply regressing earnings on education tracks will be subject to selection bias.

To identify the causal effect of education tracking on earnings, some studies utilised the discontinuity around the admission score threshold between academic and vocational education (see for example, Brunner et al. (2023) for technical high schools in the United States, and Silliman and Virtanen (2022) in the case of Finland). Other studies controlled for selectivity based on observed characteristics. For example, Meer (2007) used a multinomial logistic first-stage regression to correct selectivity in estimating the return to secondary vocational education in the United States. The predicting covariates for an individual’s option for secondary vocational education include demographic, socioeconomic and education-related variables. Böckerman et al. (2018) and Wang and Wang (2023) used propensity score matching

with several demographic and performance variables in the case of post-secondary vocational education in Finland and tertiary vocational education in China, respectively.

There are also studies which utilised exogenous variation in access to education. For example, Chen and Pastore (2024) and Dai and Martins (2020) used the year and regional variations in enrolments to generate exogenous changes in an individual's secondary education track choice in instrumental variable setups. Matthewes and Ventura (2022) used distance to academic and vocational colleges, conditional on regional features, to instrument an individual's track choice. Oosterbeek and Webbink (2007) exploited a one-year extension of secondary vocational education in the Netherlands in 1975 and used the double-difference estimator to evaluate the long-term effect of vocational education on wages. Similarly, Bertrand et al. (2021) identified the impact of a reform that incorporated general education curriculum to secondary vocational education and provided vocational students with access to college in a difference-in-discontinuity design. Fersterer et al. (2008) exploited a change in the apprentice training duration that resulted from the failure of host firms in Austria to produce exogenous variations in an individual's apprenticeship duration.

Most studies discussed above assumed that individuals are homogeneous. Recently, the variations in wage differentials between vocational and academic graduates over life cycle were studied. These studies suggested that the competence, and consequently labour market outcomes, of VET graduates typically worsens through career (Hanushek et al., 2017; Hartog et al., 2022). For example, Silliman and Virtanen (2022) showed that the income premium associated with secondary vocational education disappeared for the mid-thirties in the case of Finland. Korber (2019) used Swiss and British data and finds that the wage parity between comparable secondary vocational and academic graduates extended until the middle of working career, after which a vocational wage penalty emerged.

Only a small number of literature considered the vocational wage premium or penalty for individuals of heterogeneous ability. The scarcity of empirical evidence contrasts to the view that upper and post secondary vocational education helps keep low achievers in school, preventing them from becoming 'NEETs' (not in employment, education or training) (Brunello and Rocco, 2017a). This may make vocational education more appealing to individuals from poorer socio-economic background or those who perform less well at school or on the job (King and James, 2014). For example, Corbett et al. (2002) found that generic vocational education

offered at the secondary level and on-the-job vocational training is associated with an increase in earnings, and that all forms of vocational education and training (VET) reduced student dropout rates.

Among the limited empirical evidence on the relationship between vocational education and earnings for heterogeneous individuals with varied earnings potential, McIntosh and Morris (2021) used British data to show that vocational qualifications at the upper secondary and above level were complementary with ability. Balestra and Backes-Gellner (2017) found that post-compulsory vocational education provided a wage premium for individuals with lower earnings potential. And for those with higher earnings potential, academic education associated with higher wages. However, the findings in both studies were not causal.

3 Research design

3.1 Identification strategy

As discussed above, instead of being randomly assigned to different levels and tracks of education, an individual typically have different education attainments for two main reasons. First, individuals may self-select into different levels or tracks of education, due to individual and family characteristics (Card, 1999), or as a result of their performance at the entrance exams. Second, individual's schooling attainment may also be affected by external changes in education provision (Duflo, 2001; Dai and Martins, 2020), including policy shocks (Harmon and Walker, 2000; Huang et al., 2022). Such changes in education provision and related policy may serve as leverage to generate exogenous variation in education attainment, without direct effects on life outcomes (other than through the education attainment itself). In this study, we utilise an unprecedented and nationwide education reform - the 1999 China higher education expansion - to identify the causal relationship between tertiary tracks and earnings.

In the aftermath of the 1998 Asian financial crisis and devastating floods in Southern China in the same year, the central government made an unexpected decision to increase tertiary education enrolment. This decision sought to relieve employment pressure, stimulate domestic consumption, as well as increase average schooling and skill level of the population to meet the demand from skill-biased technological changes (Ou and Zhao, 2022). In June 1999, the central government unexpectedly announced that the number of students to be admitted to higher education would be increased by 330,000 in the autumn semester of the

same year (1999), a 42% increase from 1998.⁶ Furthermore, this growth continued over the following years – within six years, higher education enrolment had increased by 470% from 1998 (Fengyan Dai and Zhu, 2022). Previous studies found that the higher education expansion significantly increased the average years of schooling of those exposed to the policy (Li et al., 2008; Huang et al., 2022).⁷

After reviewing official records on tertiary enrolment, we found that the expansion happened mostly across universities (academic institutions). The enrolment increase in polytechnics (vocational institutions) was less significant until 2003, when the central government introduced a new policy to reform and promote vocational education. Consequently, in the first three years of this reform, the unexpected policy shock created far more opportunities for students to be admitted to a university than a polytechnic.

We draw on this differential higher education expansion to address selection. Specifically, in our analysis, we identify the groups exposed to the expansion by considering the year and month of birth. The 1986 Chinese Compulsory Education Law required children who become 6 years old by September to enter primary school in that same year. Moreover, students need to complete 9 years of compulsory education and 3 years of upper secondary education before sitting the college entrance exams. Therefore, those cohorts who were subject to the 1999 college entrance exams (the first in the new context of increased university access) were necessarily born from September 1980. We also note that, in China, like in other countries, there is segmentation between academic and vocational streams, implying that students cannot move easily between the two streams. However, from secondary to tertiary level, secondary school VET students can also apply for universities.

As shown by the education attainments by birth cohorts reported in Table 1, the share of tertiary academic graduates among those who were born in or after September 1980 (the oldest cohort exposed to the expansion) is significantly larger than that of the individuals born between September 1977 and August 1980 (the youngest cohort not exposed to the expansion). Moreover, the overall structure of education attainment remains similar.⁸ This

⁶The announcement was made suddenly, without any prior public consultation or notice. Indeed, this happened just days before the typically very demanding national college entrance exams that took place between 7-9 July in the same year (Shi and Xing, 2010).

⁷Note that higher education places in China are very competitive: even at the height of HE expansion, the overall HE admission rate was 56%. Enrolments and graduations are thus determined by the supply (quota) of seats, as there is excess demand by students across the board.

⁸The 1986 Chinese Compulsory Education Law required students to complete lower secondary education (grade 9) before they could legally drop out, which differs from the requirement of a school leaving age in some

general stability indicates that the higher education expansion served as a powerful shifter of the choice between university and polytechnic for those born before or after September 1980.

(Table 1 here)

Another advantage of the 1999 higher education expansion with respect to causal identification is that the policy shock is likely to satisfy the exclusion restriction in an IV setup. This policy reform is essentially a supply-side shock to individual education choice, without direct effects upon one's social and economic outcomes. However, the expansion increased the share of tertiary educated workforce within the population, which may have affected earnings for the cohort through general equilibrium effects. However, we reckon that this does not violate the exclusion restriction, as the relationship is indirect and applies across the board. Moreover, as shown by Figure A.1, provincial differences in socioeconomic outcomes did not affect policy implementation, which happened simultaneously across the country. Finally, overall wage changes might further interact with other factors, for example, the stock of academic and vocational graduates, skill-biased technological change, and large internal migration flows.

3.2 Empirical model

To retrieve the effect of different tertiary education tracks on earnings, we consider exclusively higher education graduates in the labour market. We then extend the Mincerian wage equation, which we specify as follows:

$$Y_{i,c,t} = \alpha + \beta_1 Voc_{i,c,t} + \beta_2 Exp_{i,c,t} + \beta_3 Exp_{i,c,t}^2 + \delta \mathbf{X}_{i,c,t} + \tau_t + \lambda_c + \mu_{i,c,t}. \quad (1)$$

The outcome of interest ($Y_{i,c,t}$) is the logarithm of annual wages of individual i in city c and year t . We modify the Mincerian equation by replacing the standard years-of-schooling variable by a dichotomous variable, Voc_i , for having a polytechnic degree (1) or a university degree (0). We also control for working experience, $Exp_{i,c,t}$, and its square, gender, marital status, migrating status, and single-digit occupation.⁹ τ_t and λ_c denote (6) year and (89) city countries. This may explain a decline in the share of observations with primary education as their highest education attainment. When we narrow the windows to those born between September 1978 and August 1982, only the difference in the shares of university graduates in the pre- and post-1980 birth groups remained economically and statistically (10%) significant - Table B.1.

⁹As children may start school at age 6 or 7, we define experience subtracting 7. Given that occupations may be endogenous to schooling, we also consider specifications without controls for occupations.

fixed effects, respectively. $\mu_{i,c,t}$ is the error term.

As aforementioned, we exploit the 1999 higher education expansion to generate exogenous change in an individual's choice and graduation between polytechnic and university. So we use a linear first-stage model (Equation 2) to predict the likelihood of attending polytechnics with all exogenous variables from the main-stage model and the IVs derived from the higher education expansion.

$$\begin{aligned} Voc_{i,c,t} = & \gamma_1 HE_{i,c,t} + \gamma_2 MT_{i,c,t} + \gamma_3 AH_{i,c,t} + \\ & + \gamma_4 HE_{i,c,t} * MT_{i,c,t} + \gamma_5 HE_{i,c,t} * AH_{i,c,t} + \gamma_6 AH_{i,c,t} * MT_{i,c,t} + \gamma_7 HE_{i,c,t} * AH_{i,c,t} * MT_{i,c,t} + \\ & + \sigma_1 Exp_{i,c,t} + \sigma_2 Exp_{i,c,t}^2 + \theta \mathbf{X}_{i,c,t} + \tau_t + \lambda_c + \epsilon_{i,c,t}, \quad (2) \end{aligned}$$

The policy treatment variable, HE , takes the value of 0 for those who were born before September 1980, and 1 for those born in or after September 1980. Following Huang et al. (2022), we also include a continuous variable for birth month trend (MT), corresponding to the number of months prior to or after September 1980. This introduces an intensive dimension from the reform, complementing the earlier, extensive, indicator (birth before or after September 1980). To allow for variation in the policy's strength over time (and asymmetric relationships before and after the policy was enacted), we interact the policy treatment variable with the month trend variable. In addition, we include additional interaction terms between the policy variable and the individual's *Hukou* (household registration) status when taking the college entrance exams (AH). This is to allow for potential variation in the policy's effect on individuals with different *Hukou* status.¹⁰ Finally, we allow for additional flexibility in the model by including a third interaction involving the policy treatment, the birth month trend, and the *Hukou* status.

