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ABSTRACT

Does Vocational Education Pay off in China? Evidence from City-Level Education Supply Shocks*

China hosts the world's largest secondary education sector: more than 14 million adolescents enrol in secondary academic or vocational schools every year. Despite the large literature on returns to education, little evidence exists as to how these two streams compare in the country. Using 2013 China Household Income Project data, we estimate the returns to secondary vocational education both at the mean and along the conditional wage distribution. We use instrumental variables based on the considerable variation in education provision across cities and years (and a 1995 policy reform). We find that vocational education generates a large wage premium (up to 54%), especially for those of lower earnings potential. Our findings indicate that vocational education can be a good option for those who do not wish to enter tertiary education, especially the less well-off.

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

Keywords: returns to education, vocational education, heterogeneity, instrumental variable quantile regression, China

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1 Introduction

As more young people in developing countries attend secondary schools, the choice between academic and vocational education becomes increasingly relevant. In the context of diminishing returns to schooling and proliferation of diversified skills, measuring returns to different educational types becomes ever more important. This is the case both from an individual and a public policy perspective.

The study of labour market effects of educational tracking is a well-established area in economics of education research (Hanushek and Wössmann, 2006; Jäger, 2016). In addition to the mean effect, an increasing number of studies pay attention to how different tracks of education benefit heterogeneous individuals. A common view is that secondary vocational education graduates enjoy better employability and higher wages upon graduation. However, these early career advantages may diminish or even turn into disadvantages in the long run (Hanushek et al., 2017).

Most studies explain this phenomenon from the perspective of technology iteration and skill upgrading. The occupation-specific knowledge and skills acquired in vocational education may quickly become obsolete in the context of rapid technological changes (Hanushek et al., 2017; Brunello and Rocco, 2015, 2017; Silliman and Virtanen, 2022; Kemper and Renold, 2024). However, this theory may not explain the fact that vocational education and training (VET) proves a better alternative than academic education for those who are more likely to drop out of school early, the minority groups or from disadvantageous backgrounds, even in their late career (Neuman and Ziderman, 2003; Brunello and Rocco, 2015).

To better understand what drives these heterogeneous effects of vocational education, it is worthwhile to investigate how educational tracking complements or substitutes for the human capital accumulated through other means. To do so, a useful approach is to estimate the distributional effects of vocational education for those of different earnings potential.

Our study contributes to the literature by providing evidence on the individual wage returns to vocational vis-à-vis academic education in the specific case of China. China is an important country in this debate because of its size and the resulting large number of graduates from different types of education: there are nearly eight million graduates each year from either vocational or academic education, as shown in Figure 1.

Our evidence may also be particularly relevant as Chinese firms seek to upgrade their

position in the global value chain and adjust to the consequences of the Covid-19 pandemic. In this context, the education profiles of their workers may be an increasingly important driver of such development process, including large spillovers (Cui and Martins, 2021). Other developing countries seeking to enhance their workforce's skill level may find these results relevant. Our evidence may also inform public and private educational investment decisions, regarding the allocation of scarce resources between academic and vocational education.

(Figure 1 here)

We also note that the research on the returns to different tracks of education faces several challenges. On the one hand, students may self-select into vocational or academic education, given different entry requirements and education/career prospects that each track offers. In this case, observational analyse would generate biased estimates and misleading conclusions. On the other hand, each track of education will be subject to heterogeneity in its quality and return. For example, Gomis et al. (2020) indicates that although academic education is generally preferred over vocational education, the latter plays a vital role to increase young workers' resilience in economic downturns, such as the pandemic. In addition, the labour market is highly heterogeneous for individuals with different education/skill portfolios and productivity potential. Although the estimation of the mean effect of a type of education provides useful information, it may overlook important variation in returns across individuals.

In this context, we believe this is the first study to allow for heterogeneous earnings effects of the two education tracks and to do so while tackling endogeneity. More specifically, our estimations combine quantile regression (QR) and instrumental variables (IV). On the latter, our approach draws on the literature that examines the role of education provision in individual schooling decision and the resulting labour market outcomes (Card, 1993; Duflo, 2001; Carneiro et al., 2022). We exploit the geographical and year variation in education provision, including education funding, the distribution of school and the number of teachers, relative to the number of school-going age students, in order to instrument individual's choice of education track. We also draw on a 1995 policy reform that made VET less attractive for students as it removed a job guarantee to VET graduates.

Our OLS and QR results (disregarding endogeneity) show that the earning differences between secondary vocational and secondary academic graduates are neither economically nor statistically significant both on average and along the conditional wage distribution. Our

first-stage results of 2SLS estimation show a statistically significant correlation between the education provision in an individual's city and year of entering the upper secondary education, on the one hand, and the individual's secondary vocational education completion, on the other hand. After controlling for selection with the education provision instrumental variables, we find that, on average, secondary vocational education does generate a significant wage premium of approximately 54%. We also find that this result is robust after using an alternative identification strategy, as well as controlling for vertical and horizontal job mismatch and selection into tertiary education among secondary academic graduates.

Moreover, our instrumental variable quantile regression (IV-QR) results show evidence of variations in the vocational effects across the conditional wage distribution. Specifically, the wage premium from vocational education is more pronounced for the individuals of lower earnings potential. For example, individuals at the bottom decile of the earning distribution earn 1.77 times more by taking the vocational track. Although the vocational premium declines when moving up along the conditional wage quantiles, the magnitudes are still substantial, standing at around 53% for those at the fifth deciles. However, for those with higher-than-average earning potential, secondary vocational education leads to neither wage premium nor penalty when compared to secondary academic education.

The remaining of the paper is organised as follows. Section 2 provides a literature review on the labour market outcomes of different tracks of education and an overview of the Chinese vocational education system. The research design and the data are described in Section 3 and 4. The empirical results are presented and discussed in Section 5 and Section 6, respectively. The final section concludes.

2 Research context

2.1 Literature review

2.1.1 Vocational versus academic education

Existing research on whether vocational or academic education offers generally better labour market prospects provides mixed findings. Some studies credit vocational education for higher employability (O'Reilly et al., 2015) and as a useful active labour market policy (Eichhorst et al., 2015). In addition, the benefits of vocational education extend beyond labour market

outcomes. Traditionally, vocational education and training are associated with skills and quality of work, leading to respectful job titles in many societies (Jäger, 2016; Hutchinson and Kettlewell, 2015). Moreover, vocational education may keep low achievers in school (Brunello and Rocco, 2015), increasing their skills and preventing them from becoming 'NEETs (not in employment, education or training)'.

In contrast, there are studies that associate vocational education with poor labour market outcomes. Evidence of wage penalties suffered by vocational education graduates is reported in several papers, e.g., in Brunello and Rocco (2015). Some indicate a trade-off between short-term gains and long-term losses, as the skills acquired in vocational education facilitate quicker school-to-work transitions, but may become increasingly outdated over time, resulting in poorer career prospects in the medium term (Hanushek et al., 2017). Indeed, in a review of returns to education studies over the past two decades, Psacharopoulos and Patrinos (2018) conclude that there is a wage premium of academic education over vocational education.[1]

There is little evidence that compares the returns to vocational and academic education in China. Among the limited quantitative evidence, Li et al. (2012) regress wages on a list of qualification dummies using a sample of twins in urban China. They find that the returns to secondary vocational education are 15-23% higher than lower secondary education, whereas the wage premium of upper secondary academic education ranges between 2% and 13%. Guo and Wang (2020) show that secondary vocational education generates a wage premium of 10% when compared with the academic education of the same level in a propensity score matching design. At tertiary level, on the contrary, tertiary academic education offers a wage premium of 35-40% over tertiary vocational education.

To address selection into different educational tracks, Meer (2007) applies multinomial logit in a first-stage equation to form counterfactuals for those in the vocational track. Using the 1999 wave of the US National Education Longitudinal Survey, the study shows that individuals with vocational qualifications would earn 3.7% less if they had been on the academic track. On the other hand, the income of academic graduates would be 18.0% less if they had taken the vocational track. However, unobserved characteristics and circumstances (Ota and Moffatt, 2007), as well as expectations for future earnings (Wilson et al., 2005), may also matter when making the choice between academic and vocational education. Oosterbeek and Webbink

[1] A different stream of this literature considers the effects of VET on student achievement - see Ferreira and Martins (2023) for a recent illustration. See also Dai and Martins (2024) for a recent evaluation of vocational education in China at the higher education level.

(2007) applies difference-in-differences to evaluate the long-term wage effect of a one-year extension of vocational education in the Netherlands in 1975, and find no marginal effect on income.

Instrumental variables are another frequently used method to estimate the returns to vocational education. For instance, Fersterer et al. (2008) use exogenous changes in apprentice duration that resulted from the failure of host firms in Austria. Their results show that the IV estimates of the marginal return to an additional year of apprenticeship are comparable with the OLS estimates, which suggests that selection into apprenticeship may be limited. Cappellari (2004) shows that, with multiple IVs derived from family characteristics, including grandparents' schooling, academic graduates are more likely to be in the low-pay group than the vocationally educated. Chen and Pastore (2022) utilise drastic changes in the share of university graduates in population across Chinese provinces to instrument individual choice between vocational and academic education. Their study indicates that university education provides a wage premium of approximately 6% when compared to polytechnics. Yet the results for secondary education are inconclusive.

2.1.2 Heterogeneity in returns to education

Another topic of interest is the heterogeneity in the returns to vocational education. Although estimating the mean return provides useful information, the analysis of how labour market rewards education for individuals with different characteristics can increase our understanding of the role of human capital. Some studies investigate heterogeneity in vocational wage effects by splitting samples by observables, e.g., gender, age cohort, etc. Another useful, and potentially more intuitive, approach is to examine heterogeneity in unobserved characteristics across the conditional outcome distribution (Koenker and Bassett Jr, 1978). Martins and Pereira (2004) investigate the heterogeneous effects of an additional year of schooling on wages using European and US data. Their study shows a consistent pattern across most of the 16 countries sampled that the individuals at upper quantiles receive higher marginal returns to schooling. However, this study did not differentiate between academic and vocational education. Neither did it consider the endogeneity of schooling.

Heterogeneity in the quality of vocational education provision and in labour market outcomes of vocational education graduates has been observed in many studies (Wolf, 2011;

Dearden et al., 2002). However, only two papers that we know examine the heterogeneity in the returns to one track of education over the other. McIntosh and Morris (2021) use quantile regression to estimate the returns to vocational qualifications, and provides evidence of heterogeneity in the earnings gap between the academically educated and the vocational educated by levels of education and subject areas. Balestra and Backes-Gellner (2017) use the same approach to examine heterogeneous wage effects of vocational and academic education and show that vocational education is better rewarded than academic education at lower quantiles. However, both McIntosh and Morris (2021) and Balestra and Backes-Gellner (2017) did not address the issue of individual selection into different tracks of education.

2.2 The case of China

2.2.1 Characteristics of vocational education

In China, vocational education forms a parallel track to academic education, yet possesses unique features of its own. As to the structure of the educational system, students who complete the nine-year compulsory education (six years of primary education plus three years of lower secondary education) can choose between academic education at secondary academic schools and vocational education at secondary vocational schools, or entering the labour market (Figure 2). Entering the academic or vocational track is largely determined by a student's performance in upper secondary entrance exams, subject to the total slots available in the city and year. Typically, the scores required to enter academic education are higher than those for entering vocational education. In addition, academic admission precedes vocational admission. Students who fail to meet the requirements of academic education enter the pools for vocational admission. Students whose scores fall below the vocational education requirement can either resit high school entrance exams in the following year or drop out. Per Ministry of Education, in 2022, 91.6% of 16.2 million compulsory education graduates entered upper secondary education. Within this group, 9.5 were enrolled in upper-secondary academic education, and 6.7 million in vocational education.

