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

We thank Jerome Adda, Yuan Jiang, Mark Rosenzweig, Michael Waldman, Jing Zhang, and Junsen Zhang for helpful comments and discussions. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Employer Learning and the Dynamics of Returns to Universities: Evidence from Chinese Elite Education during University Expansion

Sylvie Démurger, Eric A. Hanushek, and Lei Zhang

NBER Working Paper No. 25955
June 2019, Revised May 2020
JEL No. I20,I23,J2

ABSTRACT

This paper estimates the return to an elite university education over a college graduate's career in contemporary China. We find a substantial premium for graduating from an elite Chinese university at the job entry that declines quickly in early career before starting to recover subsequently. This pattern is entirely driven by the post-expansion cohorts who entered college after the higher education expansion that started in 1999. It is more pronounced in coastal provinces and in economically more developed regions, where individual skills are highly rewarded in the labor market. Both male and female elite college graduates experience the same dynamic pattern of the elite premium, but individual skills are much more rewarded over the entire career for females than males. The results are consistent with predictions of asymmetric employer learning models, both at the job entry and at the mid-career when individuals are up for promotions.

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, often defined by faculty research, 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, but this does not stop students: as college attendance expands, competition to get into the elite universities also intensifies. A particularly attractive laboratory for investigating the college quality-student outcome nexus is modern China that combines a dramatic expansion of universities with both a recognized identification of elite universities and a responsive labor market. Investigation of the impact of China's elite universities provides insights 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 labor market outcomes of universities is separating the impact of the university from the selection of students into them. 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 changing overall college attendance rates that alter the labor market for college graduates over time. This research addresses each of these challenges.

We evaluate the economic return to attending elite Chinese universities. We focus particularly on the dynamics of the college quality wage premium i.e., how it changes with labor market experience (the experience profile) and how it varies over time for different cohorts (the intertemporal profile). Much of the attention to the Chinese economy focuses on the huge shifts of industries with substantial changes in technologies. In the background, however, the labor market in China has undergone a tremendous transformation following the massive expansion of higher education since the late 1990s (Knight, Deng, and Li (2017)). The surge in the supply of the college-educated labor force clearly alters the dynamics of returns to college quality both over individual careers and across age cohorts.

We use the 2013 urban sample from the China Household Income Project (CHIP) survey to construct work histories for a panel of fulltime workers. We find a significant premium at job entry for graduating from an elite university, but this premium declines quickly in the first few years on the job before starting to rise again in a subsequent career phase. These dynamics are entirely driven by the recent cohorts of students entering college under the regime of higher education expansion, suggesting an increasing importance of college quality with the surge in college graduates. This pattern, which is independent of the returns to cognitive skills, is most pronounced in economically more developed regions.

In the post-expansion cohort, males earn a labor market premium, but this male premium is comparatively less for elite college graduates and for more skilled workers. The gender patterns are not explained by differences in the industry, occupation, or sector of employment (government, institutions, SOEs, etc.) of male and female college graduates.

After reviewing related research in the next section, we describe the underlying conceptual framework and the data base in Section 3. The empirical results in Section 4 include a series of specification analyses and robustness checks, while Section 5 provides details of female earnings. Conclusions are presented in Section 6.

2. Related Research

Estimation of the returns to college quality is heavily weighted toward U.S. experiences. Black and Smith (2004, 2006), Zhang (2009), and Hoekstra (2009), to name just a few, find significant wage premia associated with attending an elite U.S. university, and Dale and Krueger (2002, 2014) find that black, Hispanic, and low-income students earn significantly more if they have attended more selective colleges. Internationally, Broecke (2012) and Anelli (2016) find similar results for the UK and Italy, respectively. Using Chilean data, Kaufmann, Messner, and Solis (2015) find significant positive impacts on the marital outcome of women attending an elite university and on the academic performance of children whose parents attend an elite university. Also for Chile, Hastings, Neilson, and Zimmerman (2014) and Zimmerman (2019), using regression discontinuity methods, find significant labor market returns to selective colleges.

Studies for China are quite limited. Li, Meng, Shi, and Wu (2012) and Jia and Li (2019), using data from job offers of college students just prior to graduation, show that graduates of elite universities in 2010-2015 experience a sizable wage premium at labor force entry. Kang, Peng, and Zhu (2018), using data from the 2014 China Family Panel Studies (CFPS), demonstrate that wage patterns for graduates differ by subject studied and by college quality tier. These studies are unable, however, to describe either the dynamics of the elite premium or the impact of the sharp changes in the college labor market.[1]

The most relevant literature that goes beyond the average quality premium described above is that of employer learning about worker productivity. In the employer learning models of Farber and Gibbons (1996) and Altonji and Pierret (2001), employers have limited information about workers' productivity at entry into the labor market. Employers use easily observable characteristics such as the education level

[1] Zhong (2011), using data from the 2002 China Household Income Project (CHIP), finds that wages vary by the subjective rankings of colleges and universities but returns are not monotonically related to the five quality categories (from poor to very good) obtained from individual survey responses.

that are believed to be correlated with productivity for initial hiring and wage decisions, but they rely less on such proxies for setting wages as they accumulate more information about workers' true productivity. Testing this theory with U.S. data, both find that the returns to cognitive skills (initially unobserved to the employer) increase over the worker's career, and Altonji and Pierret (2001) additionally find that the return to each year of education (readily observed initially) decreases over the worker's career. Arcidiacono, Bayer, and Hizmo (2010), however, suggest that U.S. employers get sufficient information from college applicants but that the general learning model holds for high school graduates. Mansour (2012) finds that employer learning about worker skills differs substantially by occupation. More recently, Castex and Dechter (2014) find higher returns over time to educational attainment and lower returns to cognitive skills in the U.S., a pattern they attribute to slower technological growth in recent periods. A few international papers have also documented that college prestige serves as an entry signal that becomes less important throughout workers' careers (Lang and Siniver (2011) for Israel; Bordon and Braga (2017) for Chile).

