NBER WORKING PAPER SERIES

EMPLOYER LEARNING AND THE DYNAMICS OF RETURNS TO UNIVERSITIES: EVIDENCE FROM CHINESE ELITE EDUCATION DURING UNIVERSITY EXPANSION

Sylvie Démurger
Eric A. Hanushek
Lei Zhang

Working Paper 25955
http://www.nber.org/papers/w25955

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2019

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NBER Working Paper No. 25955
June 2019
JEL No. I20,I23,J2

ABSTRACT

This paper estimates the return to an elite university education over a college graduate's career using the CHIP 2013 data. We find a substantial premium for graduating from an elite Chinese university at job entry, but it declines quickly with labor market experience. This pattern is entirely driven by the young cohorts who enter college after the higher education expansion that started in 1999. This pattern is more pronounced in coastal provinces and in economically more developed regions, where individual skills are highly rewarded in the labor market. The initial elite premium and its subsequent decline is found just for males; individual skills are much more consistently rewarded for females than males. The results are consistent with employer learning, where employers pay workers based on more easily observable group characteristics at job entry but rely less on these over time when more accurate information about individual productivity becomes available.

Sylvie Démurger
Groupe d'Analyse et de Théorie Economique
University of Lyon - CNRS
93, chemin des Mouilles - B.P.167
Ecully Cedex 69131
France
sylvie.demurger@cnrs.fr

Lei Zhang
Antai College of Economics and Management
Shanghai Jiao Tong University
1954 Huashan Road
Shanghai, 200030
P. R. China
zlei89@gmail.com

Eric A. Hanushek
Hoover Institution
Stanford University
Stanford, CA 94305-6010
and NBER
hanushek@stanford.edu

1 Introduction

While no one doubts that colleges and universities differ in quality, somehow defined, there is less understanding of the implications of any quality differentials for students. Understanding differential returns to college quality proves to be a difficult research question. Nonetheless, limited information does not seem to stop strong behavioral reactions of students: as college attendance expands, competition to get into the elite universities also intensifies. A particularly attractive laboratory for understanding the college quality-student outcome nexus is modern China that combines a dramatic expansion of universities with both a well-recognized identification of which are elite universities and a responsive labor market. Investigation of the impact of China elite universities provides insight not only about the operation of its dynamic labor market but also about the role of employer learning in determining labor market outcomes.

A central problem in understanding the role of elite universities is separating the impact of the universities on the students from the selection of students into these universities. A second frequent problem is the difficulty of obtaining career information for a representative sample of graduates from different universities. And a third issue is that college attendance and graduation have been changing rapidly in many countries of the world, and this alters the labor market for college graduates. This research addresses each of these challenges.

We evaluate the return to attending an elite university as measured by the wage premium in the contemporary Chinese labor market. We focus particularly on the dynamics of this college quality premium; i.e., how it changes with one's labor market experience (the experience profile) and how it varies over time for different cohorts (the intertemporal profile). Much of the attention to the economy of China focuses on the huge shift of industries with substantial changes in technologies. In the background, however, the labor market in China has undergone a tremendous transformation following the massive higher education expansion since the late 1990s (Knight, Deng, and Li (2017)). The surge in the supply of

the college-educated labor force is likely to influence greatly the dynamics of return to college tiers both over one's career and over time.

Using the 2013 urban sample from the Chinese Household Income Project (CHIP) survey data and constructing work histories for a panel of fulltime workers, we find a significant premium for graduating from an elite university at job entry, but this premium declines quickly with labor market experience and employer learning. This dynamic is entirely driven by the young cohorts of graduates who enter college under the regime of higher education expansion, suggesting the increasing importance of college tier when there is a surge in the supply of college graduates. This pattern is more pronounced in coastal provinces and in economically more developed regions. Meanwhile, cognitive skills have a strong positive impact on wages of both the old and young cohorts, but a much larger impacts for the young cohorts. This impact appears to come completely from more developed regions.

Focusing on the young cohorts, we also find substantial differences between male and female college graduates. While the elite-university premium is large at job entry and declines over time for males, it is flat for females. Cognitive skills have a much larger impact on wages of females than males; thus skills play a critical role in narrowing the gender wage gap. These gender differences cannot be explained by differences in the industry, occupation, or sector of employment (government, institutions, SOEs, etc.) of male and female college graduates.

This research contributes to the burgeoning literature on the return to college quality. The majority of this literature focuses on the U.S. and considers the average return for the individuals under study. Black and Smith (2004, (2006), Zhang (2009), and Hoekstra (2009), to name just a few, find significant wage premiums associated with attending an elite U.S. university relative to other universities; Dale and Krueger (2002, (2014) find that black and Hispanic students and students from low-income families earn significantly more if they have attended more selective colleges. Anelli (2016) finds similar results using Italian data. Using Chilean data and considering non-labor market returns, Kaufmann, Messner, and Solis (2015) find significant and positive impacts on the marital outcome of women

attending an elite university and on the academic performance of children whose parents have attended an elite university. Studies in the Chinese context are rare. Zhong (2011) uses the 2002 China Household Income Project (CHIP) data and finds return to higher education varying substantially between high- and low-quality colleges and universities. Li, Meng, Shi, and Wu (2012) and Jia and Li (2019), using data from job offers of college students just prior to graduation for the 2010-2015 graduate cohorts, show that graduates of elite universities experience a sizable wage premium at entry into the labor market. Kang, Peng, and Zhu (2018) look at wage patterns for graduates of different tiers of schools in China, although they have limited samples and cannot look at the changing labor market for graduates.

Here we study not only the average premium of graduating from an elite university but also the evolution of this premium over workers' careers. Importantly, we are able to investigate the wage premium beyond the job entry stage and are able to compare differences in the wage setting between pre- and post-higher education expansion eras.

A crucial element in studying the return to elite education is ascertaining how employers use information about university quality. Admission to an elite university provides a coarse signal of the average cognitive skills of a graduate, but employers would be expected to refine their views of individual productivity over time. Altonji and Pierret (2001) provide a theoretical model of statistical discrimination in the labor market and propose an empirical framework to estimate the wage dynamics. Using U.S. data, they find that the return to each year of education decreases over one's career but that the return to cognitive skills increases over one's career, a finding consistent with the employer learning hypothesis. More recently, Castex and Kogan Dechter (2014) find higher returns over time in the U.S. to educational attainment and lower returns to cognitive skills, which they attribute to slower technological growth in recent periods. Mansour (2012) finds that employer learning about worker skills differs substantially by occupation. Arcidiacono, Bayer, and Hizmo (2010) and Mansour (2012) find differences in learning for high school graduates and college graduates. Our research shares the same theoretical underpinning as

these papers and permits extending these ideas to an important special case – the operation of the labor market in a rapidly changing developing country.

Our labor market data also allow investigation of the returns to cognitive skills – a topic that has not been extensively studied in developing countries where data limitations have been severe. International comparisons have recently been possible for OECD countries (Hanushek, Schwerdt, Wiederhold, and Woessmann (2015)), but comparable general labor market surveys with information about the cognitive skills of workers have not been available for developing countries. This aspect of the current work is especially interesting because of the suggestion that returns to cognitive skills are high when the economy is undergoing rapid change (Hanushek, Schwerdt, Wiederhold, and Woessmann (2017)).

2 Analytical Structure and Data

2.1 Conceptual Framework

In the employer learning and statistical discrimination model of Altonji and Pierret (2001) employers have only limited information about workers' productivity at the labor market entry. Thus in a competitive economy where individuals are paid according to their productivity, employers use easily observable characteristics that are also correlated with productivity such as the education level to proxy for potential productivity. Over time, employers accumulate more information about workers' true productivity and rely less on these proxies for setting wages. For college graduates, the tier of college they graduate from forms one such characteristic. Graduates of elite universities are deemed either to have higher innate ability or to have acquired more human capital in the richer learning environment of the elite universities and hence are better rewarded at job entry.[1] Similarly, when more information about true

[1] Signaling models focus on selection of high skill individuals as the mechanism of higher cognitive skills of graduates, while human capital models focus on the production of skills by schools. Both models indicate higher skills of graduates, and the mechanism behind the higher skills of graduates is not identified from labor market data.

productivity is revealed by actual performance in the firm, the premium associated with the college tier decreases. This component of the evolution in returns is the "experience profile" of the college quality premium.

This pattern may be attenuated for college graduates as they generally are able to reveal more information about their quality on their resumes when applying for a job. Further, employers tend to spend more time screening their applications, especially when college graduates are a relatively small fraction of the labor force.[2] However, when higher education becomes mass education, college graduates become less differentiable based on their resumes. As the quantity of applications from college graduates grows, employers come to rely more on the easily observable proxies for individual quality such as the college tier. Thus, other things being equal, the dynamics of the elite university premium become more pronounced when the population of college graduates expands.

The above discussion suggests that the dynamics of college quality premium may be more salient in China for recent cohorts of college graduates who started to enter the labor market in the early 2000s following the dramatic higher education expansion that started in 1999. Nationwide, as seen in Figure 1, college admission rates increased by over 40 percent in both 1999 and 2000 and continued at more that 10 percent per year through 2005. The number of four-year college graduates doubled between 1999 and 2003 and quadrupled by 2007. With this surge in the supply of college-educated workers, we expect a relatively larger role played by the college tier in signaling one's ability at the job entry [3] but a steeper

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For our purposes, however, the underlying mechanism does not matter. Our interest is how skills, both projected and actual, play out in the labor market.

[2] Arcidiacono, Bayer, and Hizmo (2010) use NLSY79 and show that ability is observed nearly perfectly at labor market entry for college graduates, but is revealed only gradually for high school graduates.

[3] Using the 2002 China Household Income Project (CHIP) data, Zhong (2011) highlights differences in returns to higher education at job entry depending on school quality in urban China, and finds that the gap is indeed larger for younger cohorts.

reduction in the college quality premium with the revelation of true productivity over one's career. This component of the evolution in returns is the "intertemporal profile" of college quality premium.

Because the wage dynamics we describe above depend on the extent to which individuals are rewarded in the labor market according to their productivity, we also hypothesize that the experience profile of the college tier premium is likely to vary with the strength of the market forces in the Chinese economy. Therefore, the dynamics may be more salient for individuals working in the private sector and working in regions that experience more marketization than for those working in the public sector and working in the less market-oriented regions.

The literature on gender wage gaps, notably among high-skilled workers, further suggests that the dynamics of college tier returns may also differ between men and women, through a number of complementary channels (Albrecht, Bronson, Thoursie, and Vroman (2018)). First, if men and women sort differently across firms and if, in the vein of Abowd, Kramarz, and Margolis (1999), there are firm-specific pay premiums, we may observe gender differences in the dynamics of college quality premium (Card, Cardoso, and Kline (2016)). This may be the case for instance if women sort into occupations, jobs and workplaces that are more family-friendly but offer fewer opportunities in terms of career outcomes and less rapidly increasing wages. Second, within similar firms, the earnings dynamics may also differ by gender for various reasons including taste-based or statistical discrimination (Altonji and Blank (1999)), gender differences in human capital accumulation, or gender differences in negotiation skills or the willingness to compete (Hotz, Johansson, and Karimi (2018)). Third, if men and women have different job-mobility patterns along the career and if they benefit differently from firm-to-firm mobility (as shown by Card, Cardoso, and Kline (2016)), their wage dynamics may substantially differ too.