(Figure 2 here)

Interestingly, vocational education was once a preferred option for those who did not plan to progress to higher education, for providing guaranteed employment in public-owned

firms upon graduation and waiving tuition fees. However, a 1995 policy wrote off such benefits enjoyed by secondary vocational education students and resulted in reduced demand for vocational education compared to academic education.[2]

Since then, according to Pepper (2000), the stereotype that 'bad students attend vocational schools' prevails among Chinese families and even some education practitioners. For instance, Jiang and Xu (2005) use a probit model and find that vocational schools in China tend to enrol students from poor social and economic backgrounds. This is supported by Hannum et al. (2011) and Huang et al. (2022), who show that educational opportunity and selection by exams largely determine students' transition to secondary and tertiary education in the context of China. Ling (2015) points to discrimination against vocational education through narratives from vocational graduates in China. The study indicates that vocational education, together with the hukou policy[3], serve as policy leverage to prevent the assimilation of immigrants' children into the local labour market. Specifically, children of immigrants are offered priority in admission into vocational education, which prepares them for the occupations that are predominantly taken by their migrant parents.

2.2.2 Education provision as a policy lever

Chinese vocational education experienced a volatile course of development as the government's priorities shift between vocational and academic education for decades. According to Tsang (2000), the shifts largely result from the 'two-line struggles' between conservatives and reformers within the ruling Communist party, which were reflected on three education dilemmas: education for political/ideological development versus economic development, education for equality versus efficiency, and positive versus negative attitude towards the intellectuals. As a legacy of the communist era, planning is still embedded in Chinese educational policy, as demonstrated by many studies, e.g., in Zheng (2018). Educational provision through public

[2]The *Opinion on Reform and Develop Secondary Vocational Education* was issued by National Commission of Education (Now Ministry of Education) in May 1995. It mandated a change in the role of government in vocational education, from a central planner in admission, provision and employment, to supervision and administration. This happened in a broader context of nationwide market-oriented reforms in most sectors. In the empirical section, we show that such policy discouraged students from attending and subsequently graduating from secondary vocational education. We also utilise this policy shock to identify the causal relationship between vocational education and earnings as a robustness check.

[3]The hukou, or household registration, policy is an institution by which every individual is registered as a resident of a particular administrative area since birth. Geographic migration (and social mobility, e.g., agricultural to non-agricultural) is largely limited by the hukou. Although the constraints placed by the hukou system have now been largely eliminated, they still relate to the entitlement of local social benefits. Migrant workers without the local hukou are not fully entitled to the benefits provided by governments to local residents, e.g., free compulsory education.

education expenditure, school construction, and teacher availability are frequently-used tools to adjust the supply of skilled workers to serve particular development priorities.

For example, the country's 12th 'pivotal guideline for social and economic development', *Five-year Plan for National Economic and Social Development (2011-2015)*, prioritises the supply of skilled workers to meet the labour market demand from progressing urbanisation and industrialisation. Ministry of Education responds to this guideline by publishing a key policy, *National Guideline for Intermediate and Long-term Educational Reform and Development (2010-2020)*, which mandates to increase spending to vocational education, the number of teachers and the number of vocational education institutions, among other initiatives.

Notably, the administrative and fiscal decentralisation in the late 20th century had a substantial impact on public education provision. Between 1949 and mid 1980, the central government was the sole provider of education, and public education funding was allocated equally across regions under the idea of egalitarianism. Since a major administrative and fiscal decentralisation reform in 1994, the new arrangement requires that preschool, primary and secondary education (both academic and vocational) were administered and funded by municipal and prefecture governments, under the guidance of provincial governments.

The local governments enjoyed great autonomy in the planning, establishment, supervision, and funding of secondary or lower education institutions. The fiscal decentralisation resulted in substantial regional discrepancies in education provision (Hansen and Woronov, 2013). Besides, the dynamics in urbanisation and industrialisation across China also lead to variation in educational investment (Lin et al., 2004). Moreover, previous studies have shown that local public education provision demonstrates some 'randomness' concerning local leaders, whose preference between productive goods (e.g., infrastructure) provision and protective goods (e.g., education, health care) provision influences local educational expenditure (Tian et al., 2022; Ye and Zhou, 2017; Lu and Li, 2006; Li and Zhou, 2005; Qiao et al., 2005).

The regional discrepancy in education provision is also significant with respect to different types of education. Nationally, there is no minimal requirement for public expenditure per student in secondary vocational or academic education. *National Guideline for Intermediate and Long-term Educational Reform and Development (2010-2020)* indicates that the provincial governments shall publish and implement basic standards for funding secondary vocational education in the region. As Hu (2010) shows, the public expenditure to secondary vocational

education in the capital city of Beijing is 6.3 times of that in Hubei province. And in the light of high cost of vocational education and training (ETF, 2018), empirical research has shown that the public expenditure to secondary vocational education per student in most Chinese provinces lagged behind that to academic education (Ran, 2013), yet enjoys higher growth rate (Hu, 2010)[4]. The conventional wisdom of diminishing marginal return may indicate that an increase in funding, *ceteris paribus*, may bring better results to vocational education.

This study takes advantage of the substantial changes in education provision by municipal governments to generate exogenous variation in education track choice. According to the relevant education laws and regulations, students are required to attend primary and secondary schools in their local prefecture or city. Although there are cases of migration for education reasons, the number is believed to be negligible. Therefore, an individual's schooling decision is likely to be affected by education provision in his or her city, in addition to individual and family characteristics. Moreover, the supply-side IVs derived from education provision enjoy some advantages when compared to demand-side IVs based on individual or family characteristics with respect to exclusions restrictions. We contend that year and geographic education adjustments act as a subtler version of educational reforms but are potentially powerful shifters of education choices, with significant potential for econometric identification. We will discuss this view in more details in the following section.

3 Research design

3.1 Empirical model

Our study investigates whether there is a wage premium or penalty associated with secondary vocational education, when compared to its academic secondary counterpart, in the case of China. We also investigate whether the wage premium/penalty varies among people of different earnings potential. Our empirical model is based on the conventional Mincerian wage equation by replacing the year-of-schooling variable by a dummy variable for whether an individual graduated from vocational or academic track before entering the labour market, as follows:

[4]For an analysis of the labour market of China from the perspective of wage determination, see Duan and Martins (2022) and the references therein.

$$Y_i = \beta_1 Voc_i + \beta_2 Age_i + \beta_3 Age_i^2 + \theta X_i + \gamma_i + \mu_i \quad (1)$$

where Y_i is the natural logarithm of the annual wage of individual i. Age_i denotes the age of the individual as of 2013. X_i denotes a vector of controlled variables, which includes gender and marital status. γ_i is a set of 14 provincial fixed effects. μ_i is the error term, which captures unobserved factors that affect wages. Voc_i is a dummy variable that denotes whether the highest educational qualification that an individual obtained is secondary vocational (when it takes value 1) or secondary academic (0). The coefficient for Voc_i, β_1, is the key object of interest in our study.

Given the fact that an individual is not randomly assigned to either vocational or academic education, we use instrumental variables as in the studies on the causality of education provision and individual schooling decision (e.g., Card (1993); Duflo (2001); Carneiro et al. (2022)). We use year and geographical variation in municipal education provision to instrument each individual's likelihood of attending vocational education. The education provision data are divided by the number of school-going age students by the year and city that apply to each case, namely the city where the individual was based and the year when the secondary vocational/academic decision was made.

The education provision includes (a) the total public education expenditure by municipal governments, (b) the number of general education schools and (c) the number of teachers in general education.[5] The causal identification strategy is derived from the fact that the greater the public spending in a given year and city, the higher the availability of secondary education. And as aforementioned, the effect on vocational education may be larger due to that fact that funding to vocational education lagged behind that to academic education, yet enjoys a faster growth rate. Moreover, a higher number of schools and teachers in the general track may provide more opportunities for students to attend general education (Card (1993); Duflo (2001)) than to the vocational track, resulting in a higher likelihood of completing general education.

The exclusions restriction is not directly testable. However, we reckon that such availability

[5]The data for vocational education schools and teachers are not available for most of the years when the sampled individuals made the secondary education choice.

of education provision will not have a direct effect on the wages of that individual other than through the education type itself. Indeed, wages will depend on the overall supply of graduates from different (younger and older) cohorts, when supply availability levels may have been very different. Besides, as shown in the Figure A.1, the variations in education provision across Chinese cities are not generally associated with economic performance, as richer cities in eastern and coastal China do not necessarily receive the highest levels of investment into education.

In addition, the municipal governments' education budgets include transfer payments by the central government. The latter aims precisely to reduce the correlation between local economic performance and education investment[6]. Moreover, since upper secondary education is planned and administered at the prefecture level, political factors like local education policies and/or preference of local policy makers towards productive and protective goods provision may further dwindle the potential correlation between education provision and wages.

On top of this, we control for provincial fixed effects to eliminate any potential cross-provincial pattern of correlation between education provision and wages. So while one's opportunities in terms of each track of education will vary depending on the education provision, one's outcomes in the labour market will be influenced by the relative supply of graduates of different vintages, over different time periods, and perhaps also including those that migrated to the current city.

To model heterogeneous vocational education effect on earnings, we adopt the quantile regression methods developed by Koenker and Bassett Jr (1978). The quantile regression method is applicable in scenarios where the independent variable of interest is exogenously determined. However, as indicated by Arias et al. (2002), variation of effects of vocational education along the conditional distribution of earnings may result from the endogeneity bias that also varies across earning quantile. Hence, we use the instrumental variable quantile regression (IV-QR) method developed by Chernozhukov and Hansen (2008, 2005) to tackle the endogeneity problem. The IV-QR method estimates the coefficients of interest along the conditional distribution of the dependent variable, given additional covariates. It is different from the unconditional quantile treatment effect (Firpo et al., 2009) in that those at the higher levels of the conditional wage distribution are not necessarily higher earners, but the

[6]In 2023 alone, the transfer payment into compulsory education amounted to CNY 227.4 billion, more than 10% of the total compulsory education expenditure in 2022 (MOE, 2023)

ones with higher unobserved earning ability or proneness (Doksum, 1974).

4 Data and variables

As aforementioned, we utilise the year and geographic differences in education provision (divided by the number of school-going age students) to generate exogenous variation in an individual education track decision. The education provision data are compiled from China City Statistical Yearbooks. The data are available between 1999 and 2020 and matched to individual data. Figures 3, 4 and A.2 present the changes in public expenditure, schools availability and teachers, relative to student numbers, across Chinese cities, in five-year intervals between 1999 and 2020. It is notable that the public spending in education by school-going-age student numbers by municipal governments increased substantially in the last two decades and became increasingly even across Chinese cities. General education schools by student numbers were tipically evenly distributed across Chinese cities in late 1990s.[7]

(Figures 3 and 4 here)

The individual data for our study are collected from the 2013 wave of the China Household Income Project (CHIP) data for the availability of city information. Starting from 1998, the CHIP data are among the most used data sets in social and economic researches concerning China, e.g., in Cheng et al. (2022), Li et al. (2021), and Guo et al. (2022). The data contain both objective and subjective items in representative surveys, ranging from physical information, mental health, and family to employment, education and training, etc.