These learning models assume symmetric learning such that current and prospective employers learn about individual productivity equally well over time, and hence education only has a signaling value at labor market entry. A recent strand of literature, however, emphasizes asymmetric learning after the labor market entry. If current employers have more information about a worker's ability than the general labor market, education may play a signaling role later in the career through, for example, subsequent promotions and associated wage premia (Bernhardt (1995); Schönberg (2007); DeVaro and Waldman (2012); Waldman (2016)).[2]

A final area of relevant research is how labor market dynamics may play out in male-female wage differences. Though we do not focus here on gender wage gaps, the literature on these gaps, notably among high-skilled workers,[3] suggests a number of mechanisms by which college tiers may be differentially important for males and for females. 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 premia, we may observe gender differences in both the initial college quality premium and its dynamics (Card, Cardoso, and Kline (2016)). For example, sorting of women into occupations, jobs, and workplaces that are more

[2] The gist of the asymmetric learning and the signaling value of education in promotion is that a worker's current employer learns privately about the worker's abilities, whereas prospective employers try to infer information about the worker by observing the actions of the current employer. A promotion signals higher ability, and prospective employers will bid more for a promoted worker, which prompts the current employer to offer a large wage raise to this worker. Thus firms generally promote less than the efficient level to avoid paying the wage premium associated with promotions. More highly educated workers are favored in the promotion process because the wage premium due to the promotion signal is smaller for such workers (Waldman (2016)).

[3] Part of the literature particularly documents glass-ceiling patterns, and their explanation, in OECD countries. See Blau and Kahn (2017) for a detailed literature review on gender wage gaps.

family-friendly could induce gender-specific wage dynamics. Moreover, 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)).

These labor market forces combine to produce what we call the "experience profile" for any college quality premium, i.e., the pattern of the premium as it evolves over the working career.

3 Data and Analytical Structure

Our analytical approach is motivated by this prior work indicating that employers take quality signals from the prestige of the college but that they subsequently update these estimates of worker skills based on performance. The application of these ideas must however take into account the rich nature of the Chinese labor market experience with its rapidly evolving labor market and a dramatically changing schooling system.

For Chinese college graduates, the quality tier of their college constitutes a widely-used and observable proxy for labor market skills. Graduates of elite universities are deemed either to have higher innate ability (signaling model) or to have acquired more human capital in the richer learning environment of the elite universities (human capital model). Which of the two mechanisms (the selection of individuals with high cognitive skills *versus* the production of skills by schools) is behind the higher skills of elite college graduates is not identified from labor market data. Yet, for our purposes, the underlying mechanism does not matter. Our interest here is in how these skills, both innate and learned, play out in the labor market.

3.1 The Chinese Context

China's unprecedented higher education expansion began in 1999.[4] Nationwide, as shown in the top panel of Figure 1, college admission rates increased by over 40 percent in both 1999 and 2000 and then continued to grow at more than 10 percent per year through 2005. Because almost all college students graduate, the lower panel of Figure 1 shows that the sharp expansion in admission translated into large increases in the number of 4-year college graduates, starting in 2003. The number of 4-year college graduates doubled between 1999 and 2003 and quadrupled by 2007.

Figure 2 displays the changing distribution of admissions by college types, something that is particularly relevant for the analysis here.[5] The vast majority of increased college admission is found in

[4] See Che and Zhang (2018) for a detailed description of the reform of the higher education system.
[5] Due to limited access, we have data only for the period of 1998 to 2006.

ordinary 4-year and 3-year colleges, which jumped from less than 750,000 new students in 1998 to 4.5 million in 2006. At the same time, admission to elite 4-year universities remained virtually unchanged after 2000, increasing by at most a few thousand each year to reach just over 400,000 in 2006. The difference in admission growth translates into a growing proportion of graduates from ordinary universities. As a consequence, we may expect a relatively larger role played over time by the college tier in signaling one's ability at job entry with potentially larger adjustments as employers learn about individual productivity. This changing component of the evolution in returns is what we call the "intertemporal profile" of the college quality premium.

The labor market dynamics of course depend not only on the supply of varying quality graduates but also on the demand for them. As is well-known, the Chinese economy has evolved dramatically over the past few decades leading to considerable heterogeneity in demand both by sectors and by geographical regions. These dynamics may be more salient for individuals working in the private sector or in regions that experience more marketization than for those working in the public sector or in less market-oriented regions.

3.2 2013 China Household Income Project (CHIP) Survey Data

The 2013 China Household Income Project (CHIP) survey provides high quality data on employment and background for a representative sample of the Chinese urban population from 14 provinces.[6] It contains detailed information on individual characteristics including gender, age, education attainment, quality tier of college, year, province, subject of study, and score on college entrance exam (Gaokao). The labor market information includes current salary, working hours, industry, sector, occupation, and starting year and salary at the current job.

Importantly, the job history information 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.[7] All monetary values are CPI-adjusted to be measured in constant 2013 Yuan.[8]

Our primary sample includes all four-year college graduates who are working full-time (at least 6 hours per day and 20 days per month). We define our post-expansion cohort as individuals born in 1980

[6] The 14 provinces include coastal, central, and western provinces at different stages of development, and they are sampled to represent the overall economic development of China.
[7] Using hourly wage in the empirical analysis yields similar results.
[8] 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.

or later. They were admitted to college after the start of the higher education expansion in 1999 and entered the labor market along with a substantially larger number of college graduates.[9]

The 2013 CHIP survey elicits self-reported information on each individual's university type and college entrance exam (Gaokao) score. The raw Gaokao scores differ by year-province-subject (sciences v. humanities) and are not directly comparable. We normalize them in two steps. First, because the maximum possible score varies with the specific test, we divide individual scores by the maximum possible score of each specific test.[10] We assume that the population distributions are comparable over time and across provinces and subjects, which allows us to convert this percentage score into a z-score with a mean of zero and a standard deviation of one. In the regression analyses we use the Gaokao z-score as a measure of individual cognitive skills, much like AFQT scores are used in U.S. studies (Altonji and Pierret (2001) and Arcidiacono, Bayer, and Hizmo (2010)).