2.2 2013 Chinese Household Income Project (CHIP) Survey Data

Understanding how university quality interacts with the size of the sector and with the dynamics of the economy obviously places large demands on modeling and on the data. Fortunately, recent Chinese data can support an analysis of the dynamics of the quality premium.

The data used for the empirical analysis come primarily from the urban sample of the 2013 Chinese Household Income Project (CHIP) survey data, which are drawn from 14 provinces and are representative of the Chinese urban population. This high-quality dataset contains detailed information on basic individual characteristics including gender, age, education attainment, tier of college, year, province, subject of study, and score on college entrance exams. The labor market information includes current salary, working hours, industry, sector, occupation, and starting year and salary at the current job. All monetary values are CPI-adjusted to be measured in constant 2013 Yuan.[4]

An important advantage of the 2013 CHIP dataset is that it contains job history information that allows us to construct labor market histories with current and starting monthly wages for the 2013 job. Monthly wage in 2013 is annual income divided by months worked during 2013, and the survey reports directly monthly salary at the start of the current job.[5]

Our sample for the main empirical analysis includes all individuals with a four-year college degree who work at least 6 hours per day and 20 days per month (full-time workers). We define individuals who are born in or after 1980 as the young cohorts. These individuals were admitted to

[4] Regional and time price variations are accounted for by adjusting all monetary values for provincial purchasing power differences, calculated from the urban provincial-level spatial price deflators computed by Brandt and Holz (2006), and updated to 2013.

[5] We also use hourly wage as an alternative wage measure; for 2013 it is defined as the annual income divided by hours worked in 2013, and for job starting year it is defined as monthly income divided by hours worked per month in 2013, assuming monthly hours worked is the same for the two years. The results are similar.

college in or after 1999, when the higher education expansion policy started, and hence they graduated and entered the labor market along with a substantially larger number of college graduates.[6]

The 2013 CHIP survey elicits self-reported information on individuals' university type and college entrance exam (Gaokao) score. Elite universities are the 100 or so tier-1 universities designated by the Ministry of Education (MOE) of China (the Project-211 universities). Ordinary universities are the remaining more than 2000 regular universities. Elite universities are directly under the administration of the MOE, receive substantially more funding, and are able to hire higher-quality faculty than ordinary universities. They admit students with a Gaokao score above a threshold level, which is year-province-subject (sciences v. humanities) specific. Thus, graduates from elite universities are generally considered of higher quality than those from ordinary universities. We normalize individual Gaokao score by the total score of the test one took.[7] In the regression analyses we use the Gaokao score as a measure of individual cognitive skills.

Panel A of Table 1 reports the distribution of education attainment for the entire sample of full-time employees and for subsamples by age cohort and gender separately. Although we are primarily interested in individuals with a 4-year college degree, we also report statistics for individuals of other education levels to highlight the trend in increasing education achievement in China. For ease of exposition, we divide the population into old workers (born up to 1979) and young workers (born after 1979).

Education attainment in China has increased significantly: full-time workers with less than a high school education in the young cohort is about half that of the old cohort (16.5 percent v 35.1 percent), while there are 40 percent more with at least a 3-year college education in the young cohort than in the

[6] The old cohorts are individuals born between 1954 and 1979. Results are not sensitive to using 1981 as the cutoff year for defining cohorts.

[7] The total score is year-province-subject specific and is obtained from various Gaokao-related websites such as http://edu.sina.com.cn/gaokao/.

old cohort. Consistent with the higher education expansion started in 1999, 33 percent of the young cohort has at least a 4-year college education, an 80 percent increase over the old cohort. For the first years of expansion, enrollment at both elite and ordinary universities grew at similar rates, after which the pace of expansion at ordinary universities exceeds that at elite universities as seen by the distribution within the university sector for elite and other university graduates. Because of the relative size of the two sectors, the relative growth translates into a much larger numbers of graduates from the ordinary universities.

While fewer females of the old cohort are college-educated, females of the young cohort surpass males by more than 6 percentage points; nevertheless, fewer females graduate from an elite university than males, even though the gap has narrowed by half for the young cohort.

Panel B reports the employment distribution in the public sector for the entire sample of fulltime employee and for the subsample with at least a 4-year university education.[8] The first three columns give the percent of fulltime workers who are employed in the public sector by education level. The right hand three columns give the percent of fulltime workers employed in public or other governmental institutions, leaving the residual that is employed in state owned enterprises. Almost 20 percentage points fewer university graduates of the young cohort are employed in the public sector than the old cohort, consistent with the growth of the private sector over the past 20 years. Meanwhile, relatively more graduates of elite universities from the young cohort work in the public sector. Part of this may be attributable to the relatively rigid credential requirements of the public sector in hiring and part to the stability and amenities associated with a public-sector job, job components that have become more coveted in recent years. We find similar pattern for an alternative definition of employment sector that includes just public and other institutions of government (col. 4-6). These columns exclude employment in SOEs, assuming SOEs are

[8] Public sector includes government agencies, all public schools/universities, hospitals, other public institutions, and state-owned enterprises (SOEs); private sector includes all other employers, i.e., firms of all ownerships except for SOEs and nonfarm small businesses.

also subject to similar, albeit lesser, market forces than purely private firms. Young elite university graduates are relatively more likely to enter public service or other governmental institutions, thus being more protected from private market forces, than other university graduates.

2.3 Empirical Model

The focus of our empirical model is how wages of college graduates interact with attending an elite university. We employ an augmented Mincer equation to estimate the dynamics of the college tier premium with experience:

$$\ln(wage_j) = \alpha + \gamma_1 PE_j + \gamma_2 PE_j^2 + \delta \cdot X_j + f_{PE}(elite_j) + \varepsilon_j \quad (1)$$

In Equation (1), ln($wage_j$) is the natural logarithm of monthly wage of individual j; *elite* is an indicator equal to 1 for a graduate of an elite university and 0 otherwise. *PE* is years of potential experience in the labor market, *X* is a vector of control variables, and ε is a stochastic error term.

We start with the experience profile of the premium for elite school graduation. We model the time path of the premium as an inverse quadratic in potential experience as in Eq. 2. The coefficients β_1 and β_2 reflect how this premium varies over one's career and is our estimate of the experience profile reflecting employer learning. With an inverse function of experience, we expect β_1 to be positive.

$$f_{PE}(elite_i) = \beta_1(elite_j \times \left[\frac{1}{PE_j}\right]) + \beta_2(elite_j \times \left[\frac{1}{PE_j^2}\right]) \quad (2)$$

For the estimation, we use the survey information to construct retrospective work histories for all individuals, which allows us to include observations for the starting year of employment with the current firm along with employment information for the current year (2013). We thus portray the dynamics of wages for each worker as they evolve across different phases of the education and economic development of China.

The main challenge in interpreting the experience profile estimated from Equation 1 is the potential contamination from secular change in the returns to an elite university education. Since calendar time is positively correlated with experience, people with longer experience are generally older and entered the labor market in earlier years. In a simple regression without controlling for secular changes, β_1 and β_2 may reflect the exogenous changes in the return to an elite university education over time in addition to any change in the return over a worker's career from employer learning.

There are several concerns about secular changes in the Chinese labor market that must be dealt with. First, with the growth of the Chinese economy and the increasing adoption of skill-biased technologies, overall returns to the greater skills of elite university graduates may be larger in recent years due to increased demand for highly skilled workers. As a result, an estimated decline in returns to an elite university education by individual experience may be capturing the lower relative demand for skills in earlier years. This is a particular concern when comparing return between the pre- and post-college expansion cohorts.[9] Second, as discussed, the dramatic expansion of college graduates after 1999 could clearly alter the overall labor market for graduates dramatically. Third, China is a large and heterogeneous country, where both industry and universities can follow significantly different time patterns across cities and provinces. Finally, of lesser importance, wages of workers who began jobs during the years of the planned economy saw compressed wage structures, which could interact with career wage patterns for older workers. Our pre-expansion sample, however, includes less than 20 percent of workers that began jobs during that period.

We pursue three strategies to deal with these facets of the labor market. First, we incorporate an estimate of exogenous labor market conditions directly affecting educational demand in each province and year. The labor market conditions we exploit are generated by the expansion of college workers over time and by the varying relative demand for education levels across industries. Second, we allow the elite

[9] For a discussion of changing returns over time in China, see Liu (1998) and Zhang, Zhao, Park, and Song (2005).

premium to vary with these labor market conditions. Third, we separately estimate the wage model for pre- and post-expansion cohorts.

Chinese economic policies over the relevant period provide the basis for constructing an exogenous measure of labor conditions affecting educated workers. China's industrial development, in both national and regional levels, has been strongly shaped by the continued implementation of industrial policies during the entire economic reform period.[10] These policies are appealing to the Chinese government because they allow the government to maintain strong control in resource allocation through administrative approvals (Wu (2018); Jiang and Li (2018); Aghion et al. (2015); Heilmann and Shih (2013)). Specifically, since 1989, the State Council has regularly issued and updated general guidelines and detailed catalogues specifying industries, products, production scales, and production processes that are encouraged, restricted, or marked to be eliminated. The former will receive fast-track project approvals, land appropriations, bank loans, tax subsidies, and price subsidies in electricity, transportation, and raw materials. The resulting production organization determines to a large extent technologies that are adopted and hence employment composition in each industry at a given period.[11]

The central government's guidelines help shape regional industrial structure primarily for two reasons. First, the emphasis on production scale and agglomeration implies that large, incumbent firms are favored and new firms face high entry barriers; thus provinces that already have large firms in encouraged industries have greater advantages in expanding further, and vice versa. Second, the guidelines also stipulate regional industrial development priorities. For example, provinces in the central region are encouraged to develop modern agricultural production and natural resource-intensive

[10] China's industrial policies are modeled on similar policies adopted by the Japanese government in the 1950s and 1960s, which provide various government supports to targeted industries, in particular large firms in the name of economies of scale (Beason and Weinstein (1996)).

[11] Che and Zhang (2018) document that subsequent to the higher education expansion, firms in the manufacturing sector employ more college-educated workers and are able to adopt more advanced technologies.

manufacturing industries in accordance with their endowments, whereas coastal provinces are encouraged to continue to expand and upgrade export-oriented industries.

Our measure of relevant local conditions in the labor market follows a Bartik-type projection that combines the nationwide educational distribution by industry with province-specific industrial employment composition (see Bartik (1991), Blanchard and Katz (1992)). We construct a series of time-varying province-specific educational demands for both high school and university graduates. Specifically, the projected provincial employment for workers with education level *k* in province r in year *t* ($\hat{E}_{rt}^{k}$) is the nationwide fraction of employees with education level *k* in industry *i* in year *t* (L_{it}^{k} / L_{it}) weighted by the province-specific distribution of local employment by industry (l_{irt} / l_{rt}):

$$\hat{E}_{rt}^{k} = \sum_{i} \frac{l_{irt}}{l_{rt}} \times \frac{L_{it}^{k}}{L_{it}} \tag{3}$$

The nationwide education composition by industry (L_{it}^{k} / L_{it}) captures both the relative supply of labor force with different education levels and the contemporaneous demand for workers with the different skill demands of the technology each industry is using at a given point in time. The province-industry weights (l_{irt} / l_{rt}) then aggregate the demand for different types of skills in a province based on the local industrial structure.