In terms of education, we categorise the highest qualification into either vocational or academic education. The data do not provide information on an individual's education history. As from upper secondary to tertiary level, individuals in one education track can progress to the other education track. In this study we consider only the individuals who at most completed upper secondary education and for whom we are certain of their vocational/academic status. The study sample is kept to those of working age (16 to 65 years old) and in employment at the time of survey. We also keep only non-migrant workers in the sample: migrants in the data did not report their whereabouts in the year when they were expected to choose

[7]However, there was a significant increase in Western China in the 2000s. In addition, cities in Eastern China had a larger teacher-student ratios at general schools in the late 1990s, and early 2000s, and were overtaken by cities in western China in the 2010s.

educational track, which would prevent us from constructing IVs for them.

The number of observations in the study sample is 1,427, for which the summary statistics of key variables are provided in Table 1. Column (1) and (3) contain sub-samples by educational track. Column (5) show the statistics for the whole sample and the last column shows the differences. The mean age from our sample is 24 years. Female workers are slightly under-represented in both groups, at 41%. More than two fifth in both samples are married or cohabited.

That labour market outcomes differ for individuals from different educational tracks is also well recorded in empirical studies, e.g. Wössmann (2019) and Brunello and Rocco (2015). In our study sample, the difference with respect to occupations between academic and vocational education graduates is notable. The share of graduates working as technicians and associate professionals is slightly higher for vocational education, whereas academic education graduates are more likely to work in services and sales. These results provide evidence that vocational education offers education and training in the skills that are relevant to specific trades.[8]

(Table 1 here)

5 Results

In this Section, we present our empirical evidence of the wage returns to vocational education vis-à-vis academic education. We also investigate potential heterogeneity in relative returns among individuals of different earnings potential. We test the validity of education provision as instrumental variables for individual's likelihood of completing the vocational track, and provide 2SLS estimates of wage differentials between vocational and academic qualification holders. The heterogeneous secondary vocational education effect will be presented by instrumental variable quantile regression (IV-QR) results of the vocational education effect across the conditional wage distribution.

[8]We also find that vocational education graduates are more likely to be seen in the richer 1st-tier, 2nd-tier cities, or in more developed Eastern China. Of the 114 cities where the observations were surveyed, we group them by the overall performance/competency typically used in Chinese official documents: the first-tier cities include centrally administered metropolis; the second-tier cities include the capital city of an province and the economically (secondary) largest city in a province. Note: the largest city was chosen if the capital city is not the largest.

5.1 Vocational education average effect

Column (1) and (2) in Table 2 contain the OLS estimates of the mean returns to vocational education vis-à-vis academic education for our sample. The results indicate the wage differentials between the vocationally educated and the academically educated are neither economically nor statistically significant. As already mentioned, individuals are not randomly assigned to either track of education. Earlier evidence indicates substantial selection, as students may self-select based on unobserved characteristics like preferences or motivation, or may also be screened into either vocational or academic education based on their performance in upper secondary entrance exams. Excluding this information may bias the ordinary least squares estimates. We address the issue of selection in estimation using the instrumental variable approach.

(Table 2 here)

Column (3) - (10) in Table 2 report the 2SLS estimates and the corresponding first-stage results. We use different combinations of IVs to check the robustness of our identification strategy and results. And the first-stage results are consistent to our perception that public education spending by municipal government correlate positively to vocational education decision, even when we control for access to general education schools and teacher-student ratios in general education[9].

The first-stage results are informative and useful. A 1% rise in public education spending per school-going age students associates with a 9% to 10% increase in an individual's likelihood of completing vocational education. The results are consistent to previous findings on the causality between education provision and individual educational attainments, e.g., Card (1993) and Duflo (2001), implying that adjusting education provision can substantially influence individual schooling decision. However, we could not find any significant effect of school and teacher densities on individual track choice.

The main stage results show that secondary vocational education on average leads to a wage premium in relation to secondary academic education. When using the fully specified

[9]The 2SLS identification statistics indicate that the models are properly identified. The p-value for the Keibergen-Paap LM statistics are smaller than 0.05, rejecting the null hypothesis that a specific model is under-identified (Kleibergen and Paap, 2006). As a rule of thumb, the fist-stage F statistic larger than 10 would reject that the instruments are weak (Stock and Yogo, 2002). Moreover, Hansen's J statistics (Hansen, 1982) indicate that the estimates obtained under each just-identified model are not significantly different.

model, as in Column 10, we find that the vocational premium is approximately 54% (point estimate of .429). The results are comparable to similar studies for apprenticeship countries like Germany (Hanushek et al., 2017; Kemper and Renold, 2024). We believe the result is reasonable given the fact that the observations in the study sample are relatively young (the average age is 24 years) as VET premiums may diminish as individuals age (Wössmann, 2019; Hanushek and Wössmann, 2006; Brunello and Rocco, 2017).[10] We reckon the advantages of vocational education may be more obvious at the secondary level: secondary vocational education provides ready-to-use skills, which may, as least partly, substitute on-the-job training provided by employers. In comparison, secondary academic education typically prepares students for advancing into higher education. For those who only complete secondary education, the knowledge acquired at academic education does not necessarily translate into occupational skills that are valued by employers (Brunello and Rocco, 2015).[11]

Compared with the 2SLS results, the OLS estimates are biased downwards. This indicates that students may be negatively selected into secondary vocational education. As aforementioned, the notion that 'bad students go to vocational schools' prevails among Chinese families. When facing the choice between vocational and academic schools, most students and their family prefer academic education, despite of the fact that vocational education provides a better employment prospect for those who only complete secondary education. The other reason concerns the selection process of the Chinese education system. Upon completing lower secondary schools, better performing (possibly more motivated) students can enter academic schools. Those who fail to meet the entry requirements of academic schools automatically enter the pool of vocational education enrolment. A third possibility may be that the ready-to-use knowledge and skills learnt at secondary vocational education can quickly translate into higher salary and secure jobs, appealing to students from poorer families Eichhorst et al. (2015).

5.2 Robustness checks

To check the robustness of our baseline results, we conduct a number of additional analyses. These concern an alternative IV, an extended specification of our wage equation, the role of

[10] Note that Guo and Wang (2020), applying propensity score matching to the General Social Survey (CGSS), finds VET returns of around 10% when the average age of their sample is 38.

[11] We replicate the main model specification with the standard errors clustered at city and industry. Table B.2 presents the results, which are very similar to our main specification.

job mismatches, and potentially better comparisons with secondary academic graduates.

First, we utilise the 1995 nationwide vocational education reform mentioned above (subsection 2.2.1) as an alternative policy shock and IV. As aforementioned, this 1995 policy reform made vocational education less appealing to students, resulting in a large and persistent decline in the number of vocational education applicants from that year.

We implement this alternative IV robustness check by predicting an individual's secondary vocational education status from this policy shock and the person's birth month and year. As per the 1986 Compulsory Education Law, six-year-old students were required to attend primary education. Therefore, students who were exposed to the 1995 policy were necessarily born in and after September 1979 and we construct a dichotomous variable for policy exposure. We also construct a continuous variable indicating the number of months between birth and September 1979, in order to allow the policy's effect to change over time. We also include a variable for *Hukou*, as Huang and Zhu (2020) suggested that one's *Hukou* might affect education accessibility. Finally, we interact the three IVs to allow more flexibility in model specifications. The first-stage results show a significant negative effects of policy exposure upon one's vocational education choice, with coefficients of the key variable of -.115 or -.117. Moreover, the main stage outcomes of vocational education premiums support our baseline results: the VET coefficients are .373 and .446.

(Table 3 here)

In our second robustness check, we further control for industry and occupation fixed effects. This is useful for two reasons: First, this practice allows us to retrieve the overall vocational education effect on earnings while controlling for pay gaps across industries and occupations. Second, this extended set of controls may provide evidence of occupational sorting effects of different educational tracks. The results in Table B.3 show very small increases in vocational education premiums after controlling for the industry and occupation fixed effects. This finding suggests that secondary vocational education graduates are likely to be sorted into lower-paying industries and occupations.

Third, we take into account that previous research has shown that vocational graduates and academic graduates may experience job mismatch in different ways. The summary statistics in Table 1 also indicate that academic graduates are more likely to be over-educated in their respective cohort-occupational groups. In addition to the vertical job mismatch, the

prevalence of horizontal job mismatch may also differ between academic and vocational graduates (Schmelzer and Schneider, 2020). To proxy horizontal job mismatch, we summarise the occupational profiles of all vocationally educated individuals and academically educated individuals, as in Table B.4. In this study, an individual working in the occupation (two-digit occupational codes, ISCO-08) which is dominantly occupied by workers with the other degree (vocational vs. academic) is considered to experience horizontal job mismatch. Table 3 contains the estimated returns to vocational education once we include job mismatch indicators to the models. In Column (7)-(9), after adding vertical mismatch indicators the vocational premiums increase slightly. And when we include the indicator for horizontal mismatch, as in Column(10), the vocational premium increases slightly from 54% to 55%. The results are suggestive that secondary vocational graduates are more likely to be inversely affected by job mismatch, most notably horizontal job mismatch.

Finally, in our last robustness check, we consider that our study focuses on individuals who only completed secondary education. A caveat of using secondary academic graduates as a control group is that academic students at the secondary level may be more likely to enter tertiary education when compared to secondary vocational students, since a main goal of secondary academic education is to prepare students for tertiary education.[12] Moreover, better performing students at secondary academic schools are more likely to enter higher education. In other words, secondary academic graduates who entered the labour market upon graduations may be an adversely selected group within all secondary academic students.

To address such potential selection, we use propensity score matching (PSM) to construct an alternative control group within the original secondary academic graduates who are observationally similar to the secondary academic students who advanced to higher education. The matching outcome is illustrated in Figure A.4. As shown in Table 5, the 2SLS estimates of vocational premium when using the matched academic sample as the control group is reduced only slightly when compared with the results based on the original sample. The results suggest that there indeed exists selection between secondary academic education and tertiary education, as individuals with higher earnings ability are selected into higher education. However, the small difference between the results and the main ones also provides support to the robustness of the wage premium associated with secondary vocational education.

[12] According to *Education at Glance (2023)*, a quarter of students currently enrolled in the secondary vocational programs have no subsequent direct access to tertiary education (OECD, 2023).

5.3 Vocational education distributional effects

Given the heterogeneity in vocational education provision and in labour market demand for vocational graduates as discussed in the previous sections, we investigate the variations in the vocational effect on earnings along the conditional wage distribution. The quantile regression results are reported in Figure A.3. Similar to the ordinary least squares results, we could not find any significant wage differential across the conditional wage distribution.

To address this issue of selection in quantile regression estimation, we apply the IV-QR estimator(Chernozhukov and Hansen, 2005, 2008). We use all three education provision variables for the vocational status, and the results are presented in Figure 5. The instrumental variable quantile regression estimates show that the wage premium associated with vocational education is statistically significant at the first five deciles of the conditional wage distribution. The point estimates are the largest for those at the first decile, standing at 1.08 (s.e.=0.54). And for those at the fifth decile, the estimate is reduced to 0.39 (s.e.=0.17). The IVQR results show that for those individuals whose earning potential is above the average, no evidence could be found of vocational wage premium or penalty.