Elite universities are defined as the Project-211 universities designated by the Ministry of Education (MOE) of China.[11] These Tier-1 universities are directly under the administration of the MOE and comprised 116 out of the more than 2,000 institutions of higher education in China in 2006. They receive substantially more funding and are able to hire higher-quality faculty than ordinary universities. As one simple measure, the gap between elite universities and ordinary universities in the average share of faculty holding a PhD degree soared from 8 percentage points in 1998 to 22 percentage points in 2006 (see Figure 3). Elite universities are highly selective and only admit students with a Gaokao score above a threshold that is year-province-subject specific.

The distribution by educational attainment of fulltime workers in the 2013 CHIP sample is shown in Table 1. Although we are focused on college graduates, we report statistics for all full time workers to highlight the trend in increasing education attainment. Consistent with our subsequent analysis, we divide the population into pre-expansion workers (born up to 1979) and post-expansion workers (born after 1979).

As seen in Panel A, educational attainment in China has increased significantly: full-time workers with less than a high school education in the post-expansion cohort are about half that of the pre-

[9] The pre-expansion cohort is individuals born between 1954 and 1979. Results are not sensitive to using 1981 as the cut-off year for defining cohorts.

[10] For example, the maximum possible score was 640 for the humanity-oriented test and 710 for the science-oriented test in 1989 for all provinces. It was changed to 750 in 1994 for both tests nationwide. Starting in 1999, several provinces, such as Fujian, Guangdong, Shaanxi, and Hainan adopted different tests with a maximum possible score of 900 for both tests. There are larger cross-province variations in more recent years as more provinces started to experiment different test regimes. The maximum possible score is obtained from various Gaokao-related websites such as http://edu.sina.com.cn/Gaokao/. It is missing for a small number of years and provinces, and individual observations are therefore dropped for these years and provinces.

[11] See https://en.wikipedia.org/wiki/Project_211 [accessed April 17, 2020]

expansion cohort (16.5 percent v 35.1 percent). With the higher education expansion from 1999 onwards, 33 percent of the post-expansion cohort has at least a 4-year college degree, an 80 percent increase over the pre-expansion cohort. While fewer females of the pre-expansion cohort are college-educated, females of the post-expansion cohort surpass males by more than 6 percentage points. Nevertheless, fewer females still graduate from an elite university.

Panel B reports public sector employment shares by education level.[12] Except perhaps at the lowest education levels, public employment drops across the education distribution, consistent with the growth of the private sector over the past 20 years. Similar patterns hold if employment in state-owned enterprises (SOEs) is excluded (col. 4-6), assuming SOEs are also subject to similar, albeit lesser, market forces than purely private firms. Post-expansion elite university graduates are relatively more likely than other university graduates to enter public service or other governmental institutions, thus being more protected from private market forces.

Figure 4 plots the density of the Gaokao z-score by cohort and college quality tier. Two things are interesting about these distributions. First, while the means differ across the two college sectors, there is considerable score overlap between the elite and the ordinary universities. Knowing somebody graduated from an elite university implies a higher average score but does not mean the person is necessarily at the top of ability distribution. Second, on average there is a significantly larger disparity in the Gaokao score between graduates of the elite and ordinary universities for the post-expansion cohort; the means are 0.89 and 0.29 for the post-expansion cohort and 0.77 and 0.45 for the pre-expansion cohort, respectively. These distributional patterns suggest both that there is scope for employer learning about individual skills and that the dynamics might be quite different over time.

3.3 Empirical Models

The focus of our empirical model is how the wages of college graduates attending an elite university evolve over their careers relative to their peers attending an ordinary university. We start by replicating the basic analysis of average returns to graduates from an elite institution, paralleling the most common approach in the literature, and then move to the dynamics.

Average Returns to University Quality

The standard approach for identifying the average returns to college quality is estimation of an augmented Mincer equation such as:

[12] 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 and non-farm small businesses of all ownerships except for SOEs.

$$\ln(wage_j) = \alpha + \gamma_1 PE_j + \gamma_2 PE_j^2 + \delta X_j + \theta \bullet elite_j + \varepsilon_j \quad (1)$$

In this simplest form (Eq. 1), ln(*wage*$_j$) is the natural logarithm of monthly wage of individual j; *PE* (=age-years of schooling-6) is years of potential experience in the labor market; *X* is a vector of control variables; *elite* is an indicator equal to 1 for a graduate of an elite university and 0 otherwise; and ε is a stochastic error term. θ gives the average returns to attending an elite university. In a more sophisticated version, some measure of individual ability, A_j, is added in an attempt to purge θ of the selection into the elite schools.

Dynamic Returns to University Quality

To estimate the dynamics of the college tier premium, we modify Eq. 1:

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

We allow the impact of elite schools to change over the career, and we add an ability measure, A_j. Historically, ability, measured using a cognitive skills test, has been interpreted as an indicator of true productivity that is observed imperfectly by the employer and thus enters into the estimation of employer learning (Altonji and Pierret (2001), Arcidiacono, Bayer, and Hizmo (2010)).