In the cross-section, our local skill demand measure, $\hat{E}_{rt}^{k}$, provides an exogenous portrait of how differing industrial compositions across provinces imply varying demand for the varying skill classes of workers (defined by education level). Over time, the measure incorporates the expansion of higher education coupled with the production changes by industries to utilize more skilled workers.

The Hukou registration system also aids in the identification of the effects of elite education and of employer learning. China has restricted internal migration through the household registration system (Hukou). While barriers to migration have been reduced since the mid-1980s, restrictions on labor

mobility, especially across provinces, via the Hukou regulations remain tight (Au and Henderson (2006); Chan and Zhang (1999); Chan (2019). First, without a local Hukou, one is ineligible to work for certain sectors, industries, and occupations (Au and Henderson (2006); Song and Li (2013); Ma (2018)), for example, state sector and monopolistic industries.[12] Second, even though one may be hired on short-term contracts without a local Hukou, there is no provision of local public services including basic public education for children,[13] health care, and public pension. Since these programs are administered by provincial governments, this poses big obstacles for migration across provinces. The Hukou restrictions appear to have a larger impact on cross-province migration of skilled workers than that of the unskilled workers (Appleton, Song, and Xia (2014)). Thus, this national Chinese system historically has acted to limit migration and labor market adjustments outside of industrial development in each province.

The national industrial intensity of education usage (L_{it}^{k} / L_{it}) is constructed from the Urban Household Survey (UHS) which was conducted by the Statistic Bureau of China for 1988-2009.[14] The survey data are representative of registered residents in the urban area, i.e., people with Hukou and excluding migrants. Since migrant workers disproportionately work in the informal sector, our constructed industrial education composition is only for formal sector employees. In a parallel manner, we construct provincial employment, l_{irt} / l_{rt}, for just formal sector employment from data in various issues of the China Statistic Yearbook and China Labor Statistic Yearbook. Since migrant workers in general have lower education levels, our constructed provincial education composition for formal sector employees is likely to overestimate the overall percentage of college-educated labor force and

[12] Each year, the government sets quotas of new Hukou and allocates them to these employers for them to hire new college graduates; the allocation tends to be in favor of employers in the encouraged industries by the industrial policies. Non-state sector employers may obtain Hukou quotas if, for example, they are big tax-payers (Ma (2018)).

[13] While basic education is directly financed by city governments, children can only take the college entrance exam and be admitted to college from the province (based on the province quota) of their Hukou.

[14] We extrapolate data for 1980-1987 and 2010-2013.

underestimate that of those with low education levels. Nevertheless, we believe that the education distribution of the formal sector employment is more relevant for our study since college educated individuals tend strongly to work in the formal sector.

Figure 2 plots the time series of our projected education demand of formal sector employees nationwide. The fractions with a middle school education and less decrease over the entire period and become quite flat in the most recent years, while the fraction with a college education or above increases over time. Interestingly, the fraction stopping with a high school education increases up to the late 1990s and then declines, concurrent to the implementation of the higher education expansion policy.

We estimate Equations (1) for the overall sample and for different cohorts to compare how the dynamics of the college tier premium and returns to individual skills differ before and after the dramatic increase in the supply of college graduates due to the higher education expansion policy. In robustness analyses, we further estimate the model for individuals working in different regions and in different sectors and for males and females separately.

3 Empirical Results

This section begins with estimates of the average elite-university premium. It then turns to estimates of the dynamics of the premium with experience using the historical job data for full-time employees. All regressions control for city fixed effects.

3.1 Average elite premium

We begin with an overall picture of the returns to education over time. We first estimate a simple Mincer equation of log monthly wage using the cross section data of the 2013 CHIP. We focus on full-time employees in 2013. Columns 1-3 of Table 2 report results for the overall sample and for the young and old cohorts separately. The estimates are broadly consistent with estimates of returns to schooling in the Chinese labor market that are found in the literature. The return to each year of schooling is 7.7 percent

for the overall sample and is higher for the young cohorts (9.3 percent) than the old cohorts (6.9 percent). We next provide nonparametric estimates for the return to each schooling level relative to a general high school education (columns 4-6). The return to a 4-year university education relative to a high school education is about 7 percentage points smaller for the young cohorts than the old cohort, consistent with the changes in the supply of workers of different education levels.

In Table 3, we turn attention to individuals with a 4-year university education and report estimates of the return to an elite university education and to the Gaokao score. The estimated average return to an elite university education is 10.6 percent for the old cohorts and 18.8 percent for the young cohorts; this tremendous increase suggests the much larger role played by college tier in the labor market and is the starting point of our empirical analyses in the next sections. Additionally, the return to the Gaokao score is large (1.42) and significant for the young cohorts, but much smaller and insignificant for the old cohorts (0.43). To put this magnitude in perspective, consider a female graduate of the young cohorts with a Gaokao score 10 percentile higher than that of an otherwise similar male graduate; this Gaokao score advantage will eliminate the gender wage gap between the two graduates. In contrast, female graduates of the old cohorts do not appear to benefit from higher Gaokao scores. Once Gaokao score is controlled for, the return to an elite university becomes insignificant, whereas Gaokao score continues to be a significant determinant of wages; thus university tier becomes a less valuable proxy for true individual quality when the latter can be proxied by a more accurate, individual measure.

3.2 Dynamics of elite premium and returns to individual skills

Figure 3 plots the density of the normalized Gaokao score by cohort and college tier and provides a preliminary explanation for the larger premium to an elite university education for the young cohorts. There is a much larger average disparity in the Gaokao score between graduates of the elite and ordinary universities for the young cohorts; the means are 0.74 and 0.63 for the young cohorts and 0.71 and 0.66 for the old cohorts respectively. Since Gaokao score is generally unobservable to the employers, college

tier plays a more critical role in signaling ability for the young cohorts, but this role is likely to evolve over one's career when individual quality is better observed.

In Figure 4, we plot the histogram of log monthly wage of those of the young cohorts graduating from an elite university by potential experience. We compare the wage distribution of those with 0 to 5 years of potential experience by 2009 and that of individuals with 6 to 10 years of potential experience in 2013; these two groups belong to roughly the same age cohorts. For these graduates of elite universities, the wage distribution becomes more dispersed with the increase in experience; the standard deviation of log monthly wage increases from 0.65 to 0.80 when potential experience goes up from 0-5 years to 6-10 years. Thus, college tier becomes less important in wage determination over one's career. In particular, we observe a larger mass in the left tail when potential experience is in the 6-10 year range, suggesting the revelation of low quality among some of the elite university graduates.

Table 4 reports the baseline estimates of how returns to an elite university education change with labor market experience. All estimates are based on the sample of 4-year college graduates where we use the constructed employment histories to form panel data on the evolution of wages over the current employment spell. The dependent variable is log wages, and standard errors are clustered by province.[15] The first three columns provide estimates from the most stripped down model of return dynamics, first for all workers and then separately for the old and young cohorts. The estimates on the interactions between elite university dummy and the quadratic function of the inverse of experience capture the changes in the premium to an elite university with each year increase of potential experience. They indicate a declining return to elite universities, but the estimates are only significant for the young cohort. These estimates do not, however, allow for other, correlated influences on wages of college educated workers.

[15] The small number of clusters raises concerns about the best way to estimate standard errors (see Angrist and Pischke (2009) and Cameron and Miller (2015)). Given the form of our empirical model, it is not feasible to use the wild cluster resampling, but we report different critical values of the clustered standard errors below.

The final three columns introduce our projected time and province specific employment demand for educated labor based on the provincial industrial composition. We introduce high school and college demand projections, $\hat{E}^{HS}$ and $\hat{E}^{COL}$, both separately and as interactions with elite university attendance. The clearest picture of wage dynamics is found in column 6. The estimated decline in the elite premium is significant just for the young cohort.[16] The estimates on the linear and quadratic term for the young cohort of 0.259 and -0.022 indicate that the premium to an elite university education declines rapidly at the early stage of career but much more slowly in later years of career.[17] This decline is seen vividly in Figure 5 that plots the pattern of the elite premium for the young cohort. This is consistent with findings in the literature hat much of the employer learning of worker productivity occurs in the first 10 years of labor market experience.[18]

These estimates show a 13.7 percent premium to male workers, a subject we return to below. They also indicate that in provinces with larger demand for skilled labor, wages of elite college graduates are higher for the young cohorts, but are not affected for the old cohorts.

Employers may have access at hiring to information besides the college tier of an applicant to determine qualifications and wage. While not observed by economists, this may include information listed on the resume such as courses taken, GPA, and professional certificates obtained or obtained during interviews. If this information is positively correlated with the elite type, the estimated elite university premium at job entry and the later decline may in part be due to this unmeasured productivity, and we would overestimate the role played by the university tier.

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[16] Cameron and Miller (2015) suggest in this case using critical values for t(13), which would imply a p-value of 0.057.

[17] The estimates in Table 4 use all observations. Because of some missing career information (for 54 of the 772 young workers), this involves an unbalanced panel. If we rely on just the balanced panel, the decline in the college is qualitatively the same except slightly more rapidly.

[18] Lange (2007) finds that it takes on average three years for any expectation errors of employers about worker productivity to decline by approximately 50%.

To alleviate this concern, we use the college entry examination score (Gaokao) as a proxy for qualities employers may observe at hiring and control for it in the regressions. The results are reported in Table 5 for the entire sample and the old and young cohorts separately. The estimate on the Gaokao percentile in all three columns is significant both statistically and economically and is noticeably larger for the young cohort. On average, *ceteris paribus*, for a 10-percentile increase in the Gaokao score, the wage increases by 9.6%, and this increase is not statistically different for graduates of elite and ordinary universities. Once the Gaokao score is controlled for, the estimated decline of the elite premium with the employer is largely unchanged for the young cohort and remains highly significant. Thus, while employers may partially set starting wage based on specific individual qualities, they rely heavily on college tier as a source of information for productivity in general. This may partly be attributable to the fact that some of the individual qualities listed on resumes are not comparable across universities. For example, the same courses and GPA may embody very different amounts of human capital accumulated in elite versus ordinary universities. We use the specification of this analysis and focus on the young cohorts for the rest of the paper.

In Table 6, we include a full set of fixed effects for the industry, occupation, and sector of employment, first separately and then jointly, to investigate the potential channels through which the elite university status and Gaokao score may affect the wage dynamics.[19] With these controls individually, the estimated initial elite university premium is largely unchanged. Moreover, controlling for these factors has virtually no impact on the estimated returns to Gaokao score. In other words, the initial elite premium combined with its disappearance with employer learning appears to be a pervasive fact of the urban Chinese labor market.

[19] Sectors include government agencies, public institutions, state-owned enterprises (SOEs), and firms and small businesses of all other ownerships. The sample size changes slightly across the columns because not all individuals report all information about the industry, occupation, and sector of their jobs.