(Figure 5 here)

The quantile regression (QR and IV-QR) estimates demonstrate the heterogeneous vocational education wage effects which were not captured by the least squares estimators. The IV-QR results show the overall vocational wage premium is largely driven by those whose earnings potential is lower than average. The results indicate that secondary vocational education is more beneficial to the cohort with lower earning ability, which is consistent to existing knowledge and practices in some countries, both developing and developed, that vocational education provides better employment prospect for those in disadvantage positions, especially for the youth.

6 Discussion

Our OLS and QR results show no evidence of vocational wage premium either on average or at each decile of the conditional wage distribution when ignoring the potential selection in vocational schooling. In contrast, the IV results indicate that for individuals who at most complete secondary education, vocational education on average leads to a wage premium of

54%. And moreover, the large vocational wage premium is largely driven by the individuals of lower-than average earnings potential. For those with above-average earnings potential, we could not find any wage premium nor penalty associated with secondary vocational education.

Our main results are consistent to recent evidence on the vocational education effects on labour market outcomes (Eichhorst et al., 2015; Oswald-Egg and Renold, 2021; Kemper and Renold, 2024). And complementary to similar studies like the ones by Guo and Wang (2020) and Li et al. (2012), our results based on a younger sample show a larger return to secondary vocational education. Taken together, these results indicate that there may exist declining returns to vocational education by age (Hanushek et al., 2017; Brunello and Rocco, 2017).

To explain the large secondary vocational premiums, we show the correlation between graduating with a vocational education degree and the possibility of being employed by firms as employees against being self-employed or working on family business. The 2SLS results in Table B.5 indicate that secondary vocational graduates are more likely to be employed by firms than academic graduates. The wages of the latter do not necessarily reflect total earnings from supplying knowledge and skills in the labour market, as some may come in the form of return to entrepreneurship.

In addition, we turn to the association between vocational graduate numbers and firms performance. Firm and province fixed effect models are used and applied to a matched data set that contains the Chinese industrial firm panel data and the provincial data on secondary vocational and academic education enrolments, which are lagged by three years to proxy vocational/academic education graduates. As shown in Table B.4, the associations between the lagged value of vocational enrolment and industrial firms' production and sales are both economically and statistically significant. Specifically, a 1% increase in vocational enrolment three years earlier relates to a 10% increase in industrial firms' total production, and a 9.7% increase in total sales. These results are comparable to relevant studies that examined the effect of vocational education and training on firm performance, e.g., by Martins (2021). And we could not find any significant association between academic enrolment and firms' production and sales. The results indicate that secondary vocational graduates may be more productive as compared to secondary academic graduates, at least to Chinese industrial firms.

The larger vocational premiums for low-earnings-potential individuals are also consistent to the empirical evidence as well as real-life observations that vocational education proves to

be a better alternative for under-performing students, the minority groups or students with disability and/or from disadvantageous backgrounds (Neuman and Ziderman, 2003; Brunello and Rocco, 2015). One potential explanation is that the disadvantageous individuals are negatively selected into vocational education. These groups are likely to be unemployed and earning none, if there is any via unprotected part-time jobs, shall they are not in vocational education. They are more likely to be employed after completing vocational education and witness a substantial pay rise, which may result in a larger vocational premium.

Another explanation may relate to the assimilating and transformative roles played by education (c.f. Datzberger, 2018, p.125-127). Vocational education provides opportunities to stay in schools and to learn useful and portable skills for those who would otherwise drop out, assimilating the disadvantageous groups into society and preventing them from becoming 'NEETs'. It also enables people to initiate social movements by transforming the relevant political, social, and economic structures. A good example is that in China, applications to occupational licenses and certificates are open to vocational school students while at schools. Students are required to obtain a occupational license/certificate as a condition to graduate.

7 Conclusion

As China progresses in its economic development and moves beyond the pandemic, greater attention may need to be paid to its education system and its interplay with the labour market. Vocational education may play a key role in this process. This paper contributes to this research agenda by estimating returns to secondary vocational education vis-à-vis academic education. In addition to estimating the average effect of vocational education on wages, we investigate the heterogeneity of the vocational effect for individuals of different earnings potential, as indicated by their standing in the conditional wage distribution.

Our analysis uses city-level public education expenditure, general education teacher number and the number of general education schools, relative to the number of school-going age students, as instrumental variables for an individual's likelihood of completing the vocational track. An increase in public spending provides more opportunities to attend vocational education for those who could otherwise choose the academic track, even after controlling for access to general schools and teacher-student ratios at general schools. This conforms to the role of the government in adjusting the skill structure of its workforce and providing incentives

for individuals to choose a particular track of education by changing education provision to different types of education (Zheng, 2018; Dai et al., 2022). We also draw on a 1995 policy reform that made VET less attractive for students as it removed a job guarantee to VET graduates.

Our results, using the 2013 Chinese Household Income Project data, show no evidence of vocational wage premium either on average (OLS) or along the conditional wage distribution (QR) when ignoring the potential selection in vocational schooling. In contrast, our IV results indicate that for individuals who at most complete secondary education, vocational education was a better choice with respect to earnings in early career. This was especially the case for the individuals with average and lower-than-average earnings potential.

There are a number of policy implications of our findings. First, we find supporting evidence regarding the substantial educational and labour market implications of education investment. Considering the vast number of students enrolled in education at any point in time, adjusting education provision would not only have a short-term effect individual schooling decision, but also a medium or long-term effect on labour market equilibrium. Secondly, our findings suggest that vocational education is still 'undersold' in China. The prevailing idea is still that the vocational track is inferior to the academic track. On the contrary, our results suggest that although there is negative selection into vocational education, it is still valuable, at least for those who are in less advantageous positions in labour market. Lastly and more importantly, our findings give empirical support to the prevailing concern that the knowledge and skills acquired from vocational education may become less relevant, or even obsolete, once one becomes more competitive in labour market. This concern shall be properly addressed shall we make vocational education and training more sustainable and appealing to the public.

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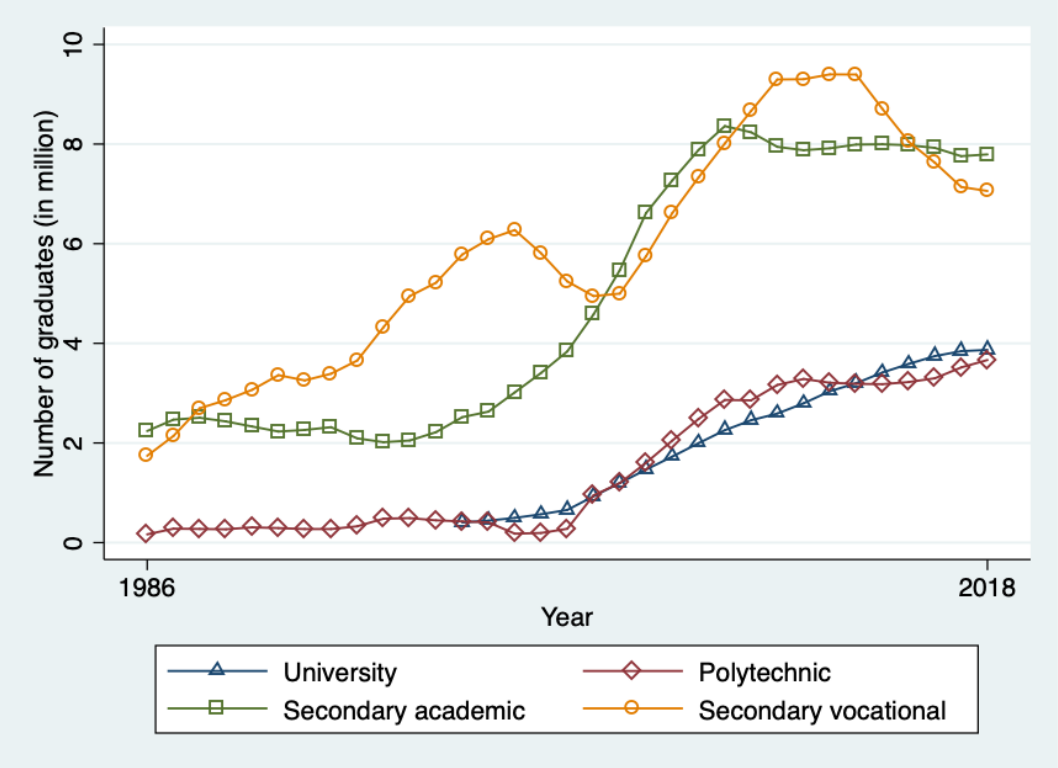

Figure 1: Number of new graduates, from different levels and tracks of education, in each year

Notes: The figure shows the number of graduates from academic or vocational education at the secondary or tertiary levels between 1986 and 2018. Data source: National Bureau of Statistics.

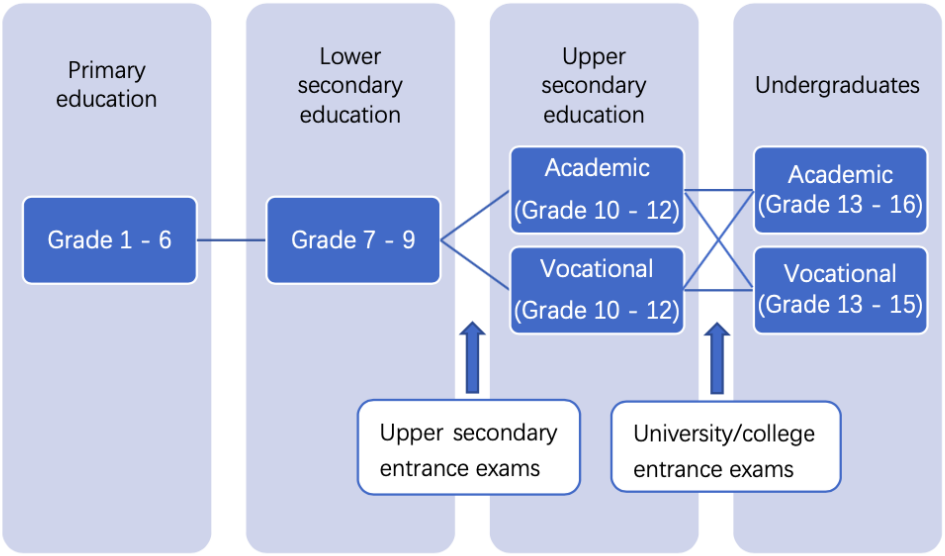

Figure 2: An illustration of structure of Chinese education system
Notes: The figure shows the education system administered by Ministry of Education in China. The postgraduate level is not shown here. The track of education diverges at upper secondary level. Both secondary vocational and academic education graduates can choose between tertiary vocational and academic education. Student application, performance at entrance exams and enrolment quota set by schools together decide admission outcome. Ministry of Human Resource and Social Security administers another track for adult education and training.