We start with a convenient characterization of the experience profile for the premium for elite university graduation. We model the time path of the premium as a quadratic function in potential experience as in Eq. 3.

$$f_{PE}(elite_i) = \beta_0 + \beta_1(elite_j \times PE_j) + \beta_2(elite_j \times PE_j^2) \quad (3)$$

β_0 measures the elite premium at job entry; β_1 and β_2 reflect how this premium varies over one's career and are our estimates of the experience profile reflecting employer learning about individual productivity. This specification differs from the linear model used by Altonji and Pierret (2001), Lang and Siniver (2011), and other papers. If the labor market is characterized by symmetric employer learning with a strong signaling value of an elite education, we expect $f_{PE}(elite_j)$ to decline monotonically.[13] If however learning is asymmetric and an elite education has signaling values later in the career, for example, due to higher probability of promotion and the accompanied large wage raise, we expect β_2 to be non-zero and likely positive. We also estimate Eq. 2 using other functional forms for $f_{PE}(elite_j)$; in particular, we more flexibly estimate the experience profile of the premium with a stepwise function for years of potential experience.

[13] In our quadratic formulation of Eq. 3, this would be consistent with β_1 being negative *and* β_2 being small or zero.

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 (2013) year. We thus track the dynamics of wages for workers across different phases of the education and economic development of China. The use of recall data for starting salary may introduce measurement error, which is possibly larger for the older cohort. While we cannot test it, we believe recall error is likely less problematic here because people might be expected to remember the first salary at the job entry (or the first salary after a job change) more accurately than other (more recent) earnings. Differential measurement error may nonetheless contribute to the different results for employer learning across age cohorts.

The main challenge in interpreting the experience profile estimated from Eq. 2 is the potential contamination from secular changes in the returns to an elite university education. Since calendar time is positively correlated with experience, people with longer experience are generally older and have 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.

Several concerns about secular changes in the Chinese labor market must be dealt with. First, with the growth of the Chinese economy and the increasing adoption of skill-biased technologies, the 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 returns between the pre- and post-expansion cohorts.[14] Second, as discussed above, the dramatic expansion of college graduates after 1999 could clearly alter the overall labor market for graduates. Third, China is a large and heterogeneous country, where both industry and university concentrations can follow significantly different time patterns across cities and provinces.[15]

To deal with these facets of the labor market, we incorporate an estimate of exogenous labor market conditions that directly affects educational demand in each province and year. The measure of labor market conditions we construct is generated by the expansion of college workers over time and by the varying relative demand for education levels across industries. We also separately estimate the wage model for pre- and post-expansion cohorts.

---

[14] For a discussion of changing returns over time in China, see Liu (1998) and Zhang, Zhao, Park, and Song (2005).
[15] Of lesser importance, wages of workers who started working 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 who entered their job during that period.

Chinese economic policies over the relevant period provide the basis for constructing an exogenous measure of labor market conditions affecting educated workers. China's industrial development, at both national and regional levels, has been strongly shaped by the continued implementation of industrial policies during the entire economic reform period.[16] These policies have appealed to the Chinese government because they allow the government to maintain a 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 encouraged industries 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.[17]

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 have been encouraged to develop modern agricultural production and natural resource-intensive manufacturing industries in accordance with their endowments, whereas coastal provinces have been 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}):

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

[17] 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.

$$\hat{E}_{rt}^{k} = \sum_{i} \frac{l_{irt}}{l_{rt}} \times \frac{L_{it}^{k}}{L_{it}} \tag{4}$$

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 skills relevant to 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 specific 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, and this is mapped into individual provincial demands.[18]

The Hukou registration system also helps in the identification of the effects of elite education and of employer learning. China had restricted internal migration through the household registration system (Hukou) since the 1950s. While barriers to migration have been reduced since the mid-1980s, restrictions on labor mobility, especially across provinces, 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 such as, for example, the state sector and monopolistic industries (Au and Henderson (2006); Song and Li (2013); Ma (2018)).[19] Second, even though people may be hired on short-term contracts without a local Hukou, they are not eligible for local public services including basic public education for children,[20] 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.

[18] Goldsmith-Pinkham, Sorkin, and Swift (2019) introduce cautions about identification issues with the use of Bartik instruments in different settings. The general governmental control of regional industrial allocations in our reduced form analysis, however, suggests less concern here.

[19] Each year, the government sets quotas of new Hukou and allocates them to employers for them to hire new college graduates. The allocation favors employers in industries encouraged by the industrial policies. Non-state sector employers may obtain Hukou quotas if, for example, they are big taxpayers (Ma (2018)).

[20] 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.

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.[21] 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 the 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 underestimate that of those with low education levels. Nevertheless, the education distribution of the formal sector employment is most relevant for our study since college educated individuals are highly concentrated in the formal sector.

Figure 5 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 Eq. 2 for the overall sample and for different cohorts in order to compare how the dynamics of the college quality 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 consider potential gender heterogeneity.

4 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.

4.1 Average elite premium

We first estimate a simple Mincer equation (Eq. 1) of log monthly wage using the cross-section data of the 2013 CHIP and highlight differences for the pre- and post-expansion cohorts. For full-time employees in 2013, the results in columns 1-3 of Table 2 are broadly consistent with prior estimates of

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

returns to schooling in the Chinese labor market. The cross-sectional return to each year of schooling is 7.7 percent while being higher for the post-expansion cohort (9.3 percent) than for the pre-expansion cohort (6.9 percent). Considering nonparametric estimates to each schooling level (columns 4-6), even though average rates increase, the return to a 4-year university education is smaller for the post-expansion cohort than for the pre-expansion cohort, consistent with the dramatic increase of workers with tertiary education.

We introduce labor market differences related to elite university education and to the Gaokao score in Table 3. The estimated average return to an elite university education is 10.6 percent for the pre-expansion cohort and 18.9 percent for the post-expansion cohort. This tremendous increase across cohorts suggests a much larger role played by college tier in the current labor market and is the starting point of our empirical analyses in the next sections. Additionally, the return to the Gaokao score is large (0.19) and significant for the post-expansion cohort, but much smaller and insignificant for the pre-expansion cohort (0.043). Once Gaokao score is controlled for, the average return to an elite university becomes insignificant, whereas Gaokao score continues to be a significant determinant of wages. The cross-sectional results also indicate that neither Gaokao score nor graduating from an elite school has a systematic impact on earnings for the pre-expansion cohort. At this point, it might be natural to conclude that graduation from elite universities provides little useful information to the market.[22] But of course the cross-sectional estimates represent an amalgam of different factors, and the estimated elite effects must be tracked over the career.