¹⁰The *Hukou* policy was introduced in the central planning era in the 1950s to restrict internal migration between regions and sectors (mostly agricultural sectors to manufacturing sectors). An individual's *Hukou* status is inherited from parents. The policy was gradually lifted since the market-orientation reform in the 1980s. In recent decades, the labour market segmentation between rural and urban residents has been largely eliminated (Wang et al., 2021), and households can change their *Hukou* status (Wang et al., 2020). Huang et al. (2022) argued that the effect of the 1999 higher education expansion on individual's years of schooling varied by the *Hukou* status, as the individuals with the rural *Hukou* benefited less from the education expansion. Their study exploited this difference and used the rural group as a control group to identify the policy's treatment effect. Notably, their study used an individual's *Hukou* status at the age of 12, which may differ from the *Hukou* status when an individual sat in the college entrance exams.

4 Data and variables

The dataset used is the China General Social Survey (CGSS), one of the most used in social and economic studies on China. Its sampling ensures that the data are nationally representative (Bian and Li, 2012). Moreover, the CGSS data also provide information on individual, family, community and society dimensions, which are important in this study. We pool the data from 2010 to 2017 into a repeated cross-sectional data set. We use observations of individuals in full-time employment at the time of survey. Individuals at the bottom or top 1% of the unconditional wage distribution are dropped.

We keep those who were born in or after September 1970: those born before turned 16 before September 1986 and were not subject to the 1986 Compulsory Education Law, which may confound our assignment rule. Only those who reported the year and month of birth are considered. Since we compare wage outcomes for university and polytechnic graduates, we keep only those who completed tertiary education (bachelor’s degree or equivalent, ISCED-6).¹¹ An additional important feature of the CGSS is that it contains information on the year when a respondent sat the college entrance exams and the year when he/she completed the highest education, based on which we can infer the year when an individual started tertiary education. We use this to cross-check eligibility and drop the individuals whose education experience violates our rule of assignment.

The final study sample contains 5,137 observations, for which the summary statistics are provided in Table 2. We find that polytechnic graduates are on average 2 years older than academic graduates. Females are equally represented in both groups. The proportion of married respondents is 80% in the vocational group, slightly higher than that in the academic group (77%). University graduates are slightly more likely to migrate (17% versus 15%). The differences in occupation destinations between university and polytechnic graduates are also significant, with the former more likely to be in high-skilled occupations (except for managerial occupations). Moreover, university graduates are more likely to be in more developed eastern China, and polytechnic graduates in central and western China.

¹¹The use of September 1980 as a cut-off point to determine the eligible group is subject to a few caveats. First, the quantity and quality of primary education provision in the 1980s and 1990s varied substantially across China. Although the 1986 Compulsory Education Law required children at the age of 6 to enter primary schools, it allowed students in regions with poorer education provision to postpone entry by one year (Fang et al., 2016). Second, there may be returning students who entered the labour market after graduating from upper secondary schools before the expansion and returned to higher education after the expansion. Third, grade retention may also introduce noise regarding our identification strategy.

(Table 2 here)

The average annual wage for university graduates is CNY 56,259. By comparison, polytechnic graduates on average receive CNY 41,118, or 27% less. However, schooling years of university graduates are 1.3 years greater than those of polytechnic graduates, which is consistent with the duration difference between the two tracks. We could not find differences in the share of individuals affected by the 1999 expansion between the two groups. However, vocational graduates were more likely to hold agricultural *Hukou* when they sat in the college entrance exams. This is consistent with the finding that the individuals with agricultural *Hukou* are the major source of polytechnic students (Ling, 2015).

5 Results and discussions

5.1 Main results

Table 3 reports the OLS and 2SLS estimates of the effects of polytechnic (tertiary vocational) education on earnings, when compared with tertiary academic education. The polytechnic coefficients in columns 1 to 3 indicate that there is a wage penalty of between 20% and 24% to polytechnic education. Regarding the other variables, we find evidence of an inverted U-shape relationship between earnings and experience and that female workers on average receive 21-22% less than comparable males. Moreover, there is a wage premium of 24-25% attributable to migration.¹²

(Table 3 here)

In the lower section of columns 4 to 6, we report the estimated coefficients of the instrumental variables. The results are informative about how an individual's tertiary decision was affected by the expansion and strengthen our identification approach. The coefficients for the higher education expansion are negative and statistically significantly different from zero at the 5% level, indicating that the policy shock reduced the likelihood of attending a polytechnic (compared to a university) by approximately 8%. The results are consistent with Figure 1, indicating that individuals born after September 1980 were less likely to enrol in polytechnics

¹²When compared with managers, other occupational groups on average receive lower wages, ranging between -49% (skilled agricultural, forestry and fishery workers) and -7% (professionals). The large earnings gap for skilled workers in agricultural, forestry and fishery occupations may result from the fact that the latter typically work informally or because of seasonality in the agricultural sector (De Brauw and Rozelle, 2008).

compared to a university. Specifically, the estimates of the interaction term of the higher education expansion and birth month trend are both economically and statistically significant. This means that although the policy shock led to an abrupt increase in university admissions in relation to polytechnic admissions, the effect declined over time. This is consistent with the discussion in Section 1. An individual’s probability of being admitted to a polytechnic increased by approximately two percentage points ($\gamma_2 + \gamma_4$ in Equation 2) per month.¹³

Drawing on this exogenous variation, our 2SLS estimates in columns 4 to 6 show that individuals with a polytechnic degree received on average 35% - 37% less than their university counterparts. And comparing the 2SLS estimates in the specification without occupational controls (Column (5)) and those with (Column (6)), we show that parts of the polytechnic degree wage penalty can be explained by occupational sorting. A comparison of the 2SLS results with the OLS results thus indicates that the latter are biased upward (towards zero).¹⁴ This may happen if the polytechnic variable was measured with error, for example, if respondents who held a vocational degree reported that they had a university degree.

To better interpret these estimates, it is important to note that polytechnic education is usually delivered in three-year programs, while university degrees typically last four years. The wage penalty mentioned above could capture both quality and quantity effects of the different types of tertiary education. Alternatively, these estimates could serve as a lower bound of the true polytechnic wage effects. Besides, the estimates can be interpreted as local average treatment effects (LATE), and only applicable to those whose choice between polytechnic and university was influenced by the 1999 expansion. Still, these ‘local’ effects are informative to both policy makers and researchers, especially in the context of the increasing access to higher education that is happening in many parts of the world (Miguel et al., 2022).

¹³Unlike the different effects of the 1999 higher education expansion for individuals with rural or urban *Hukou* reported by Huang et al. (2022), we do not find statistically significant differences in the policy’s effect between rural and urban residents. This suggests that the expansion did not favour one *Hukou* group over the other with respect to admission to different tracks of education. Furthermore, when we exclude the agricultural *Hukou* and its interactions, the estimator also produce consistent results, as shown in the Table B.2 in the Appendix. The magnitudes of estimates parameters in both stages with the alternative IV set are comparable to our baseline results.

¹⁴The IV post-estimation diagnostic tests show that our models are properly identified. The p-values for the Keibergen-Paap LM statistics are all 0.001, rejecting the null hypothesis that a model is under-identified at the 99% level. Kleibergen-Paap Wald F statistics are larger than 10, rejecting that the instruments are jointly weak. The p-values for Hansen’s J statistics cannot rule out that the instruments are valid.

5.2 Distributional results

Here we study potential differences in education track labour differentials across the wage distribution. We use the quantile regression (QR) estimator by Koenker and Bassett Jr (1978) and consider differences across individuals ranked by the error term of the main equation. In a Mincerian equation, this term contains all other wage-related factors and is typically interpreted as driven by additional earnings-related human capital (Doksum, 1974). The quantile regression results in Panel A of Table 4 show that the wage penalty associated with polytechnic degrees applies at all deciles of the conditional wage distribution. The distributional pattern displays an inverse U-shaped curve, in which the wage differential is reduced to 16% at the 7th decile.¹⁵

To address education endogeneity in regression quantiles, we adopt the instrumental variable-quantile regression (IV-QR) estimator (Chernozhukov and Hansen, 2005, 2008) and use the full set of instrumental variables, as in Model (6) in Table 3. The IV-QR estimates of the vocational wage effects in Panel B of Table 4 show that the earnings gap between polytechnic and university graduates narrows as we move up the conditional wage distribution. Specifically, polytechnic graduates at the bottom decile receive only half of what they would have earned should they have a university degree. Although the wage penalty falls (in absolute terms) with the individual's earnings potential increases, it still stands at 27% for those at the top decile of the conditional wage distribution. Compared with the mean penalty of 35% estimated above, the IV-QR estimates show considerable variations between 27% and 39% in the penalty faced by polytechnic graduates. The results indicate that, for the individuals with higher earnings potential, the polytechnic track still leads to income losses, even if lower.