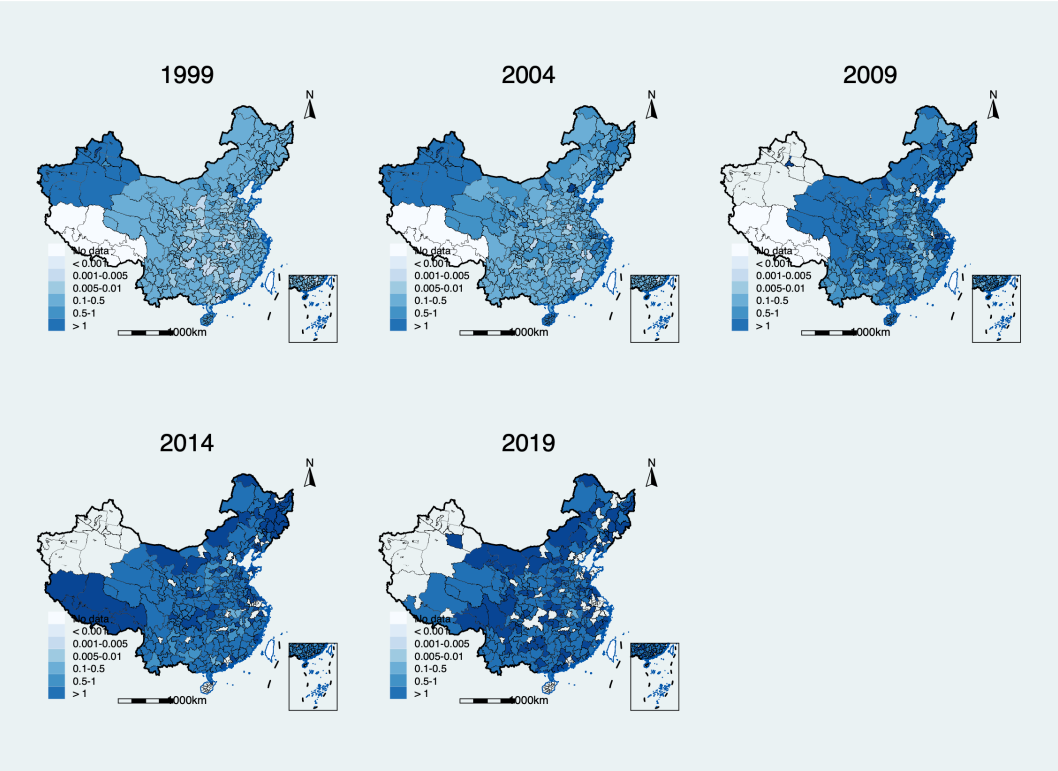

Figure 3: Education expenditure per school-going age students by local city governments
Notes: The figure shows the education expenditure (RMB 10,000 yuan) per school-age child across Chinese cities in five-year intervals between 1999 and 2020. Data source: China City Statistical Yearbook (1999-2020).

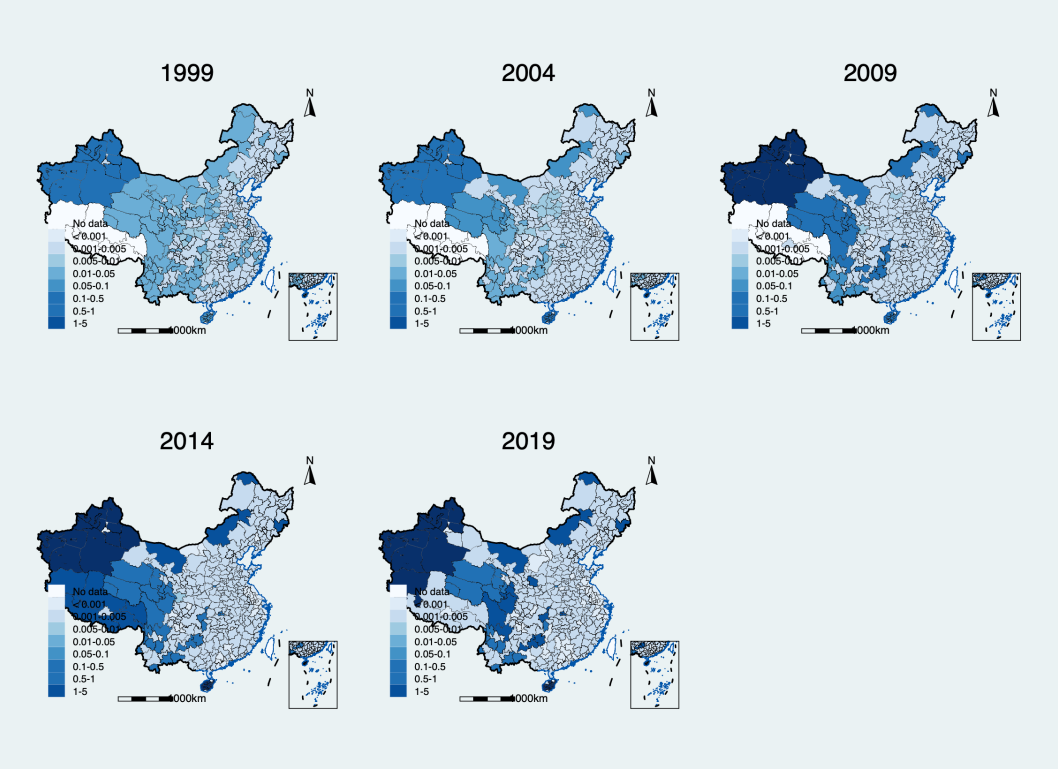

Figure 4: General schools per 10,000 school-going age students across Chinese cities
Notes: The figure shows the distribution of general (primary and academic secondary) schools per 10,000 school-going age students across Chinese cities in five-year intervals between 1999 and 2020. Data source: China City Statistical Yearbook (1999-2020).

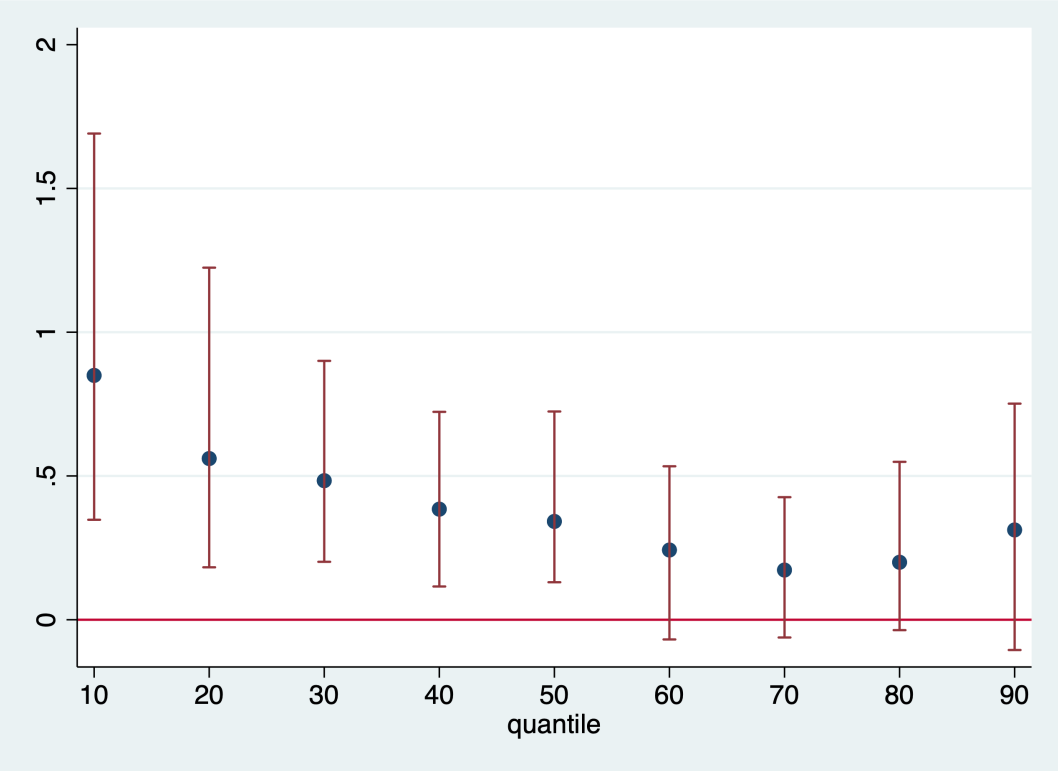

Figure 5: Heterogeneous vocational education effect on earnings, IVQR
Notes: The figure shows the instrumental variable quantile regression (IVQR) results of secondary vocational education on wages. The dependent variable is the logarithm of annual wage, and the control variables include the linear and quadratic forms of age, gender, marital status and the provincial fixed effects. Each dot (line) denotes the point estimate (95% confidence interval).

Table 1: Summary statistics by educational track

	(1) Academic	(2) obs	(3) Vocational	(4) obs	(5) Total	(6) Diff.[(1)-(3)]
Annual income (CNY)	26,709.96	644	26,771.23	660	26,740.97	-61.27
	(13955.194)		(14021.702)		(13983.561)	[-0.08]
Age	24.23	713	24.23	714	24.23	0.00
	(3.236)		(3.223)		(3.228)	[0.03]
Female (%)	0.41	713	0.40	714	0.41	0.01
	(0.492)		(0.491)		(0.491)	[0.29]
Married (%)	0.43	713	0.43	714	0.43	0.00
	(0.496)		(0.495)		(0.495)	[0.13]
Armed forces occupations	0.00	632	0.00	645	0.00	-0.00
	(0.056)		(0.068)		(0.062)	[-0.43]
Managers	0.04	632	0.03	645	0.03	0.01
	(0.187)		(0.169)		(0.178)	[0.69]
Professionals	0.05	632	0.05	645	0.05	-0.00
	(0.213)		(0.214)		(0.213)	[-0.05]
Tech. and asso. professionals	0.04	632	0.08	645	0.06	-0.04**
	(0.199)		(0.270)		(0.238)	[-2.85]
Clerical support workers	0.07	632	0.10	645	0.08	-0.03*
	(0.249)		(0.299)		(0.276)	[-2.12]
Services and sales workers	0.35	632	0.27	645	0.31	0.08**
	(0.479)		(0.444)		(0.463)	[3.28]
Skilled agri., forestry and fishery workers	0.01	632	0.00	645	0.01	0.00
	(0.089)		(0.056)		(0.074)	[1.16]
Craft and related trades workers	0.24	632	0.27	645	0.26	-0.03
	(0.430)		(0.446)		(0.438)	[-1.19]
Plant and machine operators and assemblers	0.07	632	0.06	645	0.06	0.01
	(0.252)		(0.233)		(0.242)	[0.79]
Elementary occupations	0.07	632	0.06	645	0.07	0.01
	(0.260)		(0.239)		(0.249)	[0.88]
Other occupations	0.06	632	0.08	645	0.07	-0.02
	(0.235)		(0.265)		(0.251)	[-1.24]
Overeducation_1	0.73	713	0.67	714	0.70	0.05*
	(0.446)		(0.470)		(0.459)	[2.24]
Overeducation_2	0.77	713	0.73	714	0.75	0.04
	(0.423)		(0.446)		(0.435)	[1.75]
Overeducation_3	0.09	713	0.12	714	0.11	-0.03
	(0.292)		(0.329)		(0.311)	[-1.78]
Undereducation_1	0.17	713	0.23	714	0.20	-0.06**
	(0.376)		(0.422)		(0.400)	[-2.90]
Undereducation_2	0.23	713	0.27	714	0.25	-0.04
	(0.421)		(0.443)		(0.432)	[-1.64]
Undereducation_3	0.03	713	0.05	714	0.04	-0.02
	(0.165)		(0.210)		(0.189)	[-1.82]
1st-tier city	0.03	713	0.08	714	0.05	-0.05***
	(0.173)		(0.269)		(0.227)	[-3.97]
2nd-tier city	0.12	713	0.18	714	0.15	-0.06**
	(0.324)		(0.385)		(0.357)	[-3.26]
3rd-tier city	0.85	713	0.74	714	0.80	0.11***
	(0.357)		(0.438)		(0.404)	[5.15]
Eastern	0.32	713	0.41	714	0.37	-0.08**
	(0.468)		(0.492)		(0.482)	[-3.29]
Central China	0.45	713	0.38	714	0.42	0.07*
	(0.498)		(0.487)		(0.493)	[2.55]
Western	0.21	713	0.17	714	0.19	0.04
	(0.405)		(0.374)		(0.390)	[1.85]
Northeastern	0.02	713	0.04	714	0.03	-0.02*
	(0.139)		(0.198)		(0.171)	[-2.32]

Note: The table contains summary statistics for the study sample. Standard deviations in the parentheses. t statistics in brackets. Over-education (Under-education) 1, 2 and 3 denote whether an individual's schooling is larger (smaller) than the mean, the mode and the mean +(-) one standards deviation of years of schooling of all individuals working in the same occupation and age cohort (five-year interval). Significance level for t statistics: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: China Household Income Project (CHIP) 2013.