3.3 Estimates by Regions of Marketization and Sector

The dynamic of the elite university premium reported in the previous section comes fundamentally from a desire of firms to set wages by individual marginal productivity, but true productivity can only be revealed gradually over time. Given China's vast regional disparity in economic development and the work of market forces, we might expect heterogeneity in this dynamic. In particular, we might expect the discipline of productivity to be more pronounced in more developed regions and with stronger market forces.

To assess this hypothesis, we estimate the same model as in column 3 of Table 5 for the young cohorts in different local labor markets (Table 7). We first use the broadest classification and compare the coastal and inland regions, where the coastal region is more economically developed and has more competitive markets.[20] In column 1, the estimate on the interaction between the elite university dummy and the inverse of experience for the coastal region is positive, significant, and larger than that for the overall sample of the young cohorts (0.433 v 0.265); in contrast the estimate for the inland region (column 2) is much smaller in magnitude and insignificant. Also consistent with our hypothesis that more competitive markets put more value on individual productivity, the estimate for the Gaokao score is large (1.361) and significant at the 1 percent level for the coast region but, even though still significant at the 5 percent level, less important (0.90) for the inland region. Interestingly, otherwise similar males earn 24 percent more than females in the inland region, but there is no gender wage gap in the coastal region.

In the remaining columns of Table 7, as robustness checks, we compare cities with above- and below-median measures of economic development: per capita GDP and the fraction of GDP that comes from the agricultural or service sector. We consider cities with a larger service sector or a smaller

[20] The coastal region includes Beijing, Jiangsu, Shandong, and Guangdong provinces. The inland region includes the remaining 10 provinces in the sample: Shanxi, Liaoning, Anhui, Henan, Hubei, Hunan, Chongqing, Sichuan, Yunnan, and Gansu.

agricultural sector as more developed. Cities with above-median market-orientation as measured by these factors show a noticeably stronger influence of skills (Gaokao) on wages. They also show a generally stronger impact of college tier on wage at job entry with a steeper decline in the premium over time; this is particularly evident when we consider the composition of GDP as opposed to the level of GDP. In cities with an above-median measure of marketization, the gender wage gap is also substantially smaller and less statistically significantly different from zero.

Table 8 shows how the relevant estimates vary with foreign investment (FDI). More foreign ownership leads to much the same pattern of labor market returns as noted with the previous measures of market orientation. The returns to skills seen in the Gaokao scores are systematically stronger and statistically significant in the top half of the foreign investment distribution. Similarly, the gender wage gap is substantially smaller in cities of above-median openness, but the pattern of college tier premiums is less clear.

To summarize, estimates in Tables 7 and 8 suggest that skills are valued higher at locations with a more developed economy and market. It appears that in these places females are treated more equally as males, perhaps because employers may lose out in market competition if they discriminate against highly skilled females.

We next explore how the dynamic of elite university premium may differ between public and private sectors. A natural hypothesis is that the private sector employers, under more competition pressure, will set wages based more on individual productivity, and hence the dynamic of the elite university premium should be more pronounced. Table 9 reports the estimation results. In this table, the public sector includes government agencies and public institutions (schools, universities, hospitals, and other institutions), and we lump SOEs and private firms together to reflect potentially similar competition pressures as private firms, but also consider private firms separately in recognition of the special nature of SOEs.

Estimates for the impact of college tier follow the previous patterns: they are positive and of non-trivial magnitude; however, they are insignificant at the 5 percent level for all sectors. The estimate for the impact of skills (Gaokao) is similarly positive and of non-trivial magnitude but is only significant at the 1 percent level in column 2. The insignificance is likely due to the small sample size. The non-trivial positive point estimate for the public sector, perhaps unsurprisingly, are consistent with the general observations that the public sector employers are also highly selective in hiring. For example, applicants need to pass a written exam and then rounds of interviews to be successfully hired as civil servants, and the competition has become more fierce over time since the higher education expansion. Schools, universities, and hospitals with better performance get better reputations and in turn receive more resources, from both the government and the private contributions, and they therefore have a strong incentive to hire highly capable individuals. The gender wage gap is virtually zero in the public sector, but significant for firms. Stronger local demand for college-educated workers has a positive impact on individual wages in all sectors (not shown).

Findings in Tables 7-9 suggest that regional variations in the stage of economic development and the strength of market forces are a more important factor in explaining variations in wage determination than sector of the economy. The higher degree of meritocracy in the more developed regions is likely the most important reason why large cities are enormously appealing to college graduates despite a soaring cost of living.

4 Heterogeneity by Gender

The above analyses indicate significant gender wage gap for college graduates. This section explores to what extent this is related to differences in employer screening based on college tier and to observed individual skills. We focus on the young cohorts and estimate models paralleling those in Tables 4-6 except stratified by gender.

Table 10 provides basic estimates of earnings for men and women and investigates the role of employment location by industry, occupation, or employment sector. The results are remarkably consistent across the different specifications. Females are strongly rewarded for skills as measured by Gaokao score, but males are not. On the other hand, males are initially rewarded for graduating from an elite college with this advantage going away over time. Females on average receive the same wages regardless of whether they attended an elite school.

These results hold across the economy. As seen in columns 5-12, the nature of employment has little effect on these heterogeneous rewards in the labor market.

5 Conclusion

The Chinese labor market has undergone a remarkable transformation over the past two decades. While the rapid growth of the economy is well-known, the transformation of the labor force is less appreciated. Beginning in 1999, the government instituted a dramatic increase in the availability of higher education. This expansion altered the role and importance of elite universities and provides a unique opportunity to look at the labor market dynamics of any premium for attending an elite university.

Using a representative sample of urban workers, we can see how the market changed with expansion of colleges and universities. We use employment histories to construct a panel data set that permits identifying elite college premiums at entry and the dynamics of these premiums as employers have a chance to observe actual productivity of workers. We also have a more general skill measure – the Gaokao score that is used in college selection.

We find substantial premiums to attending an elite university, but, similar to the statistical discrimination model of Altonji and Pierret (2001), this premium erodes rather quickly as the employer learns about the worker's capabilities. These patterns, however, hold strongly for young workers entering

the labor market after the higher education expansion, and not for older workers. They also hold clearest for the more competitive parts of the Chinese economy.

The labor market rewards measured skills, although more so for women than for men. Including explicit measures of skills does not, however, change the dynamics of the elite-college premium. Moreover, the labor market returns to skills and to attending an elite college are found across the economy and are not restricted to specific industries, occupations, or employment sectors (public or private).

Whether these results generalize to other labor markets and other elite colleges outside of China is unclear. But the pattern unveiled by the policy changes in China are very suggestive of how competitive economies use the varying information on skills in setting wage dynamics.

References

Abowd, John M., Francis Kramarz, and David N. Margolis. 1999. "High wage workers and high wage firms." *Econometrica* 67, no. 2 (March): 251-333.

Aghion, Philippe, Jing Cai, Mathias Dewatripont, Luosha Du, Ann Harrison, and Patrick Legros. 2015. "Industrial Policy and Competition %J American Economic Journal: Macroeconomics." *American Economic Journal: Macroeconomics* 7, no. 4 (October): 1-32.

Albrecht, James, Mary Ann Bronson, Peter Skogman Thoursie, and Susan Vroman. 2018. "The career dynamics of high-skilled women and men: Evidence from Sweden." *European Economic Review* 109(October): 83-102.

Altonji, Joseph G., and Rebecca M. Blank. 1999. "Race and gender in the labor market." In *Handbook of Labor Economics*: Elsevier: 3143-3259.

Altonji, Joseph G., and Charles R. Pierret. 2001. "Employer learning and statistical discrimination." *Quarterly Journal of Economics* 116, no. 1 (February): 313-350.

Anelli, Massimo. 2016. "The Returns to Elite College Education: A Quasi-Experimental Analysis." CESifo Working Paper NO. 6076. Munich: CESifo (September).

Angrist, Joshua D., and Jörn-Steffen Pischke. 2009. *Mostly harmless econometrics: An empiricist's companion*. Princeton, NJ: Princeton University Press.

Appleton, Simon, Lina Song, and Qingjie Xia. 2014. "Understanding Urban Wage Inequality in China 1988–2008: Evidence from Quantile Analysis." *World Development* 62(October): 1-13.

Arcidiacono, Peter, Patrick Bayer, and Aurel Hizmo. 2010. "Beyond signaling and human capital: Education and the revelation of ability." *American Economic Journal: Applied Economics* 2, no. 4 (October): 76-104.

Au, Chun-Chung, and J. Vernon Henderson. 2006. "How migration restrictions limit agglomeration and productivity in China." *Journal of Development Economics* 80, no. 2 (August): 350-388.

Bartik, Timothy J. 1991. *Who Benefits from State and Local Economic Development Policies?* Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Beason, Richard, and David E. Weinstein. 1996. "Growth, Economies of Scale, and Targeting in Japan (1955-1990)." *The Review of Economics and Statistics* 78, no. 2 (May): 286-295.

Black, Dan A., and Jeffrey A. Smith. 2004. "How robust is the evidence on the effects of college quality? Evidence from matching." *Journal of Econometrics* 121, no. 1-2 (July-August): 99-124.

Black, Dan A., and Jeffrey A. Smith. 2006. "Estimating the Returns to College Quality with Multiple Proxies for Quality." *Journal of Labor Economics* 24, no. 3: 701-728.

Blanchard, Olivier, and Lawrence F Katz. 1992. "Regional evolutions." *Brookings Papers on Economic Activity* 1: 1-75.

Brandt, Loren, and Carsten Holz. 2006. "Spatial Price Differences in China: Estimates and Implications." *Economic Development and Cultural Change* 55, no. 1 (October): 43-86.

Cameron, A. Colin, and Douglas L. Miller. 2015. "A Practitioner's Guide to Cluster-Robust Inference." *Journal of Human Resources* 50, no. 2 (Spring): 317-372.

Card, David, Ana Rute Cardoso, and Patrick Kline. 2016. "Bargaining, Sorting, and the Gender Wage Gap: Quantifying the Impact of Firms on the Relative Pay of Women *." *The Quarterly Journal of Economics* 131, no. 2 (May): 633-686.

Castex, Gonzalo, and Evgenia Kogan Dechter. 2014. "The Changing Roles of Education and Ability in Wage Determination." *Journal of Labor Economics* 32, no. 4 (October): 685-710.

Chan, Kam Wing. 2019. "China's Hukou System at 60: Continuity and Reform." In *Handbook on Urban Development in China*, edited by Ray Yep, Jun Wang, and Thomas Johnson. Cheltenham and Camberley, UK: Edwar Elgar: 59-79.

Chan, Kam Wing, and Li Zhang. 1999. "The Hukou System and Rural-Urban Migration in China: Processes and Changes." *The China Quarterly* 160(December): 818-855.

Che, Yi, and Lei Zhang. 2018. "Human Capital, Technology Adoption and Firm Performance: Impacts of China's Higher Education Expansion in the Late 1990s." *The Economic Journal* 128, no. 614: 2282-2320.

Dale, Stacy Berg, and Alan B. Krueger. 2002. "Estimating the Payoff to Attending a More Selective College: An Application of Selection on Observables and Unobservables." *Quarterly Journal of Economics* 117, no. 4: 1491-1527.