(Table 4 here)

5.3 Robustness checks

In the first three years since the 1999 expansion, university enrolment increased substantially whereas the polytechnic enrolment did not, as shown in the upper chart in Figure 1. Mean-

¹⁵We also find that the return to work experience is diminishing along the conditional wage distribution. Specifically, an extra year of working experience associates with a 4% increase in annual earnings for the individuals at the bottom of the conditional wage distribution, whilst it contributes to less than 2% earnings increase for those at the top decile. The gender-related wage differentials range between 17% and 30% and form a generally declining pattern across the conditional wage distribution. When it comes to the return to migration, the lowest returns of between 17% and 18% are received by those at the first four deciles and the highest return of 26% obtained by those at the top decile.

while, an expansive tertiary academic education encouraged students at the upper secondary level to shift to secondary academic education, which prepares students for university, a more prestigious academic track. This resulted in a booming secondary academic sector and a shrinking secondary vocational sector, demonstrated by the lower chart in Figure 1. The sluggish vocational enrolment in both tertiary and secondary levels became a concern for the Chinese government, which in August 2002 issued a *Decision of State Council on Promoting Reform and Development of Vocational Education (2002, No.29)*. The policy aims to ‘balance academic and vocational education at the secondary level’ and ‘to expand tertiary vocational education’.

As a consequence, the tertiary vocational enrolment started to increase from 2003 and exceeded that of tertiary academic education in that year. To address the concern that the introduction of this policy may confound identification, we use the sub-sample of individuals who were born before September 1984 and were not affected by this policy per our assignment rule to check the robustness of the baseline results. The number of observations in this new sample is 2,456. Table B.3 and Table B.4 report the estimates, which show that there still is a wage penalty of 33% applied to tertiary vocational graduates, and that this penalty is less pronounced for individuals of higher earnings potential.

5.4 Extensions

Here we split the study sample by gender, age cohort, and occupation to investigate the heterogeneity in the wage differentials between polytechnic and university graduates. Table 5 contains the OLS and 2SLS estimates of the vocational education coefficients and the corresponding first-stage diagnostic statistics. The 2SLS estimates in Panel A of the table show that the vocational penalty is more pronounced for females than for males. Specifically, among male tertiary education graduates, the vocational penalty is 31%; and for females, the penalty is 40%.

(Table 5 here)

The 2SLS results by age group in Panel B of Table 5 show that the wage penalty associated with polytechnics falls for the older cohort. For the younger cohort aged between 16 and 25 years, the individuals with a polytechnic degree receive 35% less than those with a university education; and for those aged 26 years or older, the vocational penalty is reduced to 29%.

Panel B of Table 5 contains 2SLS estimates of the vocational wage penalty by the level of skills. Individuals working in the first 3 occupation categories in the International Standard Classification of Occupation-08 (ISCO-08) are referred to as ‘high skilled’, while those in the occupation groups 4 to 9 are referred to as ‘middle or low skilled’. Our 2SLS results show that for the high-skilled workers, a polytechnic degree associates with a wage penalty of around 36%. In comparison, those in the ‘middle or low-skill’ occupations, the vocational wage penalty is lower, standing at 32%. The estimates and the IV statistics by sub-samples in Table 5 are consistent to the main results in Table 3.¹⁶

5.5 Discussion

Our main results show there is an average wage penalty of 35% attributable to tertiary vocational qualifications (ISCED-6) in China. The result is lower (in absolute terms) than the polytechnic wage penalty of 53%-59% reported in an observational study (Wang and Wang, 2023). These results capture a local average treatment effects (LATE) that concern those whose tertiary education choices were influenced by the policy change, i.e., students near the score threshold between academic and vocational tracks.

Notably, the wage penalty for tertiary vocational graduates contrasts to a positive wage premium for secondary vocational education in other Chinese studies (Dai and Martins, 2020; Wang et al., 2020). We believe the results from these and other studies for other countries (Heinesen and Lange, 2022; Silliman and Virtanen, 2022; Corbett et al., 2002) suggest that, while vocational education at the secondary level on average provides better wage outcomes, at the tertiary level the pattern is reversed, as such vocational graduates tend to earn less than their academic counterparts.¹⁷

A possible explanation for this asymmetry in vocational premiums is that the primary objective of vocational education is to equip students with relevant skills and knowledge for practising a particular job. In contrast, the academic education offered at the secondary

¹⁶Furthermore, we also perform quantile regression estimations with different sub-samples, and report the results in Table B.5. These IV-QR results suggest that, except for the male workers at the 8th decile and above and the middle and low-skilled workers, the vocational penalty demonstrates a diminishing pattern. Consistently with the main results, those with higher earnings potential suffer less from obtaining a vocational degree. However, the vocational wage penalty becomes more pronounced for the male workers at the 8th and 9th deciles. For middle and low-skilled workers, our IV-QR results show the vocational penalty displays an inverse-U shaped curve, in which the wage penalty suffered by polytechnic graduates is more pronounced among those with either higher or lower-than-average earnings potential.

¹⁷However, we note that some research indicates that tertiary vocational graduates from the dual vocational systems in German-speaking countries enjoyed wage premiums, especially at entry levels (Backes-Gellner and Geel, 2014; Saltiel, 2021).

level typically prepares students for college or university entrance exams. Secondary academic graduates who do not further their education may be less competitive as compared to secondary vocational graduates. Of course, the selection into tertiary education among secondary academic students may also be relevant. At the tertiary level, however, universities teach portable skills, which may not only be useful for a particular occupation, but also facilitate further learning throughout their careers (Hanushek et al., 2017). In this way, employers may be willing to pay higher wages to university graduates.

Alternatively, the dynamics of returns to educational tracks may suggest a role for the structure of workforce skills. China, as the largest exporter in the world, boasts a very large number of manufacturers. These firms create a huge demand for low- or semi-skilled workers, driving up their wages. Meanwhile, as Chinese firms are moving up along global value chains, the demand for more skilled and versatile university-educated workers can outpace supply, resulting in higher wages.

Furthermore, our instrumental variable quantile regression results show that the earnings gap between polytechnic and university graduates is less salient among individuals with higher earnings potential. This is likely to happen if the skills acquired at tertiary education can be replaced by human capital accumulated through other means. Indeed, tertiary education provides professionally related courses and aims to increase intellectual capacity in a particular discipline (Knight, 2007). In modern societies where a combination of occupation-specific and other portable skills are required, the difference in the value of skills from the two types of tertiary education would be less pronounced in the presence of other forms of human capital which workers at the top of both distributions would have.¹⁸

Our results show that the wage penalty of polytechnics is larger for females, younger workers, and those in high-skill occupations. Previous studies have shown that male polytechnic students are more likely to choose science, technology, engineering and mathematics (STEM) courses, while female students are more likely to be seen in non-STEM courses, e.g., foreign languages, accounting or nursing (Espinoza and Speckesser, 2022). In China, where the manufacturing sector is still the mainstay of the economy, STEM graduates have better labour

¹⁸The signalling effect of educational qualifications may also be weakened for those of higher earnings potential. Formal education not only teaches important skills demanded in labour market, but also awards degrees and qualifications that signal unobserved individual ability, e.g., motivation, to potential employers in a context of information asymmetry (Kroch and Sjoblom, 1994). If it is easier for individuals with higher earnings potential to demonstrate their productivity, the signalling effect of formal education qualification may be less salient, which translates to reduced earnings gaps between holders of different types of qualifications.

market prospects in relation to non-STEM graduates, which may result in higher returns to their qualifications Hu and Vargas (2015).¹⁹

On average, the earnings gap between polytechnic and university graduates is larger among high-skilled workers. A possible reason is that university education teaches portable knowledge and skills and prepares students for advanced learning, which may be more valuable for occupations like managers, professionals and technicians. For individuals working in the high-skill occupations, one’s educational records may be less relevant in the presence of higher earnings potential, as indicated by the IV-QR results.

6 Conclusions

In contrast to the abundance of the evidence on the earnings effects of *secondary* vocational education, little is known whether *tertiary* vocational degrees from polytechnics provides different labour market returns compared to university degrees. In this study, we examine the wage premiums from these two tertiary tracks (ISCED-6) and their variations. Moreover, we estimate both mean and quantile wage effects of polytechnic degrees compared to university degrees.

In the presence of selection into education tracks, we apply a two-stage least square estimator and an instrumental variable quantile regression estimator to retrieve the causal effects on earnings. Our identification exploits an unexpected and unprecedented nationwide expansion of higher education in 1999 in China, following the Asian financial crisis. The higher education expansion not only increased the average years of schooling of those exposed to the policy (Li et al., 2008, 2012; Fengyan Dai and Zhu, 2022; Huang et al., 2022), but also changed the structure of education qualifications, thus creating exogenous variation in a student’s tertiary tracking choice. Indeed, we find that in the first three years of the expansion, the increase in enrolment happened mostly to tertiary academic education.

Our 2SLS results confirm there are substantial wage differences driven by education track,

¹⁹A larger polytechnic wage penalty for the younger cohort could potentially be explained by the fact that vocational education offers quicker school-to-work transition. The benefit of secure employment may compensate for lower earnings. Besides, higher employability can lead to a lower unemployment rate among young polytechnic graduates when compared with newly university graduates. This may result in a larger income gap between vocational and academic graduates if the lower-earning polytechnic graduates are more likely to stay in labour market when compared to lower earners among university graduates. This may also explain our IV-QR results that the vocational wage penalty appears larger among the individuals with lower earnings potential, and that the dispersion in the vocational wage penalty between those with higher earnings potential and those with lower earnings potential is larger among the younger cohort.

as polytechnic graduates earn significantly less than their academic counterparts. On top of this, our IV-QR results show heterogeneity in the vocational wage penalty, disregarded by OLS or 2SLS. Specifically, our IV-QR results show that the vocational penalty falls, even though not completely, for workers of higher earnings potential.

Although vocational education potentially offers smoother school-to-work transition, its graduates, especially those with lower earnings potential, may still suffer greatly from lower wages when compared to academic graduates. However, as shown here, this penalty can be partly alleviated for individuals of higher earnings potential. We also note that results should be interpreted as LATE: they concern individuals whose tertiary education decisions were affected by the Chinese higher education expansion.