4.2 Dynamics of elite premium and returns to individual skills

Since the Gaokao score cannot generally be directly observed by the employers, college quality may play a more critical role in signaling ability for the post-expansion cohort, when the mean differences across college tiers is large (Figure 4). At the same time, employer learning models suggest that this signaling role is likely to evolve over the career as individual quality is better observed.

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 the constructed employment histories are used 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.[23]

---

[22] These results are similar to those in Arcidiacono, Bayer, and Hizmo (2010) who conclude that firms are able to observe the productive skills of college graduates at hiring and that uncertainty only enters for high school graduates.

[23] 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 for the clustered standard errors below.

The first three columns provide estimates from the most stripped down model of return dynamics, first for all workers and then separately for the pre-expansion and the post-expansion cohorts. The estimated coefficient for the elite university dummy reflects the returns to an elite university education at job entry (β_0); it is insignificant for the pre-expansion cohort but much larger and statistically significant for the post-expansion cohort. The interactions between the elite university dummy and the quadratic function of potential experience describe changes in the elite premium with increased potential experience. The estimates are close to zero and insignificant for the pre-expansion cohort (col. 2), and significant, both economically and statistically, for the post-expansion cohort (col. 3). The estimates indicate a sharp decline in the return to elite universities at the early stage of career, but they do not allow for other, correlated influences on wages.

The remaining columns introduce our projected time and province specific employment demand for educated labor based on the provincial industrial composition ($\hat{E}^{COL}$). The clearest picture of wage dynamics is found in column 6.[24] The estimated elite premium at job entry and its subsequent changes with experience are significant just for the post-expansion cohort, and the magnitude of the estimates is quite close to those in column 3.[25] The estimates on the linear and quadratic term for the post-expansion cohort of -0.069 and 0.005 indicate that the premium to an elite university education declines rapidly in the first six to seven years of the career but recovers to some extent later in the career.[26]

The estimated premium to male workers is 18.9 percent for the pre-expansion cohort, but one third smaller for the post-expansion cohort. We return to the gender disparity below. The estimates also indicate that in provinces with a larger demand for skilled labor, wages of college graduates are higher, and its magnitude is somewhat larger for the pre-expansion cohort.

Because we focus on the starting salary for the current job, job changing could bias our estimated dynamics. If elite university graduates are more likely to switch to better-paid jobs in the early stage of careers, we could underestimate the initial decline in the elite premium, and vice versa if ordinary university graduates change jobs more often. In our panel, 30 percent of the pre-expansion cohort have

[24] The number of observations reduces slightly for the pre-expansion cohort because the information for creating the predicted demand for college educated labor force is unavailable for the very early years when some of the oldest individuals started at their current job. Results in columns 1-2 are robust when we restrict the sample to those in columns 4-5.

[25] Cameron and Miller (2015) suggest in this case using critical values for t(13), which would imply p-values of 0.0003, 0.024, and 0.027 for estimates on the elite dummy and interactions between the elite dummy and the potential experience and its square (column 6 of Table 4).

[26] The estimates in Table 4 use all observations. Because of some missing career information (for 54 of the 772 post-expansion workers), this involves an unbalanced panel. If we rely on just the balanced panel, the dynamics of the elite college premium are qualitatively the same.

changed firms over their careers, with 28 percent for the elite university graduates and 31 percent for the ordinary university graduates. For the post-expansion cohort, the overall firm-changing rate is 22 percent, with 16 percent and 23 percent for the elite and the ordinary university graduates respectively. In order to gauge the potential bias, columns 7 and 8 present estimates for individuals who are still working in their first firm. The estimates on the interactive terms between the elite dummy and potential experience and its square are almost identical to those in columns 5 and 6, indicating that our results are not driven by endogenous firm switching.

The elite premium for the pre-expansion cohort is small, statistically insignificant, and constant over the career. Thus, we focus on the post-expansion cohort for the remainder of the analysis in order to understand better the employer learning component.

Employers may have access at the hiring point to additional information beyond the applicant's college tier to help determine wages. While not observed by economists, this may include information listed in the resume or revealed during interviews such as courses taken, GPA, and professional certificates obtained. If this information is positively correlated with the university type, the estimated elite university premium at job entry and its later changes may in part be due to these unmeasured skills, leading us to overestimate the role played by the university tier in the employer's decisions.

We introduce the Gaokao score, which we interpret as being partially a measure of skills that employers may observe or infer at hiring.[27] From the first column of Table 5, when the Gaokao z-score and interactions with potential experience and its square are added, the estimated elite premium falls by 23 percent (compared to col. 6 in Table 4).[28] The Gaokao z-score is positive and significant both economically and statistically, and the estimated returns are virtually constant over the career. Nonetheless, the dynamic pattern of the elite premium over experience remains quite similar to that in column 6 of Table 4. The results are robust to restricting the sample to individuals who have never changed firms (column 2).

Prior individual test scores have been interpreted in much of the employer learning literature as indicating true but unobserved ability, and the increase in their importance over time is a measure of the amount of employer learning. Thus, for example, estimating that the earnings impact of AFQT scores is

---

[27] The Gaokao score has, for example, been found to be positively correlated with college GPA and other performance measures that employers may elicit at hiring (Li, Meng, Shi, and Wu (2012)).