Dale, Stacy Berg, and Alan B. Krueger. 2014. "Estimating the Effects of College Characteristics over the Career Using Administrative Earnings Data." *Journal of Human Resources* 49, no. 2 (March 31, 2014): 323-358.

Hanushek, Eric A., Guido Schwerdt, Simon Wiederhold, and Ludger Woessmann. 2015. "Returns to skills around the world: Evidence from PIAAC." *European Economic Review* 73: 103-130.

Hanushek, Eric A., Guido Schwerdt, Simon Wiederhold, and Ludger Woessmann. 2017. "Coping with change: International differences in the returns to skills." *Economic Letters* 153(April): 15-19.

Heilmann, Sebastian, and Lea Shih. 2013. "The Rise of Industrial Policy in China, 1978-2012." Harvard-Yenching Institute Working Paper Series Cambridge, MA: Harvard University (January).

Hoekstra, Mark. 2009. "The Effect of Attending the Flagship State University on Earnings: A Discontinuity-Based Approach." *Review of Economics and Statistics* 91, no. 4: 717-724.

Hotz, V. Joseph, Per Johansson, and Arizo Karimi. 2018. "Parenthood, Family Friendly Workplaces, and the Gender Gaps in Early Work Careers." NBER Working Paper No. 24173. Cambridge, MA: National Bureau of Economic Research (June).

Jia, Ruixue, and Hongbin Li. 2019. "The Value of Elite Universities in China." Working Paper (February 9).

Jiang, Feitao, and Xiaoping Li. 2018. "China's Industrial Policies during the Economic Reform of the Past Forty Years." *Management World* 10(in Chinese): 73-85

Kang, Lili, Fei Peng, and Yu Zhu. 2018. "Returns to higher education subjects and tiers in China - Evidence from the China Family Panel Studies." GLO Discussion Paper No. 238. Maastricht: Global Labor Organization (GLO).

Kaufmann, Katja, Matthias Messner, and Alex Solis. 2015. "Returns to Elite Higher Education in the Marriage Market: Evidence from Chile." IGIER (Innocenzo Gasparini Institute for Economic Research) Milan: Bocconi University (July).

Knight, John, Quheng Deng, and Shi Li. 2017. "China's expansion of higher education: The labour market consequences of a supply shock." *China Economic Review* 43(April): 127-141.

Lange, Fabian. 2007. "The Speed of Employer Learning." *Journal of Labor Economics* 25, no. 1: 1-35.

Li, Hongbin, Lingsheng Meng, Xinzheng Shi, and Binzhen Wu. 2012. "Does attending elite colleges pay in China?" *Journal of Comparative Economics* 40, no. 1 (February): 78-88.

Liu, Zhiqiang. 1998. "Earnings, Education, and Economic Reforms in Urban China." *Economic Development and Cultural Change* 46, no. 4 (July): 697-725.

Ma, Xinxin. 2018. "Labor market segmentation by industry sectors and wage gaps between migrants and local urban residents in urban China." *China Economic Review* 47(February): 96-115.

Mansour, Hani. 2012. "Does Employer Learning Vary by Occupation?" *Journal of Labor Economics* 30, no. 2 (April): 415-444.

Song, Jin, and Shi Li. 2013. "China's Integrated Urban-Rural Hukou Reform and Occupation Distribution." *World Economy* 7: 28-47 (in Chinese).

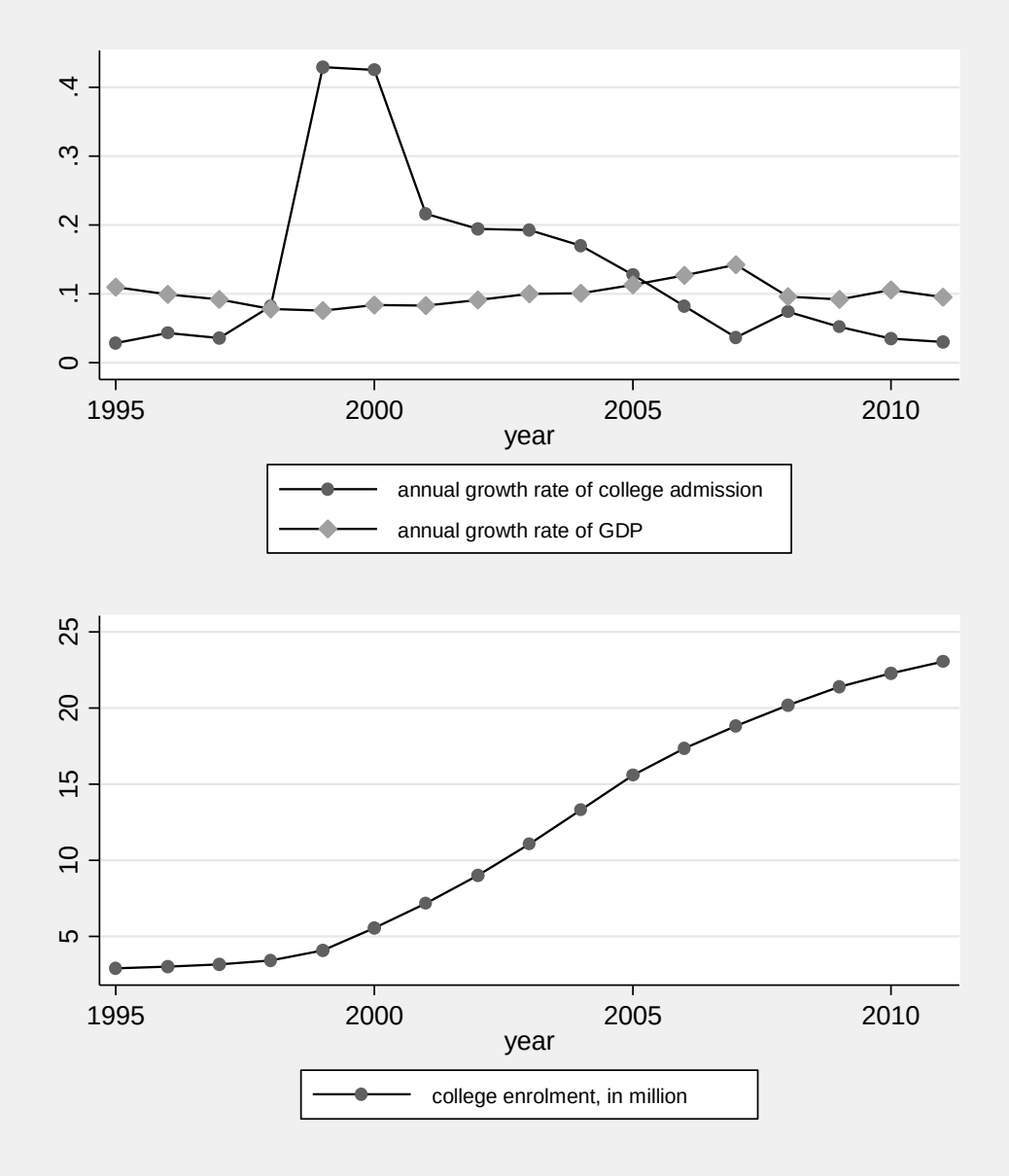
Wu, Jinglian. 2018. *The Progression of the Chinese Economic Reform*: Encyclopedia of China Publishing House (in Chinese).

Zhang, Junsen, Yaohui Zhao, Albert Park, and Xiaoqing Song. 2005. "Economic returns to schooling in urban China, 1988 to 2001." *Journal of Comparative Economics* 33, no. 4 (December): 730-752.

Zhang, Lei. 2009. "A value-added estimate of higher education quality of US states." *Education Economics* 17, no. 4 (December): 469 - 489.

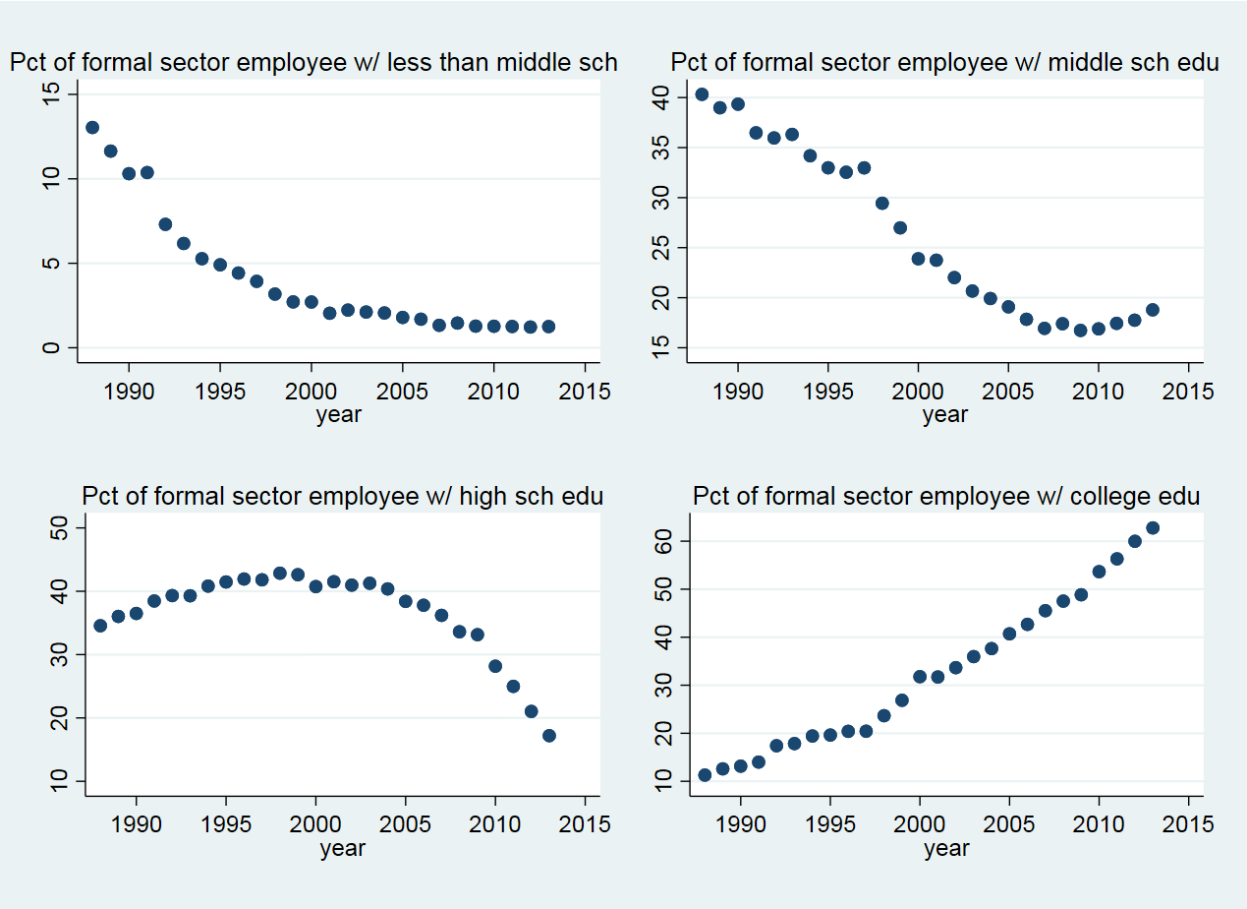
Zhong, Hai. 2011. "The impact of population aging on income inequality in developing countries: Evidence from rural China." *China Economic Review* 22, no. 1 (June): 98-107.