These findings bear several policy implications. First, on the optimal distribution of workforce/skills that relate to educational tracking in China and perhaps other countries as well. The dynamics of returns to education tracks at different levels may indicate a relative shortage or surplus of workers with particular education/training, suggesting reforms to future educational planning. In the case of this study, a (much) higher return to university degrees suggests that policy makers may consider further adjusting the supply of graduates from these two streams, increasing more university availability. Alternatively or concurrently, policy makers may need to focus more on improving the quality of tertiary vocational education. Second, the diminishing penalty to polytechnic degrees at higher conditional wage quantiles suggests that polytechnics may need to provide more support to students of lower levels of ability.

References

- Backes-Gellner, U. and Geel, R. (2014). A comparison of career success between graduates of vocational and academic tertiary education. *Oxford Review of Education*, 40(2):266–291.
- Balestra, S. and Backes-Gellner, U. (2017). Heterogeneous returns to education over the wage distribution: Who profits the most? *Labour Economics*, 44:89–105.
- Becker, G. S. (1962). Investment in human capital: A theoretical analysis. *Journal of Political Economy*, 70(5, Part 2):9–49.
- Bertrand, M., Mogstad, M., and Mountjoy, J. (2021). Improving educational pathways to

- social mobility: evidence from norway’s reform 94. *Journal of Labor Economics*, 39(4):965–1010.
- Bian, Y. and Li, L. (2012). The chinese general social survey (2003-8) sample designs and data evaluation. *Chinese Sociological Review*, 45(1):70–97.
- Böckerman, P., Haapanen, M., and Jepsen, C. (2018). More skilled, better paid: labour-market returns to postsecondary vocational education. *Oxford Economic Papers*, 70(2):485–508.
- Brunello, G. and Rocco, L. (2015). The effects of vocational education on adult skills and wages. Technical Report 168, OECD Social, Employment and Migration Working Paper.
- Brunello, G. and Rocco, L. (2017a). The effects of vocational education on adult skills, employment and wages: What can we learn from PIAAC? *SERIEs*, 8:315–343.
- Brunello, G. and Rocco, L. (2017b). The labor market effects of academic and vocational education over the life cycle: Evidence based on a British cohort. *Journal of Human Capital*, 11(1):106–166.
- Brunner, E., Dougherty, S., and Ross, S. (2022). Industry choice and within industry earnings effects. Technical report, National Bureau of Economic Research.
- Brunner, E. J., Dougherty, S. M., and Ross, S. L. (2023). The effects of career and technical education: Evidence from the Connecticut technical high school system. *Review of Economics and Statistics*, 105(4):867–882.
- Cahuc, P. and Hervelin, J. (2024). The effect of workplace vs school-based vocational education on youth unemployment: Evidence from France. *European Economic Review*, 162:104637.
- Card, D. (1993). Using geographic variation in college proximity to estimate the return to schooling. Working Paper 4483, National Bureau of Economic Research.
- Card, D. (1999). The causal effect of education on earnings. In *Handbook of Labor Economics*, volume 3, pages 1801–1863. Elsevier.
- Chen, J. and Pastore, F. (2024). Dynamics of returns to vocational education in China: 2010-2017. *Humanities and Social Sciences Communications*, 118.

- Chernozhukov, V. and Hansen, C. (2005). An IV model of quantile treatment effects. *Econometrica*, 73(1):245–261.
- Chernozhukov, V. and Hansen, C. (2008). Instrumental variable quantile regression: A robust inference approach. *Journal of Econometrics*, 142(1):379–398.
- Corbett, W. P., Clark, H. B., and Blank, W. (2002). Employment and social outcomes associated with vocational programming for youths with emotional or behavioral disorders. *Behavioral Disorders*, 27(4):358–370.
- Cui, Y. and Martins, P. S. (2021). What drives social returns to education? A meta-analysis. *World Development*, 148(C):105651.
- Dai, L. and Martins, P. S. (2020). Does vocational education pay off in China? Instrumental-variable quantile-regression evidence. GLO Discussion Paper 495.
- De Brauw, A. and Rozelle, S. (2008). Reconciling the returns to education in off-farm wage employment in rural china. *Review of Development Economics*, 12(1):57–71.
- Doksum, K. (1974). Empirical probability plots and statistical inference for nonlinear models in the two-sample case. *Annals of Statistics*, pages 267–277.
- Duflo, E. (2001). Schooling and labor market consequences of school construction in Indonesia: Evidence from an unusual policy experiment. *American Economic Review*, 91(4):795–813.
- Eichhorst, W., Rodríguez-Planas, N., Schmidl, R., and Zimmermann, K. F. (2015). A road map to vocational education and training in industrialized countries. *Industrial and Labor Relations Review*, 68(2):314–337.
- Emran, M. S., Jiang, H., and Shilpi, F. (2020). *Gender Bias and Intergenerational Educational Mobility: Theory and Evidence from China and India*. The World Bank.
- Espinoza, H. and Speckesser, S. (2022). A comparison of earnings related to higher technical and academic education. *Education Economics*, 30(6):644–659.
- EU (2023). Study in Europe - Country profiles. <https://education.ec.europa.eu/study-in-europe/countries>.

- Fang, H., N.Eggleston, K., Rizzo, J. A., Rozelle, S., and Zeckhauser, R. J. (2016). *The Returns to Education in China: Evidence from the 1986 Compulsory Education Law*. Stanford University Walter H. Shorenstein Asia-Pacific Research Center series with Brookings Institution.
- Fengyan Dai, F. C. and Zhu, Y. (2022). Returns to higher education in China – evidence from the 1999 higher education expansion using a fuzzy regression discontinuity. *Applied Economics Letters*, 29(6):489–494.
- Ferreira, J. R. and Martins, P. S. (2023). Can Vocational Education Improve Schooling and Labour Outcomes? Evidence from a Large Expansion. IZA Discussion Paper 16474.
- Ferreyra, M. M., Galindo, C., and Urzúa, S. S. (2022). Labor Market Effects of Short-Cycle Higher Education Programs: Lessons from Colombia. Technical Report 30178, National Bureau of Economic Research.
- Fersterer, J., Pischke, J.-S., and Winter-Ebmer, R. (2008). Returns to apprenticeship training in Austria: Evidence from failed firms. *Scandinavian Journal of Economics*, 110(4):733–753.
- Griliches, Z. (1977). Estimating the returns to schooling: Some econometric problems. *Econometrica*, 45(1):1–22.
- Hanushek, E. A., Schwerdt, G., Woessmann, L., and Zhang, L. (2017). General education, vocational education, and labor-market outcomes over the lifecycle. *Journal of Human Resources*, 52(1):48–87.
- Harmon, C. and Walker, I. (2000). The returns to the quantity and quality of education: evidence for men in England and Wales. *Economica*, 67(265):19–35.
- Hartog, J., Raposo, P., and Reis, H. (2022). Fluctuations in the wage gap between vocational and general secondary education: lessons from Portugal. *Journal of Population Economics*, 35(2):643–675.
- Heinesen, E. and Lange, E. S. (2022). Vocational versus general upper secondary education and earnings. *Journal of Human Resources*, 18:1–40.
- Hu, A. and Vargas, N. (2015). Economic consequences of horizontal stratification in postsecondary education: evidence from urban China. *Higher Education*, 70(1):337–358.

- Huang, B., Tani, M., Wei, Y., and Zhu, Y. (2022). Returns to education in China: Evidence from the great higher education expansion. *China Economic Review*, 74:101804.
- Jäger, M. (2016). Dual vocational education and training as an option in development cooperation, survey of experts on behalf of the donor committee for dual vocational education and training. Final report, Zurich: dcDVET.
- Kemper, J. and Renold, U. (2024). Evaluating the impact of general versus vocational education on labor market outcomes in egypt by means of a regression discontinuity design. *Journal of Development Economics*, 166:103172.
- King, C. and James, R. (2014). Increasing participation and attainment in higher education in australia: The early effects of a “demand-driven” system. *Higher Education Management and Policy*, 24(3):145–160.
- Knight, J. (2007). *Cross-border tertiary education: An introduction*. OECD.
- Koenker, R. and Bassett Jr, G. (1978). Regression quantiles. *Econometrica*, pages 33–50.
- Korber, M. (2019). *The labour market returns to vocational education over the life course*. PhD thesis, Université de Lausanne, Faculté des sciences sociales et politiques.
- Kroch, E. A. and Sjoblom, K. (1994). Schooling as human capital or a signal: Some evidence. *Journal of Human Resources*, 29(1):156–180.
- Li, F., Morgan, W. J., and Ding, X. (2008). The expansion of higher education, employment and over-education in China. *International Journal of Educational Development*, 28(6):687–697.
- Li, Y. A., Whalley, J., Zhang, S., and Zhao, X. (2012). The higher educational transformation of China and its global implications. In *The Globalization of Higher Education*, pages 135–162. Springer.
- Lin, Z., Sweet, R., and Anisef, P. (2003). Consequences and policy implications for university students who have chosen liberal or vocational education in canada: Labour market outcomes and employability skills. *Higher Education Policy*, 16:55–85.
- Ling, M. (2015). Bad students go to vocational schools!?: Education, social reproduction and migrant youth in urban China. *The China Journal*, (73):108–131.