Table 2: Baseline results

	(1) OLS	(2) OLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS	(7) 2SLS	(8) 2SLS	(9) 2SLS	(10) 2SLS
Vocational education	-0.013	-0.013	0.544	0.574	0.465	0.488	0.417	0.445	0.405	0.429
	(0.032)	(0.031)	(0.171)***	(0.177)***	(0.153)***	(0.156)***	(0.153)***	(0.158)***	(0.153)***	(0.157)***
Age	0.194	0.175	0.199	0.181	0.203	0.184	0.202	0.184	0.202	0.184
	(0.055)***	(0.055)***	(0.065)***	(0.066)***	(0.063)***	(0.064)***	(0.061)***	(0.062)***	(0.061)***	(0.062)***
Age^2	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
	(0.001)***	(0.001)**	(0.001)**	(0.001)**	(0.001)***	(0.001)**	(0.001)***	(0.001)**	(0.001)***	(0.001)**
Female		-0.199		-0.199		-0.198		-0.198		-0.199
		(0.025)***		(0.029)***		(0.027)***		(0.027)***		(0.027)***
Married		-0.027		-0.029		-0.029		-0.029		-0.029
		(0.031)		(0.041)		(0.039)		(0.038)		(0.037)
Constants	7.305	7.594	6.932	7.198	6.931	7.206	6.963	7.235	6.971	7.246
	(0.668)***	(0.668)***	(0.809)***	(0.820)***	(0.779)***	(0.791)***	(0.763)***	(0.776)***	(0.759)***	(0.770)***
Province	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage										
lnspendratio			0.098	0.098	0.114	0.114	0.087	0.087	0.101	0.101
			(0.019)***	(0.019)***	(0.019)***	(0.019)***	(0.022)***	(0.022)***	(0.024)***	(0.024)***
lnschoolratio					0.110	0.109			0.075	0.074
					(0.062)*	(0.063)*			(0.057)	(0.057)
lnfacultyratio							0.234	0.234	0.162	0.163
							(0.214)	(0.215)	(0.222)	(0.222)
Post-estimation statistics										
Kleibergen-Paap LM statistics			8.027	7.985	9.614	9.587	10.088	10.063	10.445	10.413
P>$Chi^2(LM)$			0.005	0.005	0.008	0.008	0.006	0.007	0.015	0.015
First-stage F statistics			26.685	26.548	17.992	17.964	16.993	16.988	12.019	11.998
Hansen's J statistics			0.000	0.000	1.363	1.644	2.489	2.470	2.492	2.490
P>$Chi^2(Hansen's J)$					0.243	0.200	0.115	0.116	0.288	0.288
Observations	1,242	1,242	1,242	1,242	1,237	1,237	1,237	1,237	1,237	1,237

Note: The table includes the OLS and 2SLS estimates and the first-stage results for the whole sample. Vocational education is a dummy variable with 1 for secondary vocational graduates and 0 for secondary academic graduates. The instrumental variables used include a) the logarithm of total education spending per school-going age students, b) the logarithm of the number of schools in general education at the primary and secondary levels per school-going age students, and c) the logarithm of the number of teachers in general education at the primary and secondary levels per school-going age students. Standard errors are clustered at the city level. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: China Household Income Project (CHIP) 2013.

Table 3: Average vocational education wage effect from 1995 policy shock

	(1) OLS	(2) OLS	(3) 2SLS	(4) 2SLS
Vocational education	0.003	0.004	0.373	0.446
	(0.021)	(0.020)	(0.138)***	(0.134)***
Age	0.093	0.087	0.090	0.084
	(0.014)***	(0.013)***	(0.014)***	(0.015)***
Age^2	-0.001	-0.001	-0.001	-0.001
	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Female		-0.216		-0.214
		(0.016)***		(0.017)***
Married		-0.002		-0.006
		(0.027)		(0.031)
Constants	8.676	8.842	8.451	8.557
	(0.200)***	(0.200)***	(0.216)***	(0.223)***
Province	YES	YES	YES	YES
First-stage				
Treat			-0.115	-0.117
			(0.051)**	(0.051)**
Trend			-0.000	-0.000
			(0.003)	(0.003)
Rural			-0.075	-0.076
			(0.056)	(0.056)
Treat * Trend			0.002	0.002
			(0.005)	(0.005)
Treat * Rural			-0.072	-0.073
			(0.078)	(0.078)
Rural * Trend			-0.002	-0.002
			(0.001)*	(0.001)*
Treat * Trend * Rural			0.001	0.001
			(0.001)	(0.001)
Post-estimation statistics				
Kleibergen-Paap LM statistics			44.184	43.975
P>Chi$^2(LM)$			0.000	0.000
First-stage F statistics			13.839	14.076
Hansen's J statistics			7.388	7.107
P>Chi$^2(Hansen'sJ)$			0.286	0.311
Observations	3,067	3,067	3,050	3,050

Note: The table contains the baseline regression results with identification strategy derived from the 1995 secondary vocational education reform, which wrote off tuition waiver and guaranteed employment for secondary vocational education students. The instrumental variable *Treat* equals 1 if an individual was subject to the policy, based on birth year and month. *Trend* indicates the month trend before and after September 1995. *Rural* equals 1 if an individual held a agricultural *Hukou*. The sample is kept to those who were born after September 1970 and were subject to 1986 Compulsory Education Law. Standard errors (in parentheses) are clustered at city. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Regression results after controlling for horizontal and vertical job mismatch

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) 2SLS	(8) 2SLS	(9) 2SLS	(10) 2SLS	(11) 2SLS	(12) 2SLS
Vocational education	-0.013	-0.015	-0.015	-0.015	0.017	0.014	0.429	0.428	0.432	0.431	0.439	0.440
	(0.031)	(0.031)	(0.031)	(0.031)	(0.033)	(0.034)	(0.157)***	(0.163)***	(0.161)***	(0.156)***	(0.160)***	(0.158)***
Age	0.175	0.177	0.178	0.187	0.182	0.190	0.184	0.188	0.186	0.186	0.198	0.194
	(0.055)***	(0.054)***	(0.054)***	(0.057)***	(0.054)***	(0.057)***	(0.062)***	(0.062)***	(0.061)***	(0.065)***	(0.062)***	(0.065)***
Age^2	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
	(0.001)**	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)***	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)***	(0.001)**
Female	-0.199	-0.202	-0.201	-0.200	-0.187	-0.188	-0.199	-0.199	-0.198	-0.199	-0.171	-0.171
	(0.025)***	(0.024)***	(0.024)***	(0.025)***	(0.025)***	(0.025)***	(0.027)***	(0.026)***	(0.026)***	(0.027)***	(0.028)***	(0.029)***
Married	-0.027	-0.027	-0.027	-0.027	-0.025	-0.026	-0.029	-0.028	-0.029	-0.029	-0.026	-0.026
	(0.031)	(0.031)	(0.031)	(0.031)	(0.029)	(0.029)	(0.037)	(0.037)	(0.037)	(0.038)	(0.033)	(0.033)
Overeducation_1		-0.040						-0.030				
		(0.042)						(0.047)				
Undereducation_1		-0.008						-0.043				
		(0.046)						(0.054)				
Overeducation_2			-0.207						-0.063			
			(0.167)						(0.201)			
Undereducation_2			-0.185						-0.074			
			(0.166)						(0.193)			
Overeducation_3				0.033		0.023				0.006		-0.013
				(0.039)		(0.040)				(0.043)		(0.044)
Undereducation_3				0.080		0.069				0.020		0.003
				(0.065)		(0.063)				(0.079)		(0.082)
Horizontal_mismatch					-0.135	-0.133					-0.314	-0.315
					(0.042)***	(0.043)***					(0.081)***	(0.082)***
Constants	7.594	7.604	7.764	7.451	7.513	7.410	7.246	7.229	7.287	7.214	7.092	7.137
	(0.668)***	(0.659)***	(0.678)***	(0.702)***	(0.667)***	(0.703)***	(0.770)***	(0.766)***	(0.802)***	(0.802)***	(0.781)***	(0.814)***
Province	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Kleibergen-Paap LM statistics							10.413	10.040	10.336	10.243	11.265	11.000
P>Chi$^2(LM)$							0.015	0.018	0.016	0.017	0.010	0.012
First-stage F statistics							11.998	10.954	11.592	11.875	13.059	12.863
Hansen's J statistics							2.490	2.522	2.514	2.492	2.688	2.675
P>Chi$^2(Hansen's J)$							0.288	0.283	0.285	0.288	0.261	0.262
Observations	1,242	1,242	1,242	1,242	1,242	1,242	1,237	1,237	1,237	1,237	1,237	1,237

Note: The table contains the OLS and 2SLS regression results with or without controlling for vertical or horizontal job mismatch. The instrumental variables used include a) the logarithm of total education spending per school-going age students, b) the logarithm of the number of schools in general education at the primary and secondary levels per school-going age students, and c) the logarithm of the number of teachers in general education at the primary and secondary levels per school-going age students. Clustered (city) standard errors in parentheses. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Regression results for the alternative matched sample

	(1) OLS	(2) OLS	(3) 2SLS	(4) 2SLS
Vocational education	-0.010	-0.010	0.409	0.428
	(0.032)	(0.031)	(0.151)***	(0.156)***
Age	0.203	0.185	0.215	0.197
	(0.055)***	(0.055)***	(0.060)***	(0.062)***
Age^2	-0.003	-0.003	-0.004	-0.003
	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Female		-0.196		-0.194
		(0.025)***		(0.026)***
Married		-0.035		-0.038
		(0.032)		(0.039)
Constants	7.165	7.448	6.780	7.046
	(0.668)***	(0.673)***	(0.755)***	(0.772)***
Province	YES	YES	YES	YES
Kleibergen-Paap LM statistics			9.739	9.727
P>Chi$^2(LM)$			0.021	0.021
First-stage F statistics			10.931	10.956
Hansen's J statistics			2.768	2.818
P>Chi$^2(Hansen's J)$			0.251	0.244
Observations	1,226	1,226	1,221	1,221

Note: The table contains the OLS and 2SLS regression results when using secondary academic graduates who are observationally similar to the secondary academic students who advanced to higher education as a control group. The instrumental variables used include a) the logarithm of total education spending per school-going age students, b) the logarithm of the number of schools in general education at the primary and secondary levels per school-going age students, and c) the logarithm of the number of teachers in general education at the primary and secondary levels per school-going age students. Clustered (city) standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