Figure 1: Annual Growth Rate of College Admission and Number of College Students Enrolled in Each Year



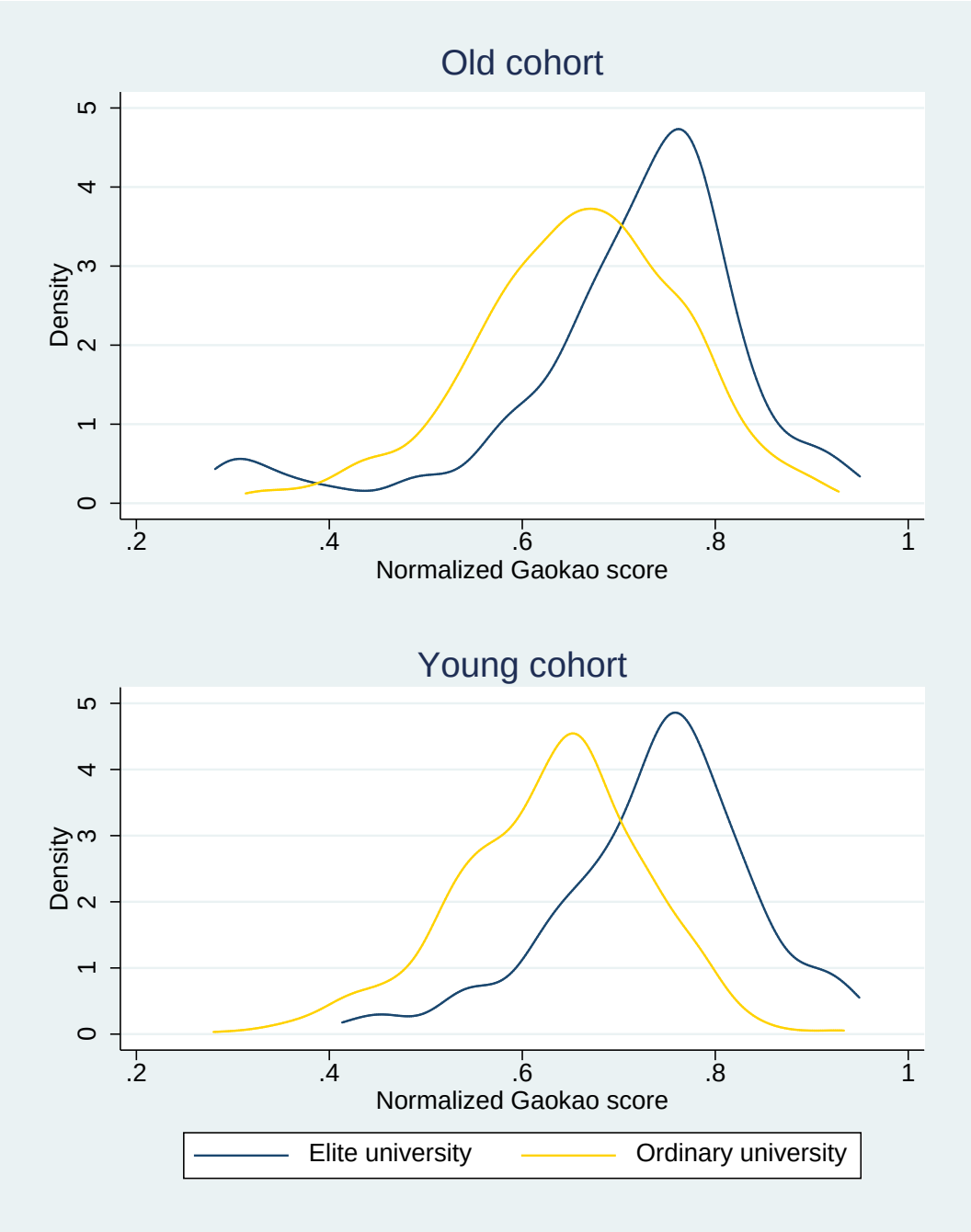
Notes: The top panel plots the annual growth rate of college admission, equal to the number of students admitted to 3- or 4-year regular colleges in current year divided by the number for the previous year minus 1, and the annual growth rate of GDP. The bottom panel depicts the total number of students (in millions) enrolled in regular colleges and universities, including both undergraduate and graduate students. Data come from various issues of China Statistics Yearbook.

Figure 2: Projected Employment Demand for Educated Labor in the Formal Sector in Urban China (Nationwide Aggregates)



Notes: We construct the province-specific education demand as a weighted sum of nationwide education distribution by industry weighted by the province-specific industrial employment composition. Both measures are for formal sector employees only. For the national aggregate education demand, the weight is the nationwide industrial employment composition. National education distribution by industry is calculated from the Urban Household Survey conducted by the Statistic Bureau of China. Provincial employment distribution by industry comes from various issues of China Statistics Yearbook and China Labor Statistics Yearbook.

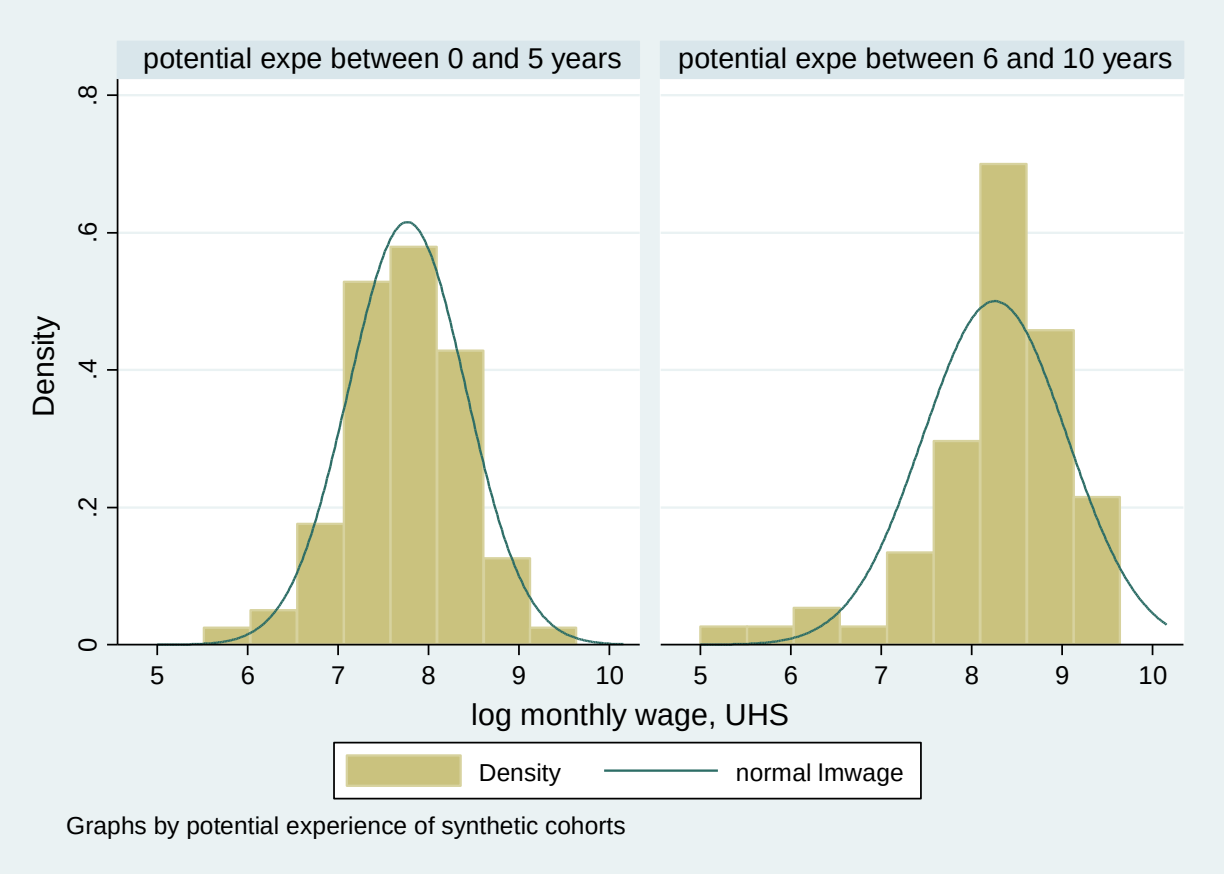
Figure 3: Distribution of Gaokao Score



Notes: The sample includes all full-time workers with hourly wage between 1 and 100 Yuan per hour and a four-year college degree, aged 20 to 60. The young cohort sample refers to individuals born in or after 1980; the old cohort sample individuals born between 1954 and 1979. The Gaokao score is normalized by the total score of the test one took.

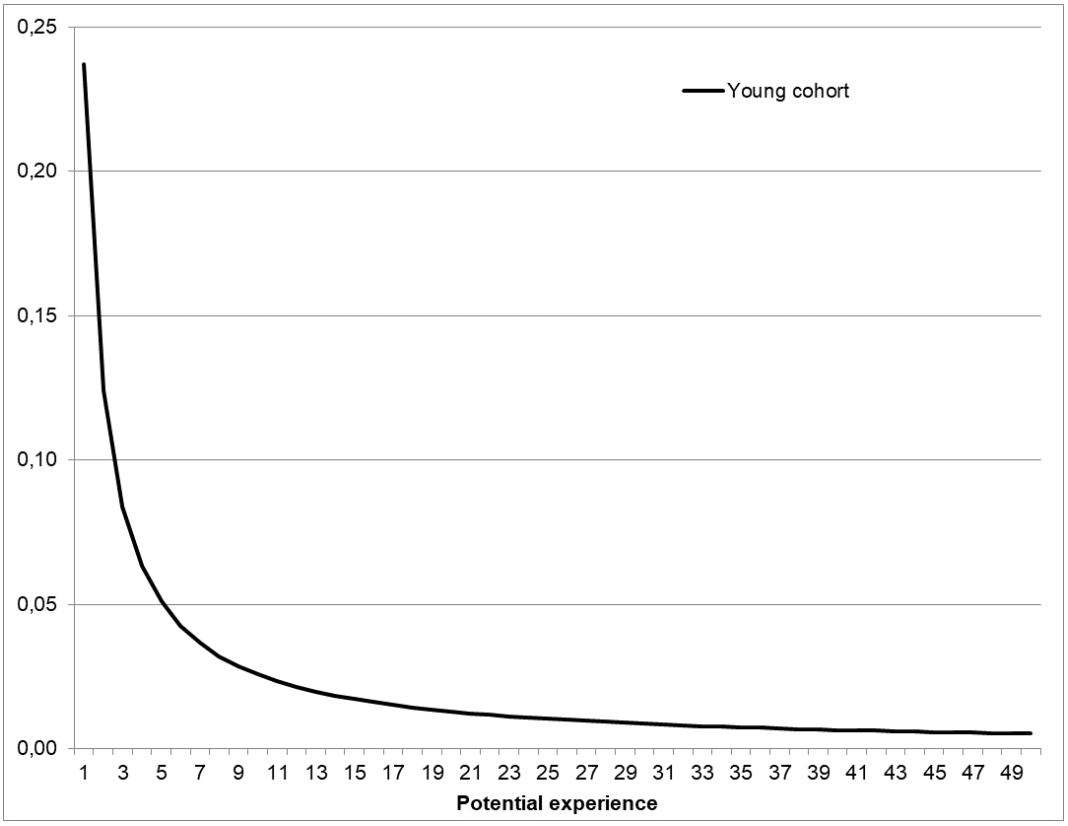
Source: Authors' calculation from the China Household Income Project 2013. Total Gaokao score comes from various Gaokao-related websites.