- Matthewes, S. H. and Ventura, G. (2022). On Track to Success? Returns to Vocational Education Against Different Alternatives. CEPA Discussion Papers 58, Center for Economic Policy Analysis.
- McIntosh, S. and Morris, D. (2021). Variation in the labour market rewards to vocational qualifications in the UK. *Scottish Journal of Political Economy*, 68(5):535–552.
- Meer, J. (2007). Evidence on the returns to secondary vocational education. *Economics of Education Review*, 26(5):559–573.
- Miguel, L., Tambe, T., and da Costa, C. (2022). Examining expansion and trends in higher education in Mozambique. *Higher Education*, 83(1):411–439.
- Mincer, J. (1974). *Schooling, Experience, and Earnings*. New York: National Bureau of Economic Research.
- OECD (2023). *Education at a Glance 2023*. OECD, Paris, France.
- Oosterbeek, H. and Webbink, D. (2007). Wage effects of an extra year of basic vocational education. *Economics of Education Review*, 26(4):408–419.
- Ota, M. and Moffatt, P. G. (2007). The within-household schooling decision: a study of children in rural Andhra Pradesh. *Journal of Population Economics*, 20(1):223–239.
- Ou, D. and Zhao, Z. (2022). Higher education expansion in china, 1999–2003: Impact on graduate employability. *China & World Economy*, 30(2):117–141.
- Piachaud, D. (1975). The economics of educational opportunity. *Higher Education*, 4(1):201–212.
- Psacharopoulos, G. and Patrinos, H. A. (2018). Returns to investment in education: A decennial review of the global literature. *Education Economics*, 24(5):445–458.
- Saltiel, F. (2021). Fast-tracked to success: Evidence on the returns to vocational education in Switzerland. *Annals of Economics and Statistics*, (142):5–44.
- Schultz, T. W. (1961). Investment in human capital. *American Economic Review*, 51(1):1–17.
- Shi, L. and Xing, C. (2010). China’s higher education expansion and its labor market consequences. Technical Report 4974, IZA Discussion Paper.

- Silliman, M. and Virtanen, H. (2022). Labor market returns to vocational secondary education. *American Economic Journal: Applied Economics*, 14(1):197–224.
- Stevens, A. H., Kurlaender, M., and Grosz, M. (2019). Career technical education and labor market outcomes: Evidence from California community colleges. *Journal of Human Resources*, 54(4):986–1036.
- Wang, C., Akgü, M., Liu, X., and Tani, M. (2020). Expropriation with Hukou change and labour market outcomes in China. *China Economic Review*, 60:101391.
- Wang, F., Milner, C., and Scheffel, J. (2021). Labour market reform and firm-level employment adjustment: Evidence from the hukou reform in China. *Journal of Development Economics*, 149:102584.
- Wang, G. and Wang, Z. (2023). Vocational education: a poor second choice? A comparison of the labour market outcomes of academic and vocational graduates in China. *Oxford Review of Education*, 49(3):408–427.
- Wilson, K., Wolfe, B., and Haveman, R. (2005). The role of expectations in adolescent schooling choices: Do youths respond to economic incentives? *Economic Inquiry*, 43(3):467–492.

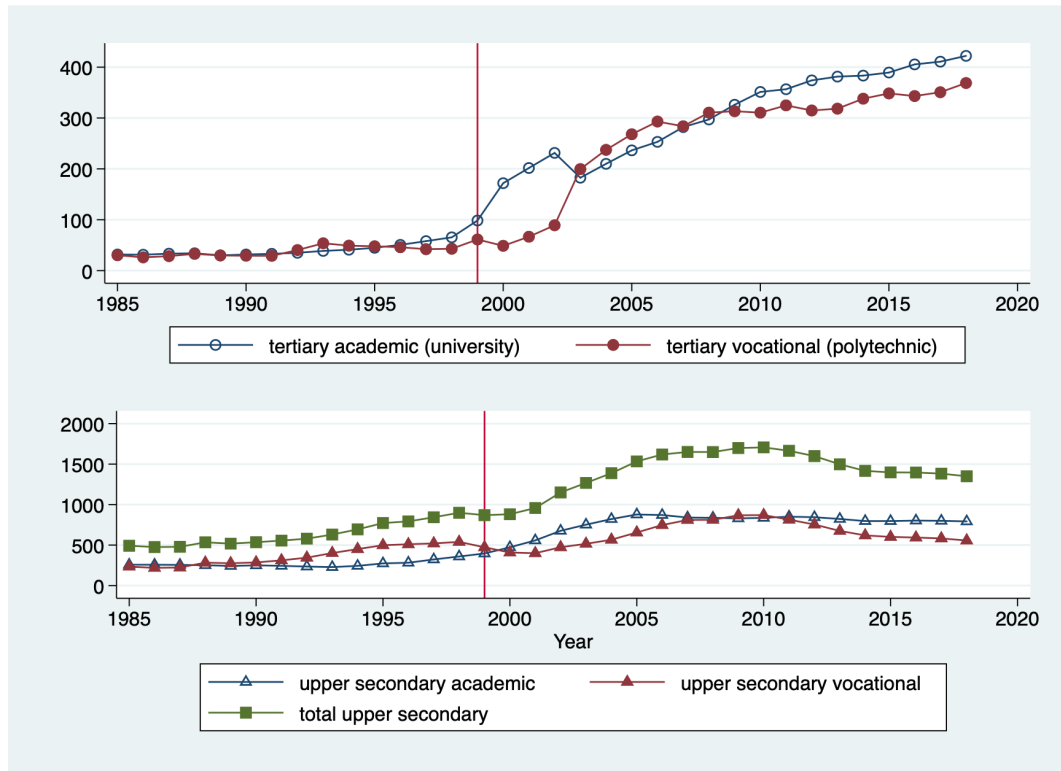


Figure 1: Tertiary enrolment and upper secondary graduation by education track
Notes: The top figure shows the number of enrolment by tertiary track. The bottom figure shows the number of graduates by upper secondary track and the total (in 10 thousand). The vertical reference line is for the year of 1999, when the higher education expansion took place. Data source: China Education Yearbook (1986-2019).

Figures

Tables

Table 1: Highest education attainment, birth cohorts 1977-1983

	(1)	(2)	(3)
	Post-expansion	Pre-expansion	Diff. [(1)-(2)]
No education	0.020 (0.142)	0.025 (0.157)	-0.005 [-1.07]
Primary education	0.099 (0.299)	0.131 (0.338)	-0.032 [-3.40]***
Lower secondary education	0.330 (0.470)	0.336 (0.473)	-0.007 [-0.49]
Vocational secondary education	0.116 (0.320)	0.112 (0.315)	0.004 [0.43]
Academic secondary education	0.084 (0.278)	0.103 (0.304)	-0.019 [-2.15]*
Polytechnics	0.149 (0.356)	0.140 (0.347)	0.009 [0.83]
University	0.177 (0.381)	0.132 (0.339)	0.044 [4.12]***
Postgraduate's degree	0.025 (0.157)	0.020 (0.140)	0.005 [1.23]
N	2248	2259	

Note: The table contains the summary statistics of highest education attainments for individuals born within three years before and after September 1980 (between September 1977 and September 1983). Significance level for t statistics: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: China General Social Survey (CGSS) 2010-2017.

Table 2: Descriptive statistics of the study sample

	(1) All Mean	(2) N	(3) University Mean	(4) N	(5) Polytechnics Mean	(6) N	(7) Diff. Mean	(8) [(3)-(5)] Std.Err.
Age	37.077	6477	35.606	3063	38.397	3414	-2.791	[-10.40]***
Female	0.462	6477	0.453	3063	0.470	3414	-0.017	[-1.37]
Marital	0.778	6471	0.758	3059	0.795	3412	-0.037	[-3.58]***
Migrant	0.166	6471	0.177	3063	0.155	3414	0.022	[2.35]*
Managers	0.133	5368	0.137	2673	0.135	2695	-0.004	[-0.40]
Professionals	0.288	5368	0.363	2673	0.214	2695	0.148	[12.17]***
Technicians and Associate Professionals	0.207	5368	0.220	2673	0.194	2695	0.027	[2.41]*
Clerical Support Workers	0.174	5368	0.154	2673	0.193	2695	-0.040	[-3.83]***
Services and Sales Workers	0.111	5368	0.090	2673	0.132	2695	-0.043	[-4.98]***
Skilled Agricultural, Forestry and Fishery Workers	0.007	5368	0.003	2673	0.010	2695	-0.007	[-3.20]**
Craft and Related Trades Workers	0.034	5368	0.016	2673	0.051	2695	-0.035	[-7.10]***
Plant and Machine Operators and Assemblers	0.028	5368	0.013	2673	0.043	2695	-0.031	[-6.83]***
Elementary Occupations	0.017	5368	0.009	2673	0.025	2695	-0.017	[-4.73]***
Eastern	0.587	6477	0.623	3063	0.554	3414	0.070	[5.70]***
Central/Northeastern	0.266	6477	0.247	3063	0.283	3414	-0.036	[-3.29]**
Western	0.148	6477	0.130	3063	0.163	3414	-0.034	[-3.80]***
Annual wage (CNY)	48485.855	5166	56262.345	2489	41117.876	2627	15144.469	[15.25]***
Schooling	15.642	6477	16.357	3063	15.000	3414	1.357	[69.53]***
Exposed to expansion	0.556	4438	0.564	2295	0.546	2143	0.018	[1.20]
Agricultural Hukou	0.279	6477	0.243	3063	0.312	3414	-0.068	[-6.15]***

Note: Significance level for t statistics: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: China General Social Survey (CGSS) 2010-2017.