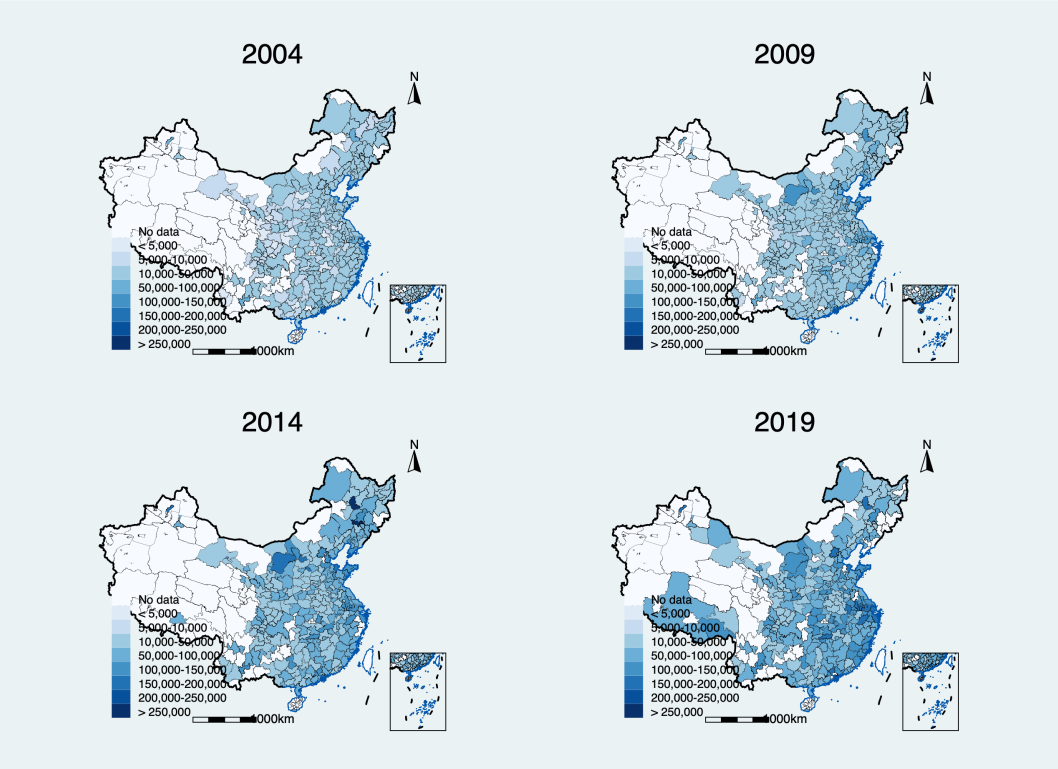

Figure A.1: GDP per capita for Chinese cities(2004-2019)
Notes: The figure shows the GDP per capita for Chinese city in every five-year interval between 2004 and 2019. Data for 1999 are not available. Data source: National Bureau of Statistics. Data source: China City Statistical Yearbook (1999-2020).

Appendices

A Supplementary figures and tables

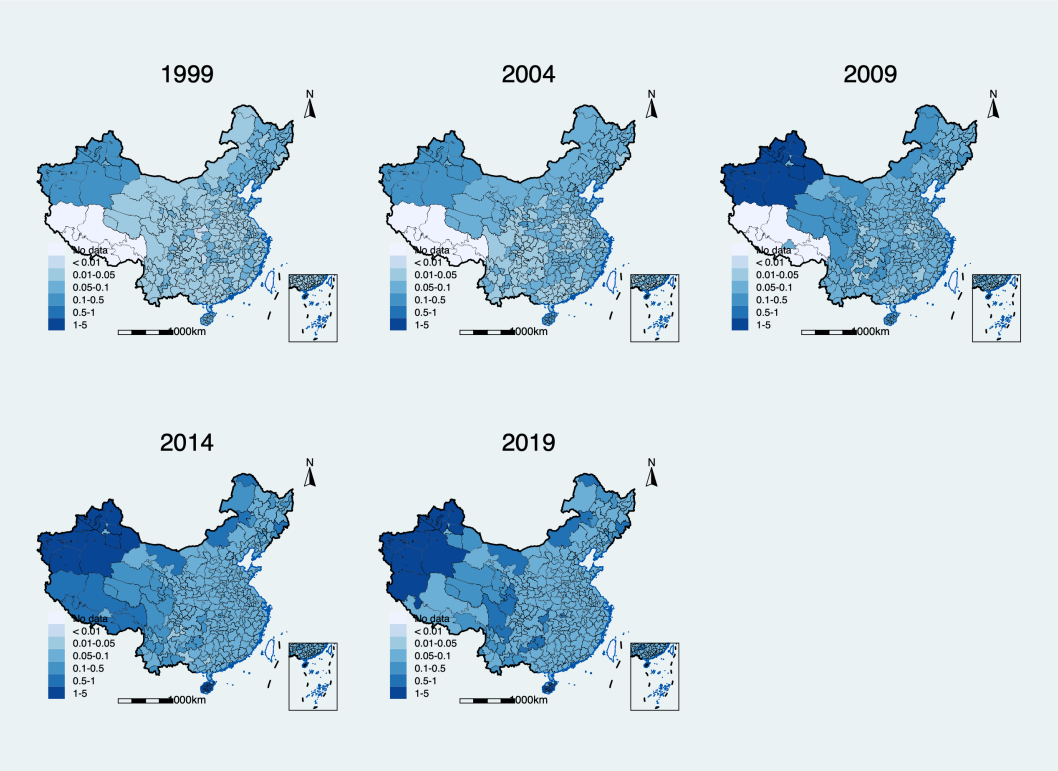

Figure A.2: Teachers in general education per 10,000 school-going age students across Chinese cities

Notes: The figure shows the number of teachers at general (primary and academic secondary) schools per 10,000 school-going age students across Chinese cities in five-year intervals between 1999 and 2020. Data source: China City Statistical Yearbook (1999-2020).

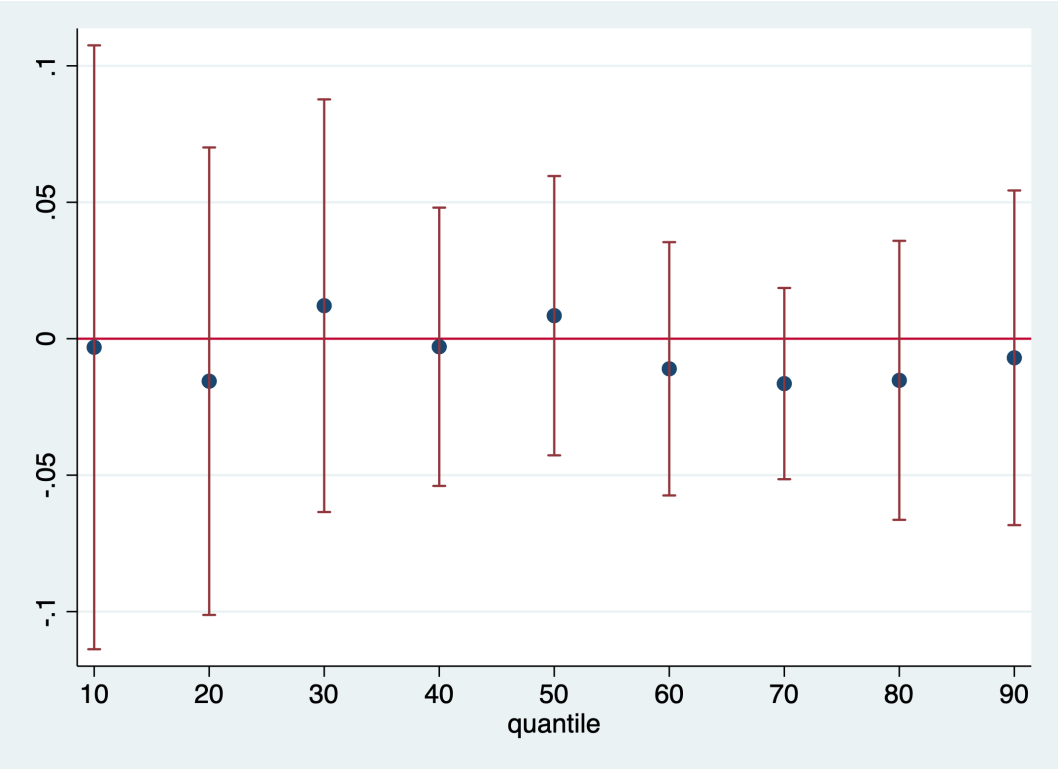

Figure A.3: Heterogeneous vocational education effect on earnings, QR
Notes: The figure shows the quantile regression (QR) results of the effect of secondary vocational education on wages. The dependent variable is the logarithm of annual wage, and the control variables include the linear and quadratic forms of age, gender, marital status and the provincial fixed effects. Each dot (line) denotes the point estimate (95% confidence interval).

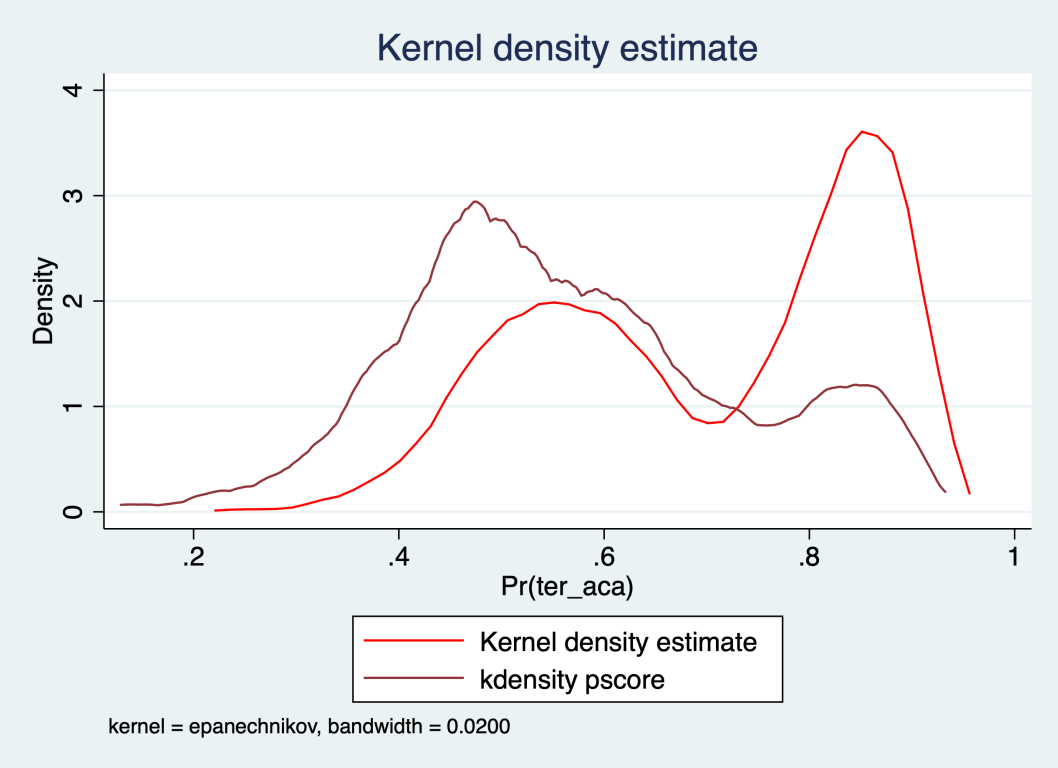

Figure A.4: Propensity score matching for secondary academic students
Notes: The figure shows the propensity score matching outcome for taking the tertiary education within all secondary education students. Matching variables include year of birth, number of sibling, household registration type at birth, gender, ethnicity, disability, self-report health status, province of taking college entrance exams, category of and subject taken at upper secondary schools. Data source: China Household Income Project (CHIP) 2013.