Figure 4: Wage Distribution of Elite College Graduates of the Younger Cohorts (born after 1979) by Potential Experience



Notes: The left panel is for elite college graduates with 0 to 5 years of potential experience by 2009, and the right panel is for elite college graduates with 6 to 10 years of potential experience in 2013. These two groups come roughly from the same cohorts.
Source: Authors' calculation from the panel data sample constructed from the China Household Income Project 2013. .

Figure 5: Predicted Elite University Premium over Potential Experience for the Young Cohort



Notes: For each year of potential experience, the predicted value of the elite university premium is calculated from the coefficient estimates on *1/PE* and $1/PE^2$ in column 6 of Table 4; i.e., $0.259/PE-0.022/PE^2$.

Table 1: Distribution of Education Attainment and Employment Sector (percent)

Panel A: Educational Distribution by Age Cohort

		Old cohort			Young cohort		
Education level	Total	Total	Female	Male	Total	Female	Male
Primary school or less	4.6	6.0	7.1	5.1	1.2	1.4	1.0
Middle school	25.2	29.2	29.1	29.2	15.3	14.4	16.3
High school	18.2	20.5	20.3	20.6	12.4	12.0	12.8
Technical high school	11.7	10.5	11.7	9.7	14.7	12.7	16.6
Technical college	17.8	15.6	15.0	16.0	23.3	24.7	22.0
University	22.5	18.3	16.9	19.4	33.1	34.8	31.4
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0
University breakdown							
Elite university	16.9	17.4	14.7	19.0	16.4	15.3	17.5
Ordinary university	83.1	82.6	85.3	81.0	83.6	84.7	82.5

Table 1 (cont.)

Panel B: Educational Distribution of Public Employment

Education level	% public sector			% of public sector workers in government and institutions		
	Total	Old	Young	Total	Old	Young
Primary school or less	13.0	12.8	16.1	5.2	5.6	0.0
Middle school	24.4	27.0	11.9	7.3	7.7	5.2
High school	37.8	41.9	21.2	13.8	15.5	6.5
Technical high school	47.6	56.1	32.3	22.1	26.6	14.1
Technical college	58.9	67.6	44.3	32.3	40.6	18.5
University	73.3	80.8	63.0	52.8	61.9	40.2
University breakdown						
Elite university	69.4	72.2	66.7	43.4	46.0	40.9
Ordinary university	62.0	72.0	52.6	39.5	50.4	29.3

*Note*s: The sample includes all full-time workers with hourly wage between 1 and 100 Yuan per hour, aged 20 to 60. The young cohort sample refers to individuals born in or after 1980; the old cohort sample individuals born between 1954 and 1979. Public sector includes government agencies, institutions, and state-owned enterprises (SOEs).

Source: China Household Income Project 2013, authors' calculation.

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Table 2: Returns to Individual Skills

	1	2	3	4	5	6
	All	Old	Young	All	Old	Young
Male	0.290***	0.348***	0.165***	0.298***	0.352***	0.167***
	[0.013]	[0.015]	[0.023]	[0.013]	[0.015]	[0.023]
PE	0.051***	0.023***	0.062***	0.054***	0.033***	0.066***
	[0.003]	[0.006]	[0.012]	[0.003]	[0.006]	[0.012]
PE^2	-0.001***	-0.000***	-0.001	-0.001***	-0.001***	-0.002***
	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.001]
Years of schooling	0.077***	0.069***	0.093***			
	[0.003]	[0.003]	[0.006]			
Primary school				-0.189***	-0.183***	-0.244**
				[0.039]	[0.042]	[0.115]
Middle school				-0.113***	-0.102***	-0.174***
				[0.021]	[0.023]	[0.050]
Technical high school				0.092***	0.140***	-0.045
				[0.024]	[0.028]	[0.047]
Technical college				0.278***	0.298***	0.170***
				[0.021]	[0.026]	[0.041]
University				0.540***	0.525***	0.454***
				[0.022]	[0.026]	[0.043]
Constant	6.369***	6.816***	6.195***	7.151***	7.385***	7.341***
	[0.053]	[0.110]	[0.108]	[0.038]	[0.095]	[0.078]
City fixed effects	yes	yes	yes	yes	yes	yes
Observations	9,166	6,550	2,616	9,166	6,550	2,616
R-squared	0.273	0.295	0.27	0.284	0.312	0.265

Notes: The sample includes all full-time workers with hourly wage between 1 and 100 Yuan per hour, aged 20 to 60. The young cohort sample refers to individuals born in or after 1980; the old cohort sample individuals born between 1954 and 1979. Dependent variable is the natural logarithm of monthly CPI-adjusted wage in 2013. Explanatory variables include a dummy for male workers, potential experience (PE=Age-years of schooling-6) and its square (PE^2), the number of years of education or dummies for the education level reached (Primary education, Middle school education, Technical high school education, Technical college education, University education, with High school education the reference), and city fixed effects.

Robust standard errors are in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Average Elite Premium for College Graduates

	1	2	3	4	5	6	7	8	9
	all	old	young	all	old	young	all	old	young
Male	0.140***	0.189***	0.126***	0.152***	0.194***	0.147***	0.150***	0.192***	0.145***
	[0.030]	[0.041]	[0.046]	[0.035]	[0.050]	[0.050]	[0.035]	[0.050]	[0.050]
PE	0.071***	0.055**	0.095***	0.078***	0.054*	0.102***	0.077***	0.058**	0.101***
	[0.008]	[0.023]	[0.034]	[0.009]	[0.029]	[0.037]	[0.009]	[0.029]	[0.037]
PE^2	-0.001***	-0.001**	-0.004**	-0.002***	-0.001**	-0.004*	-0.002***	-0.001**	-0.004*
	[0.000]	[0.001]	[0.002]	[0.000]	[0.001]	[0.002]	[0.000]	[0.001]	[0.002]
Elite	0.142***	0.106**	0.188***				0.083*	0.073	0.052
	[0.040]	[0.052]	[0.066]				[0.048]	[0.063]	[0.081]
Gaokao score				0.905***	0.434	1.420***	0.789***	0.389	1.309***
				[0.210]	[0.276]	[0.345]	[0.217]	[0.275]	[0.397]
Constant	7.815***	7.977***	7.843***	7.209***	7.773***	6.865***	7.262***	7.729***	6.926***
	[0.059]	[0.246]	[0.131]	[0.152]	[0.358]	[0.281]	[0.154]	[0.359]	[0.298]
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,481	724	757	1,152	540	612	1,152	540	612
R-squared	0.361	0.335	0.362	0.396	0.364	0.436	0.398	0.366	0.437

Notes: The sample includes all full-time workers with hourly wage between 1 and 100 Yuan per hour and a four-year college degree, aged 20 to 60. The young cohort sample refers to individuals born in or after 1980; the old cohort sample individuals born between 1954 and 1979. Dependent variable is the natural logarithm of monthly CPI-adjusted wage in 2013. Explanatory variables include a dummy for male workers, potential experience (PE=Age-years of schooling-6) and its square (PE^2), a dummy variable (*elite*) for elite university graduates, the Gaokao score (normalized by the total score of the test one took), and city fixed effects.

Robust standard errors are in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Dynamic Returns to Elite Universities

	1	2	3	4	5	6
	All	Old	Young	All	Old	Young
Male	0.045	0.151***	0.117***	0.137***	0.185***	0.128***
	[0.031]	[0.034]	[0.040]	[0.025]	[0.023]	[0.039]
PE	0.113***	0.148***	0.096***	0.056***	0.023	0.064***
	[0.007]	[0.010]	[0.016]	[0.005]	[0.017]	[0.016]
PE^2	-0.002***	-0.003***	-0.002***	-0.001***	-0.001*	-0.002**
	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.001]
$elite \times (1/PE)$	0.256	0.318	0.237***	0.184	-0.091	0.259**
	[0.205]	[0.286]	[0.078]	[0.147]	[0.271]	[0.124]
$elite \times (1/PE^2)$	-0.023	-0.030	-0.020***	-0.016	0.007	-0.022*
	[0.019]	[0.027]	[0.007]	[0.014]	[0.025]	[0.011]
$elite \times \hat{E}_{rt}^{HS}$				-0.003	0.002	-0.005
				[0.004]	[0.005]	[0.004]
$elite \times \hat{E}_{rt}^{COL}$				0.003**	0.001	0.003**
				[0.001]	[0.001]	[0.002]
$\hat{E}_{rt}^{HS}$				0.012**	0.002	0.005
				[0.005]	[0.007]	[0.011]
$\hat{E}_{rt}^{COL}$				0.028***	0.033***	0.016**
				[0.003]	[0.004]	[0.008]
Constant	7.378***	6.779***	7.630***	5.827***	6.138***	6.630***
	[0.050]	[0.068]	[0.057]	[0.265]	[0.355]	[0.743]
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,841	2,830	2,830	1,340	1,340	1,490
Number of individuals	1,501	1,501	1,501	729	729	772

Notes: The panel data sample includes all full-time workers with hourly wage between 1 and 100 Yuan per hour and a four-year college degree, aged 20 to 60. The young cohort sample refers to individuals born in or after 1980; the old cohort sample individuals born between 1954 and 1979. Dependent variable is the natural logarithm of monthly CPI-adjusted wage, measured in 2013 and in the year when one starts the current job. Explanatory variables include a dummy for male workers, potential experience (PE=Age-years of schooling-6) and its square (PE^2), an inverse quadratic in PE interacted with a dummy variable indicating elite university graduates (*elite*), time-varying province-specific demand for high school graduates and college graduates ($\hat{E}_{rt}^{HS}$ and $\hat{E}_{rt}^{COL}$, each as a percentage of total labor demand) and their interactions with the elite dummy, and city fixed effects.