Table 3: Monetary return to vocational education, OLS and 2SLS estimates

Dependent variable: logged annual wage	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) IV	(6) IV
Vocational Education	-0.274 (0.020)***	-0.266 (0.019)***	-0.226 (0.020)***	-0.458 (0.039)***	-0.456 (0.039)***	-0.432 (0.042)***
Experience	0.039 (0.003)***	0.039 (0.004)***	0.035 (0.004)***	0.070 (0.008)***	0.069 (0.009)***	0.058 (0.009)***
Experience ²	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.003 (0.000)***	-0.002 (0.000)***	-0.002 (0.000)***
Female		-0.236 (0.019)***	-0.246 (0.020)***		-0.240 (0.022)***	-0.242 (0.023)***
Married		0.084 (0.028)***	0.078 (0.029)***		0.042 (0.029)	0.040 (0.029)
Migrant		0.221 (0.028)***	0.217 (0.028)***		0.235 (0.031)***	0.234 (0.031)***
Professionals			-0.074 (0.031)**			-0.118 (0.041)***
Technicians and Associate Professionals			-0.116 (0.034)***			-0.154 (0.043)***
Clerical Support Workers			-0.176 (0.035)***			-0.173 (0.042)***
Services and Sales Workers			-0.117 (0.042)***			-0.078 (0.049)
Skilled Agricultural, Forestry and Fishery Workers			-0.664 (0.264)**			-0.357 (0.354)
Craft and Related Trades Workers			-0.286 (0.053)***			-0.216 (0.064)***
Plant and Machine Operators and Assemblers			-0.249 (0.060)***			-0.166 (0.075)**
Elementary Occupations			-0.350 (0.065)***			-0.310 (0.077)***
Constant	10.767 (0.046)***	10.745 (0.049)***	10.916 (0.056)***	10.782 (0.058)***	10.775 (0.060)***	10.956 (0.070)***
City fixed effects	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES
First-stage estimates and statistics						
HE expansion (HE)				-0.081 (0.035)**	-0.081 (0.034)**	-0.082 (0.036)**
Birth month trend (MT)				-0.025 (0.001)***	-0.025 (0.001)***	-0.023 (0.001)***
Agricultural Hukou (AH)				-0.032 (0.048)	-0.033 (0.048)	-0.038 (0.049)
HE * MT				0.047 (0.002)***	0.047 (0.002)***	0.045 (0.002)***
HE * AH				-0.007 (0.065)	-0.006 (0.065)	-0.004 (0.067)
AH * MT				0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
HE * AH * MT				0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
Kleibergen-Paap LM statistics				1056.005	1026.515	888.358
p-value(LM)				0.000	0.000	0.000
Kleibergen-Paap rk Wald F statistics				88.622	86.791	73.554
Hansen J statistics				10.563	10.158	8.347
p-value(Hansen J)				0.103	0.118	0.214
N	5110	5107	4752	3606	3604	3385

Note: The table includes least squares results on the wage premium/penalty associated with tertiary vocational education (polytechnic degree) when compared with tertiary academic education (university degree). Experience denotes year of working experience (age - years of schooling - 7). Males, the unmarried, the non-migrant and managers (Group 1 in ISCO-08) are omitted. Armed forces occupations are excluded from the study sample. HE expansion indicates whether an individual is subject to higher education expansion in 1999. Birth month trend is a continuous variable for the month of birth, and September 1980 is set as the baseline. Agricultural Hukou indicates whether an observation hold agricultural Hukou (household registration) when taking the college entrance exams. Standard errors are clustered at city. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: China General Social Survey (2010-2017).

Table 4: Variations in vocational premium along wage distribution

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	1st decile	2nd decile	3rd decile	4th decile	5th decile	6th decile	7th decile	8th decile	9th decile
Panel A: Quantile regression (education tracking is treated as exogenous) N=4752									
Vocational education	-0.217 (0.024)***	-0.224 (0.015)***	-0.242 (0.014)***	-0.210 (0.014)***	-0.192 (0.015)***	-0.178 (0.014)***	-0.174 (0.015)***	-0.209 (0.015)***	-0.218 (0.020)***
Experience	0.044 (0.006)***	0.037 (0.004)***	0.035 (0.003)***	0.031 (0.003)***	0.031 (0.003)***	0.026 (0.003)***	0.025 (0.003)***	0.021 (0.003)***	0.020 (0.004)***
Experience ²	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.000 (0.000)***	-0.000 (0.000)***
Female	-0.292 (0.025)***	-0.246 (0.017)***	-0.211 (0.016)***	-0.210 (0.013)***	-0.218 (0.015)***	-0.236 (0.014)***	-0.236 (0.015)***	-0.228 (0.015)***	-0.197 (0.018)***
Married	0.122 (0.043)***	0.055 (0.024)**	0.035 (0.022)	0.049 (0.021)**	0.032 (0.026)	0.034 (0.021)	0.062 (0.020)***	0.073 (0.019)***	0.115 (0.030)***
Migrant	0.169 (0.047)***	0.166 (0.022)***	0.155 (0.019)***	0.163 (0.022)***	0.201 (0.035)***	0.220 (0.024)***	0.224 (0.021)***	0.219 (0.018)***	0.236 (0.033)***
Constant	9.943 (0.103)***	10.428 (0.061)***	10.638 (0.056)***	10.831 (0.046)***	10.997 (0.053)***	11.218 (0.044)***	11.334 (0.052)***	11.516 (0.050)***	11.840 (0.067)***
Occupation	YES	YES	YES	YES	YES	YES	YES	YES	YES
City fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Panel B: Instrumental variable-quantile regression (education tracking is treated as endogenous) N=3867									
Vocational education	-0.461 (0.087)***	-0.414 (0.058)***	-0.405 (0.050)***	-0.410 (0.041)***	-0.384 (0.045)***	-0.367 (0.055)***	-0.340 (0.047)***	-0.336 (0.033)***	-0.308 (0.057)***
Experience	0.074 (0.016)***	0.056 (0.013)***	0.047 (0.010)***	0.043 (0.010)***	0.042 (0.009)***	0.042 (0.007)***	0.037 (0.008)***	0.035 (0.012)*	0.029 (0.020)
Experience ²	-0.003 (0.001)***	-0.002 (0.001)**	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.001)	-0.001 (0.001)
Female	-0.240 (0.035)***	-0.207 (0.027)***	-0.212 (0.022)***	-0.219 (0.027)***	-0.229 (0.022)***	-0.230 (0.018)***	-0.236 (0.024)***	-0.257 (0.046)***	-0.247 (0.038)***
Married	0.135 (0.070)	0.067 (0.033)**	0.039 (0.039)	0.032 (0.039)	0.027 (0.046)	0.020 (0.026)	0.036 (0.031)	0.071 (0.034)**	0.106 (0.056)
Migrant	0.180 (0.071)***	0.154 (0.033)***	0.142 (0.033)***	0.141 (0.029)***	0.164 (0.037)***	0.186 (0.043)***	0.231 (0.034)***	0.241 (0.035)***	0.263 (0.051)***
Constant	9.641 (0.862)***	10.026 (0.512)***	10.319 (0.489)***	10.319 (0.450)***	10.261 (0.441)***	10.188 (0.404)***	10.355 (0.497)***	10.224 (0.521)***	10.258 (0.467)***
Occupation	YES	YES	YES	YES	YES	YES	YES	YES	YES
City fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: The table includes the quantile regression results on the wage premium/penalty associated with tertiary vocational education (polytechnic degree) when compared with tertiary academic education (university degree) along the conditional wage distribution. Experience denotes year of working experience (age - years of schooling - 7). Males, the unmarried, and the non-migrant are omitted. In IV-QR estimation, the instrumental variables include a) HE expansion, b) birth month trend, c) agricultural hukou at college entrance exams, and the interactions terms of the three variables. Standard errors are clustered at city. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The full tables of estimates are available upon request from the authors. Data source: China General Social Survey (2010-2017).

Table 5: Heterogeneity in average return to vocational education, OLS and 2SLS estimates

	(1) OLS	(2) OLS	(3) 2SLS	(4) 2SLS
Panel A: by gender				
	Male	Female	Male	Female
Vocational education	-0.190 (0.029)***	-0.271 (0.041)***	-0.372 (0.085)***	-0.511 (0.055)***
First-stage statistics				
Kleibergen-Paap LM statistics			22.923	31.403
p-value(LM)			0.002	0.000
Kleibergen-Paap rk Wald F statistics			18.523	53.073
Hansen J statistics			10.425	4.250
p-value(Hansen J)			0.108	0.643
N	2639	2113	1774	1611
Panel B: by age cohort				
	Younger cohort	Older cohort	Younger cohort	Older cohort
Vocational education	-0.217 (0.037)***	-0.215 (0.033)***	-0.428 (0.056)***	-0.334 (0.065)***
First-stage statistics				
Kleibergen-Paap LM statistics			22.533	22.997
p-value(LM)			0.002	0.002
Kleibergen-Paap rk Wald F statistics			18.939	34.832
Hansen J statistics			8.155	6.853
p-value(Hansen J)			0.227	0.335
N	1662	3090	1645	1740
Panel C: by occupation skill level				
	High-skill	Middle and low-skill	High-skill	Middle and low-skill
Vocational education	-0.203 (0.028)***	-0.266 (0.036)***	-0.448 (0.065)***	-0.393 (0.064)***
First-stage statistics				
Kleibergen-Paap LM statistics			24.536	26.417
p-value(LM)			0.001	0.000
Kleibergen-Paap rk Wald F statistics			32.046	40.562
Hansen J statistics			6.004	6.957
p-value(Hansen J)			0.423	0.325
N	2988	1764	2058	1327

Note: The table includes the least squares results on the wage premium/penalty associated with tertiary vocational education (polytechnic degree) when compared with tertiary academic education (university degree) by gender, age cohort, and occupation skill level. The younger cohort includes those who were 25 years or younger at the time of survey; the older cohort contains individuals who were 26 years old or beyond. High-skills occupations are occupations coded 1, 2 and 3 in International Standard of Classification of Occupations-08 (ISCO-08), and middle and low-skill occupations contain the rest in ISCO-08. Covariates include the linear and quadratic forms of job experience, gender(only for estimations by age cohort), marital status, migrant status, occupation (only for estimations by gender and age cohort), and the fixed effect of city and survey year. Instrumental variables include a) HE expansion, b)birth month trend, c) agricultural Hukou at college entrance exams, and the interactions terms of the three variables. Standard errors are clustered at city. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The full tables, including the first-stage and reduced-form results are available upon request from the authors. Data source: China General Social Survey (2010-2017).