Table B.1: Public expenditure in education by municipal governments (in CNY 10,000)

	(1)	(2)	(3)	(4)	(5)
Year	2011	2010	2009	2008	2007
Total	168,045,617	134,895,629	114,193,032	96,855,602	76,549,082
- *YoY growth rate*	0.25	0.18	0.18	0.27	-
Secondary vocational	4,728,781	3,694,266	2,968,624	2,385,192	1,756,232
- *YoY growth rate*	0.28	0.24	0.24	0.36	-
Academic upper secondary	15,376,404	11,758,580	9,853,696	8,378,922	6,899,098
- *YoY growth rate*	0.31	0.19	0.18	0.21	-
General lower secondary	35,334,458	29,372,793	25,472,473	20,884,380	16,016,421
- *YoY growth rate*	0.20	0.15	0.22	0.30	-
General secondary	50,710,862	41,131,373	35,326,169	29,263,302	22,915,519
- *YoY growth rate*	0.23	0.16	0.21	0.28	-
Primary	53,147,915	43,896,249	37,701,029	31,129,002	25,179,148
- *YoY growth rate*	0.21	0.16	0.21	0.24	-
Special	654,865	619,899	406,915	333,761	261,311
- *YoY growth rate*	0.06	0.52	0.22	0.28	-
Preschool	3,516,392	2,187,411	1,524,543	1,227,865	954,947
- *YoY growth rate*	0.61	0.43	0.24	0.29	-

Note: The table contains public expenditure into different educational levels by municipal governments and the year-on-year growth rates between 2007 and 2011. Data source: Bureau of Statistics in China.

Table B.2: Baseline results with standard errors clustered at city and industry

	(1) OLS	(2) OLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS	(7) 2SLS	(8) 2SLS	(9) 2SLS	(10) 2SLS
Vocational education	-0.013	-0.013	0.547	0.580	0.469	0.495	0.420	0.450	0.409	0.435
	(0.028)	(0.027)	(0.162)***	(0.162)***	(0.148)***	(0.146)***	(0.146)***	(0.144)***	(0.144)***	(0.142)***
Age	0.193	0.175	0.197	0.178	0.201	0.182	0.201	0.182	0.201	0.182
	(0.059)***	(0.058)***	(0.071)***	(0.070)**	(0.069)***	(0.068)***	(0.067)***	(0.067)***	(0.067)***	(0.066)***
Age^2	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
	(0.001)***	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**
Female		-0.200		-0.201		-0.200		-0.200		-0.200
		(0.027)***		(0.032)***		(0.031)***		(0.031)***		(0.030)***
Married		-0.028		-0.031		-0.031		-0.030		-0.030
		(0.032)		(0.038)		(0.036)		(0.036)		(0.035)
Constants	7.312	7.604	6.953	7.223	6.949	7.227	6.980	7.255	6.988	7.265
	(0.714)***	(0.700)***	(0.864)***	(0.854)***	(0.838)***	(0.825)***	(0.819)***	(0.808)***	(0.815)***	(0.802)***
Province	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
First-stage										
lnspendratio			0.098	0.098	0.114	0.115	0.087	0.088	0.101	0.101
			(0.017)***	(0.017)***	(0.018)***	(0.018)***	(0.018)***	(0.018)***	(0.021)***	(0.021)***
lnschoolratio					0.109	0.109			0.074	0.073
					(0.051)**	(0.051)**			(0.057)	(0.057)
lnfacultyratio							0.237	0.237	0.166	0.167
							(0.128)*	(0.128)*	(0.141)	(0.141)
Post-estimation statistics										
Kleibergen-Paap LM statistics			22.209	22.084	24.915	24.856	25.768	25.697	26.611	26.553
P>Chi$^2(LM)$			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
First-stage F statistics			35.030	35.051	20.514	20.592	21.076	21.122	14.307	14.345
Hansen's J statistics			0.000	0.000	2.267	2.622	4.722	4.667	4.800	4.804
P>Chi$^2(Hansen'sJ)$					0.132	0.105	0.030	0.031	0.091	0.091
Observations	1,240	1,240	1,240	1,240	1,235	1,235	1,235	1,235	1,235	1,235

Note: The table includes the OLS and 2SLS estimates for the whole sample. Vocational education is a dummy variable with 1 for secondary vocational graduates and 0 for secondary academic graduates. The instrumental variables used include a) the logarithm of total education spending per school-going age students, b) the logarithm of the number of schools in general education at the primary and secondary levels per school-going age students, and c) the logarithm of the number of teachers in general education at the primary and secondary levels per school-going age students. Standard errors in parentheses are clustered at city and industry. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: China Household Income Project (CHIP) 2013.

Table B.3: Baseline results with additional industry and occupation controls

	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
Vocational education	-0.013	-0.013	-0.018	0.405	0.429	0.479
	(0.032)	(0.031)	(0.031)	(0.153)***	(0.157)***	(0.183)***
Age	0.194	0.175	0.185	0.202	0.184	0.176
	(0.055)***	(0.055)***	(0.056)***	(0.061)***	(0.062)***	(0.066)***
Age^2	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
	(0.001)***	(0.001)**	(0.001)***	(0.001)***	(0.001)**	(0.001)**
Female		-0.199	-0.179		-0.199	-0.173
		(0.025)***	(0.027)***		(0.027)***	(0.030)***
Married		-0.027	-0.018		-0.029	-0.013
		(0.031)	(0.031)		(0.037)	(0.039)
Constants	7.305	7.594	7.288	6.971	7.246	7.313
	(0.668)***	(0.668)***	(0.753)***	(0.759)***	(0.770)***	(0.878)***
Industry			YES			YES
Industry			YES			YES
Province	YES	YES	YES	YES	YES	YES
Kleibergen-Paap LM statistics				10.445	10.413	9.295
P>Chi$^2(LM)$				0.015	0.015	0.026
Fist-stage F statistics				12.019	11.998	8.880
Hansen's J statistics				2.492	2.490	3.531
P>Chi$^2(Hansen's J)$				0.288	0.288	0.171
Observations	1,242	1,242	1,217	1,237	1,237	1,212

Note: The table includes the OLS and 2SLS estimates for the whole sample. Vocational education is a dummy variable with 1 for secondary vocational graduates and 0 for secondary academic graduates. The instrumental variables used include a) the logarithm of total education spending per school-going age students, b) the logarithm of the number of schools in general education at the primary and secondary levels per school-going age students, and c) the logarithm of the number of teachers in general education at the primary and secondary levels per school-going age students. Standard errors in parentheses are clustered at city. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: China Household Income Project (CHIP) 2013.

Table B.4: Occupational destinations by educational track

	(1) Academic	(2) Vocational	(3) Total	(4) Diff.[(1)-(2)]
Armed forces	0.00	0.00	0.00	-0.00
	(0.029)	(0.045)	(0.035)	(-1.19)
Managers	0.05	0.04	0.05	0.01
	(0.217)	(0.201)	(0.212)	(1.26)
Professionals	0.05	0.07	0.06	-0.02
	(0.224)	(0.259)	(0.237)	(-2.98)**
Tech. and asso. professionals	0.05	0.08	0.06	-0.04
	(0.217)	(0.278)	(0.241)	(-5.23)***
Clerical support workers	0.11	0.13	0.12	-0.02
	(0.314)	(0.340)	(0.324)	(-2.46)*
Services and sales workers	0.35	0.30	0.33	0.05
	(0.476)	(0.458)	(0.470)	(3.71)***
Skilled agri., forestry and fishery workers	0.02	0.01	0.02	0.01
	(0.148)	(0.112)	(0.136)	(2.60)**
Craft and related trades workers	0.18	0.19	0.18	-0.01
	(0.386)	(0.391)	(0.388)	(-0.60)
Plant and machine operators and assemblers	0.06	0.04	0.05	0.02
	(0.241)	(0.200)	(0.228)	(3.17)**
Elementary occupations	0.05	0.06	0.05	-0.01
	(0.221)	(0.240)	(0.228)	(-1.57)
Other occupations	0.07	0.06	0.07	0.01
	(0.256)	(0.241)	(0.251)	(1.23)

Note: The table contains the occupational destinations of secondary academic and secondary vocational graduates for the original sample. Standard deviations in the brackets. Significance level for t statistics: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: China Household Income Project (CHIP) 2013.

Table B.5: Regression results for being employed by others

	(1) Logit	(2) Logit	(3) 2SLS	(4) 2SLS
Vocational education	0.331	0.334	0.110	0.106
	(0.271)	(0.275)	(0.041)***	(0.042)**
Age	-1.323	-0.969	-0.045	-0.042
	(0.679)*	(0.652)	(0.019)**	(0.019)**
Age^2	0.025	0.020	0.001	0.001
	(0.013)*	(0.013)	(0.000)**	(0.000)**
Female		0.253		0.012
		(0.272)		(0.012)
Married		-1.173		-0.057
		(0.317)***		(0.017)***
Constants	20.190	15.085	1.476	1.399
	(8.665)**	(8.318)*	(0.235)***	(0.235)***
Province	YES	YES	YES	YES
Kleibergen-Paap LM statistics			11.545	11.546
P>Chi$^2(LM)$			0.009	0.009
First-stage F statistics			12.608	12.435
Hansen's J statistics			0.146	0.165
P>Chi$^2(Hansen'sJ)$			0.929	0.921
Observations	1,307	1,307	1,301	1,301

Note: Dependent variable is whether an individual is employed by firms as employee (1), or self-employed/working in family business (0). Clustered (city) standard errors in parentheses. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: China Household Income Project (CHIP) 2013.

Table B.6: Vocational and academic enrolment on industrial firm performance

	(1)	(2)	(3)	(4)	(5)
		Firm FE			Province FE
	Ln(production)	Ln(sales)	Ln(export)	Ln(import)	Ln(firm)
Ln(vocational enrolment)	0.100	0.097	-0.008	-0.014	0.148
	(0.039)**	(0.039)**	(0.118)	(0.086)	(0.089)*
Ln(academic enrolment)	0.040	0.027	-0.153	-0.031	0.403
	(0.097)	(0.100)	(0.201)	(0.091)	(0.119)***
Constant	1.378	1.571	8.766	5.367	-21.624
	(1.124)	(1.181)	(1.653)***	(1.268)***	(5.109)***
Observations	365,033	365,026	321,172	237,353	238
R-squared	0.463	0.461	0.127	0.055	0.749
Number of firm/province	135,500	135,500	117,047	89,289	31

Note: The table reports the estimates of the association between vocational education provision and firms performance, and between vocational education provision and the number of industrial firms. The vocational enrolments are lagged by three years to proxy the number of graduates, of which the data are not available. All firms in the sample are industrial firms and have a minimum of 5 million annual sales revenue in Mainland China. Control variables for firm-level regressions include asset, number of employees, firm size (by revenue, categorical), value of imported goods. Control variables for province-level regression include GDP, national income, consumption, population, aggregated physical capital investment, tax revenue, number of compulsory schools. All values were logged except for firm size. Standard errors for Column (5) are clustered on province. Significance level for t statistics: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data source: National Bureau of Statistics, China.