[28] The number of observations in Table 5 is reduced by about 18 percent because of missing Gaokao z-scores. About half of the missing Gaokao z-scores comes from missing individual survey data. The other half reflects missing information on the maximum possible Gaokao score, which is collected from the internet and is needed for the normalization and comparison of scores. About 10 percent of ordinary university and 5 percent of elite university graduates, respectively, are missing Gaokao scores. For robustness we estimate the models in Table 4 using the same sample as in Table 5, and the results are statistically indistinguishable.

constant over time for college graduates leads Arcidiacono, Bayer, and Hizmo (2010) to conclude that worker ability is perfectly observed for college graduates. In our estimation, with the separate quality proxy of graduation from an elite university, the career pattern of the elite premium is a better measure of the amount of employer learning.[29]

Ceteris paribus, a one standard deviation increase in the Gaokao score is related to a wage increase of 14.6 percent, and importantly this is not statistically different for graduates of elite and ordinary universities (col. 3). Additionally, the results still hold when we restrict the sample to individuals who have never changed firms (col. 4).

The quadratic estimates in Table 5 indicate that the elite premium declines quite quickly through about the sixth year of potential experience and then starts to rise (col. 3). As a more flexible alternative, we estimate the pattern of the elite premium with a stepwise function in potential experience. Figure 6 plots the evolution of the elite premium with the same controls as in column 6 of Table 4.[30] The elite premium declines quickly up to the fifth year of potential experience, a result consistent with prior findings in the employer learning literature where most employer learning of worker productivity occurs quickly.[31] Controlling for Gaokao score reduces the estimated elite premium by roughly 10 percentage points over the entire career path, consistent with the estimate in Table 5 where returns to measured skills do not change over the career.[32]

These estimates are not fully consistent with a symmetric learning model. The turnaround of the elite premium at the mid-career is more consistent with asymmetric learning and a promotion signaling model (DeVaro and Waldman (2012); Waldman (2016)). This predicts that, *ceteris paribus*, better educated individuals (elite university graduates here) are more likely to be promoted and hence experience later wage increases.

Our survey data allow us to go further into firm learning dynamics. We create an indicator variable *promotion* that equals 1 if an individual is currently in at least a mid-level manager position or professional rank and equals 0 otherwise. Elite and ordinary university graduates with less than five years of potential experience have similarly low and insignificantly different probabilities of having been

---

[29] This interpretation is closer to that of Bordon and Braga (2017) who look at the impact of elite universities in Chile along with university admission scores.

[30] Specifically, we include interactive terms between the elite dummy and a series of indicators for 1-2 years, 3-5 years, 6-10 years, and 11-16 years of potential experience. All estimates on the interactive terms are significant at the 5 percent level or above. Full regression results are available from the authors upon request.

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

[32] Potentially stronger social networks of the elite graduates might enable these students both to receive lucrative job offers at the entry and to receive promotions at the mid-career (Granovetter (1973); Montgomery (1991)), but models of social network alone do not appear to be sufficient to explain the entire dynamics of the wage growth.

promoted – 13 percent and 19 percent, respectively. After five years, however, promotion rates for elite graduates rises to 53 percent, significantly larger (at 1 percent level) than the 39 percent for ordinary university graduates. This pattern continues to hold in regression analyses that control for gender, Gaokao score, and city fixed effects.[33] Since we do not have information on the exact timing of individual promotions, this is not a direct test of the promotion signaling model, but it does suggest that the signaling role of an elite university education evolves over the career in a more complex manner and warrants further study.

The pattern of the elite premium and the returns to measured skills might reflect differential patterns of occupational and industry choices across university types, but that does not appear to be the case. In Table 6, we include a full set of fixed effects for the industry, occupation, and sector of employment to investigate the potential channels for the wage dynamics.[34] The results for both the elite premium dynamics and the returns to Gaokao score are unchanged, and they are robust to changing the estimation sample to individuals who have never changed firms. In other words, the initial elite premium combined with its variation due to employer learning appears to be a pervasive fact of the urban Chinese labor market and holds within broad occupational and industry categories.

As a robustness check, we estimate the models of Table 5 controlling for individual fixed effects, where identification solely comes from within-individual differences.[35] This approach relies heavily on the two observations of career data for each individual, but it offers the possibility of removing individual-specific factors that are constant over time including ability, motivation, family background, and the like. The key employer learning components reported in Table 7 are similar to those in Table 5. Similarly, the impact of Gaokao scores shows no significant pattern over time. In short, while this is not a strong test, there is no evidence that employer learning effects are driven by unmeasured individual characteristics.

4.3 Variations by Degree of Marketization and Sector

The underlying model behind this analysis is that employers are driven by profit maximization that pushes them to pay wages in line with productivity. Given China's vast regional heterogeneity in

[33] The estimation results are available from the authors upon request.

[34] 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. Occupation and industry are identified essentially at the one-digit level. Industries include: Agriculture and mining; Electricity, gas & water; Manufacturing; Construction; Transport, storage, post and telecom & IT; Wholesale and retail trade and catering services; Finance and insurance; Real estate; Social services; Health, education, culture & research; and Party and Government organs and social organizations. Occupations include: Leading cadres; Professional and technical staff; Office workers; Service workers; and Production workers.

[35] The main effects of elite college attendance and Gaokao score are subsumed by the individual fixed effect.

economic and market forces, we might expect spatial heterogeneity in the dynamics of wage setting. Here we consider variations in returns to skills and in the elite university premia, again for the post-expansion cohort; in the next section, we consolidate discussion of the estimated male-female wage differential.

To assess the influence of differential market forces, we estimate the basic model of Table 6 for the post-expansion cohort in different geographical regions defined by alternative measures of local economic development (Table 8). We first compare coastal and inland regions, where the coastal regions are more economically developed and have more competitive markets.[36] While the picture of the elite university premium in coastal regions mirrors that seen in the previous employer learning models in both magnitude and statistical significance (col. 1), the estimates for the less developed inland region (col. 2) are much smaller in magnitude and statistically insignificant. Further, the estimate of returns for the Gaokao score is large (0.209) and significant at the 1 percent level for the coastal region but is much smaller (0.112) for the inland region, even though still significant at the 10 percent level.