Appendices

A Supplementary figures and tables

Table B.1: Highest education attainment, birth cohorts 1977-1983

	(1)	(2)	(3)
	Post-expansion	Pre-expansion	Diff. [(1)-(2)]
No education	0.025 (0.156)	0.022 (0.148)	0.002 [0.42]
Primary education	0.108 (0.310)	0.124 (0.329)	-0.016 [-1.38]
Lower secondary education	0.318 (0.466)	0.336 (0.472)	-0.017 [-1.02]
Vocational secondary education	0.111 (0.314)	0.104 (0.305)	0.007 [0.64]
Academic secondary education	0.089 (0.285)	0.102 (0.303)	-0.013 [-1.23]
Polytechnics	0.154 (0.361)	0.147 (0.354)	0.007 [0.56]
University	0.172 (0.378)	0.144 (0.351)	0.029 [2.18]***
Postgraduate's degree	0.022 (0.147)	0.021 (0.144)	0.001 [0.19]
N	1533	1513	

Note: The table contains the summary statistics of highest education attainments for individuals born within three years before and after September 1980 (between September 1977 and September 1983). Significance level for t statistics: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: China General Social Survey (CGSS) 2010-2017.

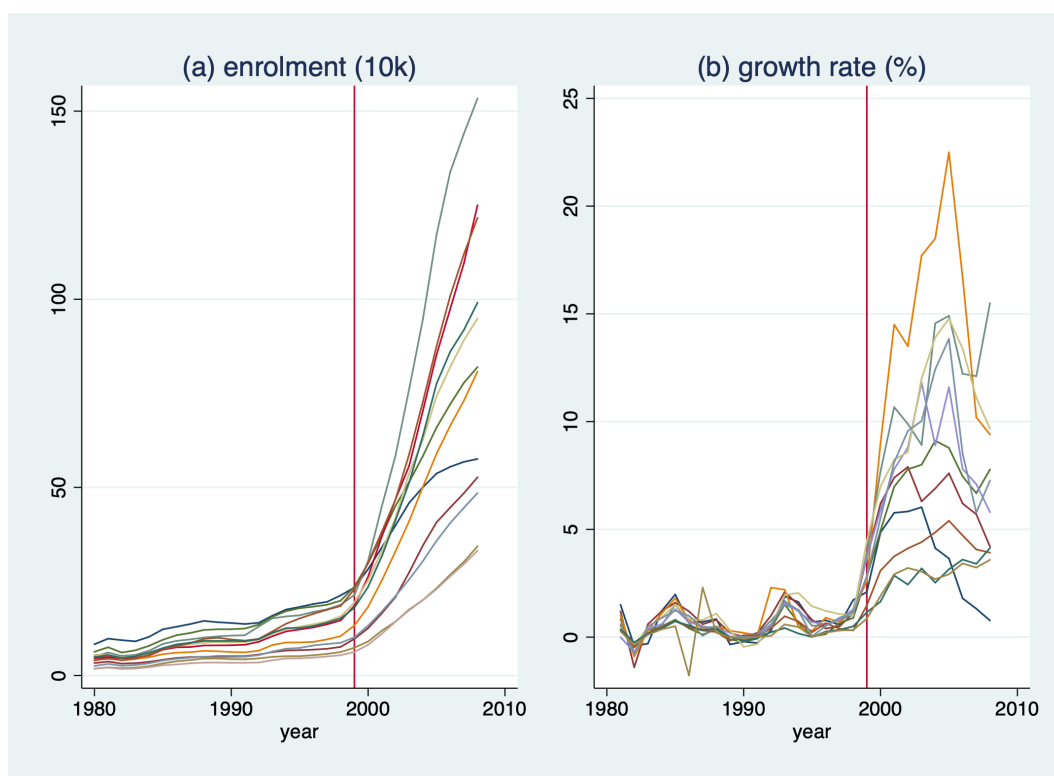


Figure A.1: Enrolment changes in selected province

Notes: The figure shows the changes in tertiary education enrolment in several centrally administered metropolises and provinces, which include Beijing, Shanghai, Anhui, Shandong, Henan, Hubei, Hunan, Guangdong, Chongqing, Sichuan, Yunan, Gansu. Data source: China Education Yearbook (1981-2009).

Table B.2: Monetary return to vocational education, alternative IV set

	(1)	(2)	(3)
Dependent variable: logged annual wage	IV	IV	IV
Vocational education	-0.465 (0.057)***	-0.458 (0.054)***	-0.434 (0.056)***
Experience	0.070 (0.011)***	0.069 (0.014)***	0.058 (0.015)***
Experience ²	-0.002 (0.001)***	-0.002 (0.001)***	-0.002 (0.001)***
Female		-0.240 (0.027)***	-0.242 (0.026)***
Married		0.042 (0.039)	0.039 (0.040)
Migrant		0.235 (0.023)***	0.234 (0.025)***
Professionals			-0.118 (0.035)***
Technicians and Associate Professionals			-0.154 (0.039)***
Clerical Support Workers			-0.173 (0.038)***
Services and Sales Workers			-0.078 (0.048)
Skilled Agricultural, Forestry and Fishery Workers			-0.356 (0.372)
Craft and Related Trades Workers			-0.215 (0.063)***
Plant and Machine Operators and Assemblers			-0.165 (0.084)**
Elementary Occupations			-0.310 (0.070)***
Constant	10.785 (0.039)***	10.776 (0.038)***	10.957 (0.046)***
City fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
First-stage estimates and statistics			
HE expansion (HE)	-0.090 (0.028)**	-0.090 (0.028)**	-0.088 (0.028)**
Birth month trend (MT)	-0.025 (0.002)***	-0.025 (0.002)***	-0.023 (0.002)***
HE * MT	0.048 (0.003)***	0.048 (0.003)***	0.045 (0.003)***
Kleibergen-Paap LM statistics	20.139	20.499	21.722
p-value(LM)	0.000	0.000	0.000
Kleibergen-Paap rk Wald F statistics	66.678	63.051	58.657
Hansen J statistics	2.764	1.806	0.943
p-value(Hansen J)	0.251	0.405	0.624
N	3606	3604	3385

Note: The table includes least squares results on the wage premium/penalty associated with tertiary vocational education (polytechnic degree) when compared with tertiary academic education (university degree). Experience denotes year of working experience (age - years of schooling - 7). Males, the unmarried, the non-migrant and managers (Group 1 in ISCO-08) are omitted. Armed forces occupations are excluded from the study sample. HE expansion indicates whether an individual is subject to higher education expansion in 1999. Birth month trend is a continuous variable for the month of birth, and September 1980 is set as the baseline. Standard errors are clustered at city. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: China General Social Survey (2010-2017).

Table B.3: Monetary return to vocational education, pre-1984 birth cohort

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: logged annual wage	OLS	OLS	OLS	IV	IV	IV
Vocational education	-0.277 (0.032)***	-0.271 (0.031)***	-0.228 (0.029)***	-0.442 (0.062)***	-0.440 (0.060)***	-0.405 (0.061)***
Experience	0.023 (0.005)***	0.026 (0.005)***	0.024 (0.005)***	0.035 (0.011)***	0.041 (0.012)***	0.036 (0.014)***
Experience ²	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.001)**	-0.001 (0.001)**	-0.001 (0.001)
Female		-0.226 (0.026)***	-0.238 (0.027)***		-0.243 (0.032)***	-0.244 (0.029)***
Married		0.050 (0.048)	0.038 (0.042)		0.009 (0.056)	-0.010 (0.052)
Migrant		0.224 (0.028)***	0.222 (0.029)***		0.242 (0.032)***	0.245 (0.032)***
Professionals			-0.059 (0.031)*			-0.077 (0.034)**
Technicians and Associate Professionals			-0.092 (0.032)***			-0.112 (0.050)**
Clerical Support Workers			-0.178 (0.034)***			-0.159 (0.043)***
Services and Sales Workers			-0.135 (0.054)**			-0.078 (0.062)
Skilled Agricultural, Forestry and Fishery Workers			-0.687 (0.324)**			-0.426 (0.450)
Craft and Related Trades Workers			-0.272 (0.052)***			-0.210 (0.068)***
Plant and Machine Operators and Assemblers			-0.215 (0.048)***			-0.081 (0.074)
Elementary Occupations			-0.374 (0.064)***			-0.329 (0.088)***
Constant	10.943 (0.050)***	10.915 (0.060)***	11.067 (0.062)***	11.004 (0.070)***	10.977 (0.071)***	11.122 (0.075)***
City fixed effects	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES
First-stage estimates and statistics						
HE expansion (HE)				-0.101 (0.045)**	-0.104 (0.045)**	-0.097 (0.047)**
Birth month trend (MT)				-0.023 (0.002)***	-0.023 (0.002)***	-0.022 (0.002)***
Agricultural Hukou (AH)				-0.019 (0.063)	-0.020 (0.062)	-0.026 (0.061)
HE * MT				0.042 (0.003)***	0.042 (0.003)***	0.040 (0.003)***
HE * AH				-0.018 (0.091)	-0.017 (0.091)	-0.002 (0.095)
AH * MT				0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
HE * AH * MT				0.003 (0.003)	0.002 (0.003)	0.002 (0.003)
Kleibergen-Paap LM statistics				24.209	24.538	23.286
p-value(LM)				0.001	0.001	0.002
Kleibergen-Paap rk Wald F statistics				38.365	38.826	32.093
Hansen J statistics				4.733	6.444	6.023
p-value(Hansen J)				0.578	0.375	0.421
N	4013	4010	3753	2584	2582	2456

Note: The table includes least squares results on the wage premium/penalty associated with tertiary vocational education (polytechnic degree) when compared with tertiary academic education (university degree). The sample is kept to those who were born before September 1984, in order to prevent the confoundedness from the vocational education promotion policy effective from 2003. Experience denotes year of working experience (age - years of schooling - 7). Males, the unmarried, the non-migrant and managers (Group 1 in ISCO-08) are omitted. Armed forces occupations are excluded from the study sample. HE expansion indicates whether an individual is subject to higher education expansion in 1999. Birth month trend is a continuous variable for the month of birth, and September 1980 is set as the baseline. Agricultural Hukou indicates whether an observation hold agricultural Hukou (household registration) when taking the college entrance exams. Standard errors are clustered at city. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: China General Social Survey (2010-2017).