Robust standard errors clustered at province level are in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Dynamic returns to elite university and returns to measured skills

	1 All	2 Old	3 Young
Male	0.143***	0.182***	0.143***
	[0.026]	[0.036]	[0.045]
PE	0.054***	0.025*	0.057***
	[0.006]	[0.015]	[0.016]
PE^2	-0.001***	-0.001**	-0.001
	[0.000]	[0.000]	[0.001]
$elite \times (1/PE)$	0.145	-0.117	0.265***
	[0.143]	[0.388]	[0.090]
$elite \times (1/PE^2)$	-0.012	0.008	-0.022***
	[0.013]	[0.037]	[0.008]
$elite \times \hat{E}_{rt}^{HS}$	0.001	0.007	-0.009
	[0.005]	[0.008]	[0.007]
$elite \times \hat{E}_{rt}^{COL}$	0.004	0.003	-0.001
	[0.005]	[0.005]	[0.006]
$\hat{E}_{rt}^{HS}$	0.011***	0.001	-0.003
	[0.004]	[0.006]	[0.013]
$\hat{E}_{rt}^{COL}$	0.029***	0.034***	0.007
	[0.003]	[0.003]	[0.011]
Gaokao score	0.960***	0.680***	1.077***
	[0.126]	[0.198]	[0.368]
Elite x Gaokao score	-0.241	-0.292	0.337
	[0.516]	[0.548]	[0.612]
Constant	5.150***	5.707***	6.654***
	[0.214]	[0.235]	[0.890]
City fixed effects	Yes	Yes	Yes
Observations	2,244	1,029	1,215
Number of individuals	1,178	552	626

Notes: The panel data sample includes all full-time workers with hourly wage between 1 and 100 Yuan per hour and a four-year college degree, aged 20 to 60. The young cohort sample refers to individuals born in or after 1980; the old cohort sample individuals born between 1954 and 1979. Dependent variable is the natural logarithm of monthly CPI-adjusted wage, measured in 2013 and in the year when one starts the current job. Explanatory variables include a dummy for male workers, potential experience (PE=Age-years of schooling-6) and its square (PE^2), an inverse quadratic in PE interacted with a dummy variable indicating elite university graduates (*elite*), time-varying province-specific demand for high school graduates and college graduates ($\hat{E}_{rt}^{HS}$ and $\hat{E}_{rt}^{COL}$, each as a percentage of total labor demand) and their interactions with the elite dummy, the Gaokao score (normalized by the total score of the test one took) and its interaction with the elite dummy, and city fixed effects.

Robust standard errors clustered at province level are in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Dynamic returns to elite university and returns to measured skills within Industry, Occupation, and Sector (young cohort)

	Young cohort			
	1	2	3	4
Male	0.135***	0.147***	0.134***	0.133***
	[0.045]	[0.051]	[0.043]	[0.052]
PE	0.058***	0.058***	0.057***	0.056***
	[0.017]	[0.016]	[0.017]	[0.016]
PE^2	-0.001	-0.001	-0.001	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]
$elite \times (1/PE)$	0.246**	0.254***	0.257***	0.235**
	[0.097]	[0.083]	[0.097]	[0.094]
$elite \times (1/PE^2)$	-0.020**	-0.021***	-0.021**	-0.019**
	[0.008]	[0.007]	[0.008]	[0.008]
$elite \times \hat{E}_{rt}^{HS}$	-0.010	-0.006	-0.009	-0.007
	[0.007]	[0.008]	[0.007]	[0.008]
$elite \times \hat{E}_{rt}^{COL}$	-0.002	-0.000	-0.001	-0.001
	[0.005]	[0.006]	[0.006]	[0.005]
$\hat{E}_{rt}^{HS}$	-0.002	0.004	-0.003	0.003
	[0.014]	[0.012]	[0.013]	[0.012]
$\hat{E}_{rt}^{COL}$	0.009	0.014	0.007	0.013
	[0.011]	[0.009]	[0.011]	[0.009]
Gaokao score	0.990**	1.091***	1.087***	1.057***
	[0.391]	[0.339]	[0.392]	[0.364]
Elite x Gaokao score	0.442	0.144	0.324	0.260
	[0.503]	[0.637]	[0.598]	[0.551]
Constant	6.830***	5.978***	6.673***	6.279***
	[0.979]	[0.780]	[0.895]	[0.869]
City fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	No	No	Yes
Occupation fixed effects	No	Yes	No	Yes
Sector fixed effects	No	No	Yes	Yes
Observations	1,213	1,191	1,215	1,189
Number of individuals	625	612	626	611

Notes: The panel data sample includes all full-time workers with hourly wage between 1 and 100 Yuan per hour and a four-year college degree, born in or after 1980. Model specifications are the same as that in Table 5, with industry, occupation, and sector fixed effects added separately in columns 1-3 and jointly in column 4.

Robust standard errors clustered at province level are in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Returns to elite university and skills by region and economic characteristics (young cohort)

	1	2	3	4	5	6	7	8
	coastal	inland	≥median GDP/pop	<median gdp/pop	≥median agri GDP share	<median agri GDP share	≥median service GDP share	<median service GDP share
Male	0.009	0.245***	0.079*	0.221***	0.159***	0.139**	0.086***	0.201**
	[0.064]	[0.039]	[0.041]	[0.047]	[0.056]	[0.056]	[0.032]	[0.084]
$elite \times (1/PE)$	0.433***	0.165	0.237*	0.339*	0.159	0.432***	0.439***	-0.067
	[0.062]	[0.144]	[0.139]	[0.179]	[0.199]	[0.134]	[0.145]	[0.160]
$elite \times (1/PE^2)$	-0.036***	-0.014	-0.019	-0.030*	-0.014	-0.036***	-0.037***	0.007
	[0.005]	[0.012]	[0.013]	[0.016]	[0.018]	[0.013]	[0.013]	[0.015]
Gaokao score	1.361***	0.900**	1.914***	0.019	0.413	1.667***	1.951***	0.301
	[0.418]	[0.406]	[0.311]	[0.502]	[0.419]	[0.347]	[0.445]	[0.327]
Elite x Gaokao score	0.386	-0.406	0.320	-0.488	-0.549	0.296	0.162	-0.334
	[0.390]	[1.416]	[0.620]	[1.293]	[0.908]	[0.870]	[0.719]	[1.226]
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	529	686	639	576	652	563	616	599
Number of individuals	268	358	325	301	338	288	315	311

Notes: The panel data sample includes all full-time workers with hourly wage between 1 and 100 Yuan per hour and a four-year college degree, born in or after 1980. Each column is a separate regression estimated on different samples. Column 1 is the sample of individuals from the coastal provinces (Beijing, Jiangsu, Shandong, Guangdong); column 2 is the sample of inland provinces (Shanxi, Liaoning, Anhui, Henan, Hubei, Hunan, Chongqing, Sichuan, Yunnan, Gansu); columns 3 and 4 are samples of cities whose per capita GDP is above or below the national median in 2011; columns 5 and 6 are samples of cities where the share of GDP from the agricultural sector is above or below the national median in 2011; and columns 7 and 8 are samples of cities where the share of GDP from the service sector is above or below the national median in 2011.

Model specifications are the same as that in Table 5.

Robust standard errors clustered at province level are in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Returns to elite university by regional external investment (young cohort)

	1	2	3	4
	≥median FDI VA %	<median FDI VA %	≥median FDI number %	< median FDI number %
Male	0.132***	0.159*	0.075*	0.212***
	[0.038]	[0.091]	[0.041]	[0.064]
$elite \times (1/PE)$	0.169	0.479**	0.294**	0.281
	[0.173]	[0.216]	[0.123]	[0.175]
$elite \times (1/PE^2)$	-0.012	-0.042**	-0.024**	-0.025
	[0.016]	[0.020]	[0.011]	[0.015]
Gaokao score	1.618***	0.424	1.661***	0.380
	[0.384]	[0.424]	[0.362]	[0.484]
Elite x Gaokao score	0.917	-1.645**	0.352	-0.276
	[0.815]	[0.806]	[0.562]	[1.434]
City fixed effects	Yes	Yes	Yes	Yes
Observations	681	534	608	607
Number of individuals	351	275	310	316

Notes: The panel data sample includes all full-time workers with hourly wage between 1 and 100 Yuan per hour and a four-year college degree, born in or after 1980. Each column is a separate regression estimated on different samples. Columns 1 and 2 are samples of cities whose value-added share from foreign-owned firms (FDI) is above or below the national median in 2011, and columns 3 and 4 are samples of cities where the fraction of foreign-owned firms is above or below the national median in 2011.

Model specifications are the same as that in Table 5.

Robust standard errors clustered at province level in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Returns to elite university and skills by job sector (young cohort)

	1	2	3
	Government agencies+ public institutions	private + SOE	private firms
Male	0.043	0.188***	0.166**
	[0.055]	[0.054]	[0.075]
$elite \times (1/PE)$	0.332	0.194	0.361*
	[0.268]	[0.132]	[0.188]
$elite \times (1/PE^2)$	-0.027	-0.016	-0.032*
	[0.024]	[0.012]	[0.018]
Gaokao score	0.836	1.479***	1.146*
	[0.742]	[0.467]	[0.660]
Elite x Gaokao score	0.970**	0.054	1.679
	[0.417]	[1.266]	[1.680]
City fixed effects	Yes	Yes	Yes
Observations	496	719	435
Number of id	255	371	224

Notes: The panel data sample includes all full-time workers with hourly wage between 1 and 100 Yuan per hour and a four-year college degree, born in or after 1980. Column 1 is estimated from the sample of individuals working in the public sector, i.e., government agencies and public institutions; column 2 employs the sample of individuals working in the private sector (domestic private firms and foreign owned firms) and state owned enterprises (SOEs); and column 3 employs the sample of individuals working in the private sector.

Model specifications are the same as that in Table 5.

Robust standard errors clustered at province level in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 10: Heterogeneity by gender (young cohort)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
					Industry FEs		Occupation FEs		Sector FEs		all three FEs	
	female	male	female	male	female	male	female	male	female	male	female	male
$elite \times (1/PE)$	0.020	0.470***	0.024	0.502***	0.040	0.448***	0.005	0.466***	0.014	0.476***	0.030	0.401***
	[0.194]	[0.180]	[0.232]	[0.156]	[0.223]	[0.151]	[0.219]	[0.162]	[0.226]	[0.180]	[0.224]	[0.145]
$elite \times (1/PE^2)$	0.000	-0.041**	0.000	-0.044***	-0.001	-0.039***	0.002	-0.040***	0.001	-0.042**	-0.000	-0.034**
	[0.017]	[0.017]	[0.021]	[0.015]	[0.020]	[0.014]	[0.020]	[0.015]	[0.021]	[0.017]	[0.021]	[0.014]
Gaokao score			1.556***	0.761	1.407***	0.606	1.614***	0.730	1.532***	0.772	1.445***	0.650
			[0.308]	[0.744]	[0.331]	[0.732]	[0.377]	[0.699]	[0.296]	[0.833]	[0.433]	[0.762]
Elite x Gaokao score			0.813	0.456	0.799	0.827	0.628	0.102	0.787	0.460	0.639	0.476
			[0.660]	[0.918]	[0.659]	[0.821]	[0.850]	[0.808]	[0.658]	[0.875]	[0.851]	[0.616]
City fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	753	737	624	589	622	589	611	578	624	589	609	578
Number of id	391	381	323	302	322	302	315	296	323	302	314	296

Notes: The panel data sample includes all full-time workers with hourly wage between 1 and 100 Yuan per hour and a four-year college degree, born in or after 1980. Models are separately estimated on the male and female samples.

Model specifications are generally the same as that in Table 5, with columns 1-2 not controlling for Gaokao score (normalized by the total score of the test one took) and its interaction with the elite dummy; columns 5-6 controlling additionally for industry fixed effects; columns 7-8 occupation fixed effects; columns 9-10 sector fixed effects; and columns 11-12 all three groups of fixed effects.

Robust standard errors clustered at province level in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.