The remaining columns of Table 8 use alternative, more city-specific measures of development: the share of services in output (col. 3-4) and the share of agriculture in output (col. 5-6) where more services and less agriculture are signs of greater economic development. Uniformly, more economically developed cities show large initial premia for elite university graduates but also rapid employer learning about individual productivity. More skilled individuals (as measured by Gaokao score) also receive strong returns in these cities. Less developed cities (col. 4 and 6) show very low returns for Gaokao scores and, while the patterns of elite premia seen before hold, the estimates are all statistically insignificant.

Table 9 turns to how wage settings may vary with foreign direct investment (FDI). The size of the foreign sector is measured by the value-added share of foreign-owned firms in a city in the first two columns and by the percentage of foreign-owned firms relative to the total number of firms in a city in the remaining two columns. While the results for the elite premia do not systematically vary across the cities by the concentration of FDI, the returns to Gaokao scores are systematically stronger and statistically significant in the top half of the foreign investment distribution but not the bottom half.

To summarize, estimates in Tables 8 and 9 generally suggest that skills are more highly valued at locations with more developed economy and market. Further, the patterns of significant elite university premia with strong and asymmetric employer learning are much more prevalent in the more developed cities.

---

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

A final way of viewing wage setting in China is to compare the labor market dynamics in the public and private sectors. A natural hypothesis is that the private sector employers, under more competitive pressure, will set wages based more on individual productivity, and hence the dynamics of the elite university premium should be more pronounced. Table 10 reports the estimation results where state-owned enterprises (SOEs) are alternately treated as more like private firms (col. 2) versus more like public firms (col. 3). The public sector includes just purely government agencies and public institutions such as schools, universities, and hospitals (col. 1).

Estimates for the impact of college tier follow the previous patterns – more competitive employers initially bid for elite graduates but then quickly adjust wages to observed productivity. Interestingly, both public and private employers consistently provide high returns to skills (Gaokao score). The strong estimate for the public sector is consistent with the general observation that public sector employers are also highly selective in hiring. For example, applicants need to pass a written exam and then go through rounds of interviews to receive a civil service job offer, and the competition has become more intense 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 private contributions. They therefore have a strong incentive to hire highly capable individuals.

5 Heterogeneity by Gender

The above analyses indicate a significant gender wage gap of 14 percent for college graduates as a whole (Table 4, column 4). For subsamples, we find that the gender wage gap is generally smaller for the post-expansion cohort (Table 4, col. 5 versus 6), and for this post-expansion cohort it becomes insignificant in the subsample of coastal provinces (Table 8, column 1), is generally smaller in more developed regions (Tables 8 and 9), and is insignificant in government agencies and public institutions.

It is possible to explore further how gender enters into wage setting (Table 11). The elite premia results show little gender-specific variation with experience, even when industry, occupation, and sector employment is taken into account. This, combined with higher elite premium at job entry for women, generates higher returns for an elite education for women over the entire career (Col. 1-3). More interestingly, as seen in col. 4, the returns to Gaokao scores for females are roughly twice the size as those for males (0.232 vs 0.107), a finding that is robust to controlling for the industry, occupation, and sector of job (column 5) and independent of elite university status. These results suggest that highly-skilled women, identified by graduating from an elite university, by showing high individual abilities, or by both, are greatly valued in the labor market and rewarded for their skills. This contrasts with the literature on glass ceilings in OECD countries where significant gender wage gaps among highly-skilled men and women are usually found (Blau and Kahn (2017). Moreover, elite educated women tend to work

proportionally more in coastal provinces, where the gender wage gap is found to be insignificant, than non-elite educated women.[37]

Of course, there is the other side. The opposite holds for less-skilled women. For them, the wage gap gets very large.

6 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 expansion of higher education admissions. This expansion altered the role and importance of elite universities and provides a unique opportunity to look at employer learning in the labor market.

Using a representative sample of urban workers, we examine how the market changed with the expansion of colleges and universities. At the same time, we control for exogenous changes in the demand for skills due to technological progress in the Chinese economy, taking advantage of the remaining planned features of the economy arising from government industrial policies and the Hukou restrictions. We use employment histories to construct a panel data set that permits identifying both elite college premia at entry and the dynamics of these premia as employers have a chance to observe actual productivity of workers. We also incorporate a more general skill measure – the Gaokao score that is used in college selection.

We find a substantial premium to attending an elite university, but this premium erodes rather quickly as the employer learns about the worker's capabilities. It increases again at the mid-career, suggesting asymmetric learning about skills across employers. These patterns hold strongly for post-expansion workers entering the labor market after the higher education expansion, but not for pre-expansion workers. They also appear more clearly in the more competitive parts of the Chinese economy.

The labor market also rewards measured skills, and these returns to skill are larger 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).

[37] As elite universities are disproportionately located in coastal provinces, especially in Beijing, Shanghai, and Jiangsu province, most elite graduates also tend to be found working in coastal provinces.

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." *American Economic Journal: Macroeconomics* 7, no. 4 (October): 1-32.

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.

Bernhardt, Dan. 1995. "Strategic Promotion and Compensation." *The Review of Economic Studies* 62, no. 2 (April): 315-339.

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.

Blau, Francine D., and Lawrence M. Kahn. 2017. "The Gender Wage Gap: Extent, Trends, and Explanations." *Journal of Economic Literature* 55, no. 3: 789-865.

Bordon, Paola, and Breno Braga. 2017. "Employer Learning, Statistical Discrimination and University Prestige." (mimeo) Available at SSRN: http://dx.doi.org/10.2139/ssrn.2966167 (accessed 4/12/2020).

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.

Broecke, Stijn. 2012. "University selectivity and earnings: Evidence from UK data on applications and admissions to university." *Economics of Education Review* 31, no. 3 (June): 96-107.