Table B.4: Variations in vocational premium along wage distribution, pre-1984 birth cohort

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	1st decile	2nd decile	3rd decile	4th decile	5th decile	6th decile	7th decile	8th decile	9th decile
Panel A: Quantile regression (education is treated as exogenous) N=3753									
Vocational Education	-0.254 (0.024)***	-0.219 (0.015)***	-0.223 (0.015)***	-0.203 (0.017)***	-0.193 (0.017)***	-0.181 (0.015)***	-0.185 (0.017)***	-0.210 (0.020)***	-0.186 (0.023)***
Experience	0.035 (0.006)***	0.026 (0.004)***	0.028 (0.003)***	0.023 (0.005)***	0.024 (0.004)***	0.023 (0.004)***	0.020 (0.004)***	0.018 (0.005)***	0.012 (0.005)**
Experience ²	-0.001 (0.000)***	-0.001 (0.000)***	-0.001 (0.000)***	-0.000 (0.000)***	-0.001 (0.000)***	-0.000 (0.000)***	-0.000 (0.000)***	-0.000 (0.000)**	-0.000 (0.000)**
Female	-0.294 (0.023)***	-0.258 (0.019)***	-0.227 (0.016)***	-0.197 (0.017)***	-0.206 (0.017)***	-0.210 (0.015)***	-0.212 (0.016)***	-0.205 (0.019)***	-0.196 (0.021)***
Married	0.076 (0.039)*	0.009 (0.032)	0.025 (0.021)	0.014 (0.033)	-0.000 (0.033)	0.011 (0.028)	0.020 (0.025)	0.011 (0.043)	0.051 (0.047)
Migrant	0.174 (0.059)***	0.179 (0.020)***	0.174 (0.026)***	0.189 (0.031)***	0.205 (0.035)***	0.215 (0.033)***	0.253 (0.023)***	0.234 (0.035)***	0.284 (0.048)***
Constant	10.213 (0.130)***	10.602 (0.052)***	10.742 (0.062)***	10.936 (0.062)***	11.088 (0.069)***	11.272 (0.054)***	11.421 (0.050)***	11.590 (0.085)***	11.990 (0.097)***
Occupation	YES	YES	YES	YES	YES	YES	YES	YES	YES
City fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Panel B: Instrumental variable-quantile regression (education is treated as endogenous) N=2595									
Vocational education	-0.404 (0.100)***	-0.388 (0.060)***	-0.380 (0.057)***	-0.359 (0.040)***	-0.346 (0.047)***	-0.351 (0.064)***	-0.338 (0.084)***	-0.317 (0.074)***	-0.303 (0.083)***
Experience	0.033 (0.026)	0.028 (0.016)*	0.031 (0.011)***	0.029 (0.011)***	0.029 (0.014)**	0.032 (0.013)**	0.021 (0.014)**	0.007 (0.025)	0.030 (0.037)
Experience ²	-0.001 (0.001)	0.001 (0.001)*	-0.001 (0.001)**	-0.001 (0.000)*	-0.001 (0.001)	-0.001 (0.001)	-0.000 (0.001)	0.000 (0.001)	-0.001 (0.002)
Female	-0.254 (0.033)***	-0.231 (0.032)***	-0.226 (0.025)***	-0.219 (0.024)***	-0.221 (0.024)***	-0.228 (0.024)***	-0.243 (0.023)***	-0.241 (0.034)***	-0.225 (0.085)**
Married	0.110 (0.056)	0.045 (0.052)	0.022 (0.043)	0.009 (0.056)	-0.012 (0.050)	-0.001 (0.045)	0.012 (0.045)	0.071 (0.059)	0.019 (0.085)
Migrant	0.184 (0.070)***	0.167 (0.054)***	0.159 (0.040)***	0.160 (0.044)***	0.167 (0.041)***	0.200 (0.052)***	0.240 (0.056)***	0.257 (0.039)***	0.292 (0.053)***
Constant	10.294 (0.683)***	10.284 (0.501)***	10.462 (0.493)***	10.509 (0.473)***	10.608 (0.438)***	10.604 (0.301)***	10.663 (0.496)***	10.934 (0.489)***	10.366 (0.603)***
Occupation	YES	YES	YES	YES	YES	YES	YES	YES	YES
City fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: The table includes the quantile regression results on the wage premium/penalty associated with tertiary vocational education (polytechnic degree) when compared with tertiary academic education (university degree) along the conditional wage distribution. The sample is kept to those who were born before September 1984, in order to prevent the confoundedness from the vocational education promotion policy effective from 2003. Experience denotes year of working experience (age - years of schooling - 7). Males, the unmarried, and the non-migrant are omitted. In IV-QR estimation, the instrumental variables include a) HE expansion, b) birth month trend, c) agricultural Hukou at college entrance exams, and the interactions terms of the three variables. Standard errors are clustered at city. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The full tables of estimates are available upon request from the authors. Data source: China General Social Survey (2010-2017).

Table B.5: Distributional vocational effects by gender and age cohort

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	1st decile	2nd decile	3rd decile	4th decile	5th decile	6th decile	7th decile	8th decile	9th decile
Panel A: Quantile regression estimates by gender									
Male	-0.223	-0.195	-0.208	-0.192	-0.148	-0.124	-0.134	-0.193	-0.217
(N=2639)	(0.026)***	(0.023)***	(0.019)***	(0.022)***	(0.024)***	(0.016)***	(0.021)***	(0.023)***	(0.018)***
Female	-0.197	-0.219	-0.275	-0.252	-0.244	-0.258	-0.237	-0.242	-0.262
(N=2113)	(0.039)***	(0.026)***	(0.024)***	(0.025)***	(0.022)***	(0.020)***	(0.026)***	(0.023)***	(0.030)***
Panel B: Instrumental variable-quantile regression estimates by gender									
Male	-0.397	-0.337	-0.303	-0.282	-0.285	-0.274	-0.326	-0.290	-0.394
(N=1771)	(0.098)***	(0.064)***	(0.061)***	(0.082)***	(0.071)***	(0.085)***	(0.089)***	(0.059)***	(0.074)***
Female	-0.553	-0.528	-0.491	-0.447	-0.441	-0.434	-0.405	-0.387	-0.458
(N=1611)	(0.090)***	(0.061)***	(0.050)***	(0.036)***	(0.034)***	(0.035)***	(0.054)***	(0.053)***	(0.049)***
Panel C: Quantile regression estimates by age cohort									
Younger	-0.172	-0.196	-0.240	-0.252	-0.217	-0.191	-0.183	-0.164	-0.223
(N=1662)	(0.052)***	(0.036)***	(0.030)***	(0.026)***	(0.033)***	(0.029)***	(0.025)***	(0.032)***	(0.028)***
Older	-0.217	-0.206	-0.207	-0.175	-0.179	-0.170	-0.167	-0.204	-0.247
(N=3090)	(0.031)***	(0.016)***	(0.019)***	(0.016)***	(0.016)***	(0.014)***	(0.019)***	(0.017)***	(0.022)***
Panel D: Instrumental variable-quantile regression estimates by age cohort									
Younger	-0.605	-0.488	-0.474	-0.468	-0.471	-0.410	-0.358	-0.344	-0.376
(N=1645)	(0.132)***	(0.131)***	(0.110)***	(0.072)***	(0.050)***	(0.047)***	(0.050)***	(0.075)***	(0.025)***
Older	-0.336	-0.334	-0.329	-0.297	-0.284	-0.250	-0.312	-0.245	-0.189
(N=1740)	(0.096)***	(0.066)***	(0.064)***	(0.056)***	(0.069)***	(0.068)***	(0.117)***	(0.080)***	(0.030)***
Panel E: Quantile regression estimates by occupation skill level									
High skills	-0.206	-0.205	-0.232	-0.201	-0.174	-0.171	-0.183	-0.189	-0.138
(N=2,988)	(0.030)***	(0.019)***	(0.018)***	(0.017)***	(0.016)***	(0.017)***	(0.016)***	(0.021)***	(0.023)***
Middle and low skills	-0.267	-0.266	-0.262	-0.277	-0.277	-0.272	-0.236	-0.273	-0.334
(N=1,764)	(0.039)***	(0.022)***	(0.022)***	(0.028)***	(0.024)***	(0.028)***	(0.033)***	(0.030)***	(0.028)***
Panel F: Instrumental variable-quantile regression estimates by occupation skill level									
High-skill	-0.518	-0.464	-0.441	-0.419	-0.380	-0.349	-0.352	-0.315	-0.245
(N=2058)	(0.063)***	(0.077)***	(0.076)***	(0.049)***	(0.045)***	(0.051)***	(0.057)***	(0.066)***	(0.052)***
Middle and low-skill	-0.332	-0.331	-0.325	-0.340	-0.340	-0.344	-0.351	-0.354	-0.384
(N=1372)	(0.094)***	(0.098)***	(0.090)***	(0.079)***	(0.069)***	(0.052)***	(0.040)***	(0.071)***	(0.108)***

Note: The table includes the quantile regression results on the wage premium/penalty associated with tertiary vocational education (polytechnic degree) when compared with tertiary academic education (university degree) along the conditional wage distribution. The younger cohort includes those who were 30 years or younger at the time of survey; the older cohort contains individuals who were 31 years old or beyond. Covariates include the linear and quadratic forms of job experience, gender(only for age cohort), marital status, migrant status, occupation, and the fixed effect of city and survey year. In IV-QR estimation, the instrumental variables include a) HE expansion, b) birth month trend, c) agricultural Hukou at college entrance exams, and the interactions terms of the three variables. Standard errors are clustered at city. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The full tables of estimates are available upon request from the authors. Data source: China General Social Survey (2010-2017).