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.

DeVaro, Jed, and Michael Waldman. 2012. "The Signaling Role of Promotions: Further Theory and Empirical Evidence." *Journal of Labor Economics* 30, no. 1 (January): 91-147.

Farber, Henry S., and Robert Gibbons. 1996. "Learning and Wage Dynamics." *The Quarterly Journal of Economics* 111, no. 4 (November): 1007-1047.

Goldsmith-Pinkham, Paul, Isaac Sorkin, and Henry Swift. 2019. "Bartik Instruments: What, When, Why, and How." NBER Working Paper No. 24408. Cambridge, MA: National Bureau of Economic Research (November).

Granovetter, Mark S. 1973. *Getting a job: A study of contacts and careers*. Cambridge, MA: Harvard University Press.

Hastings, Justine S., Christopher A. Neilson, and Seth D. Zimmerman. 2014. "Are Some Degrees Worth More than Others? Evidence from college admission cutoffs in Chile." NBER Working Paper 19241. Cambridge, MA: National Bureau of Economic Research (September).

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.

Lang, Kevin, and Erez Siniver. 2011. "Why is an elite undergraduate education valuable? Evidence from Israel." *Labour Economics* 18, no. 6 (December): 767-777.

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.

Montgomery, James D. 1991. "Social Networks and Labor-Market Outcomes: Toward an Economic Analysis." *The American Economic Review* 81, no. 5 (December): 1408-1418.

Schönberg, Uta. 2007. "Testing for Asymmetric Employer Learning." *Journal of Labor Economics* 25, no. 4: 651-691.

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

Waldman, Michael. 2016. "The dual avenues of labor market signaling." *Labour Economics* 41(August): 120-134.

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

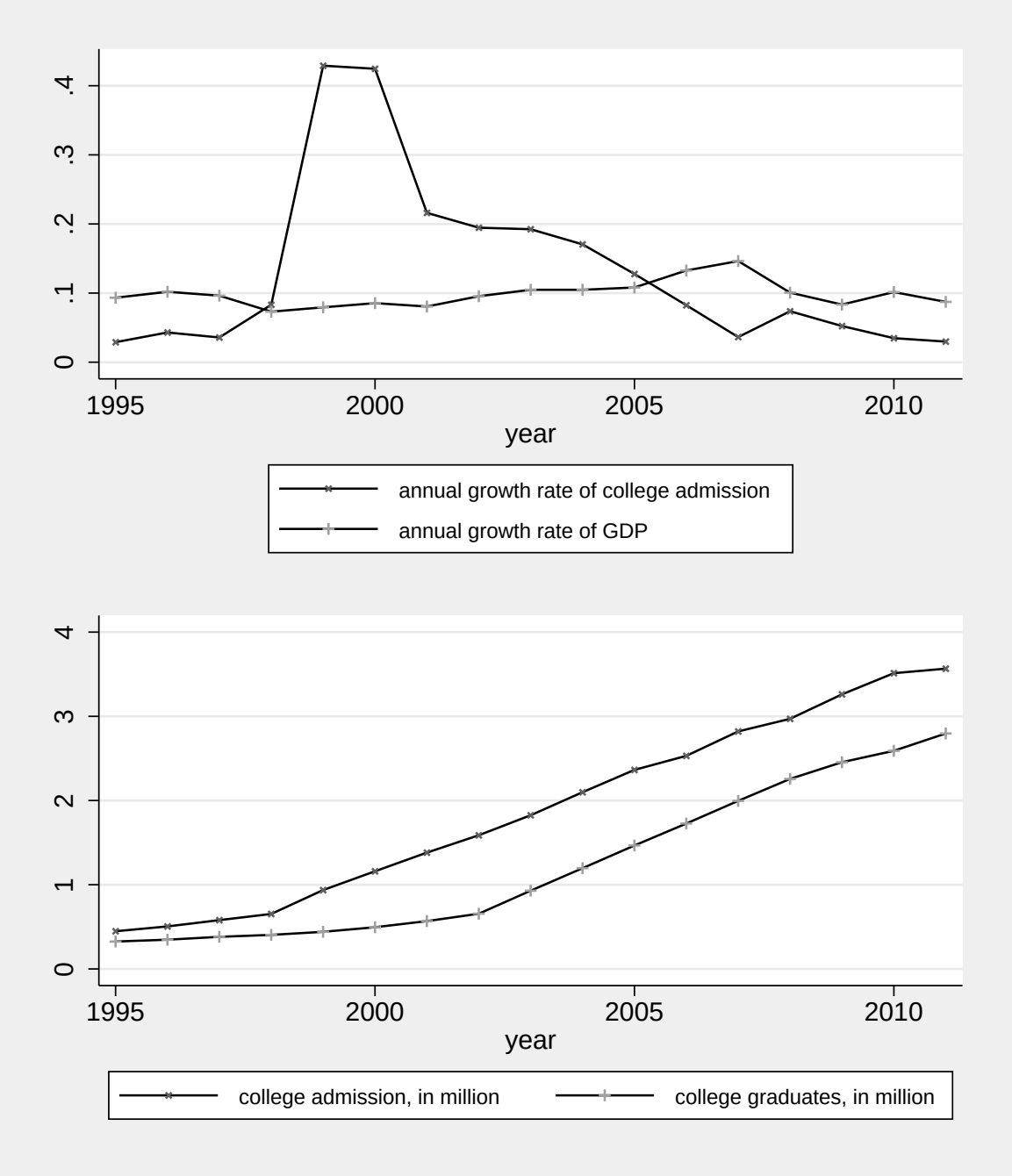
Zhang, Junsen, Yaohui Zhao, Albert Park, and Xiaoqing Song. 2005. "Economic returns to schooling in urban China, 1988 to 2001." *Journal of Comparative Economics* 33, no. 4 (December): 730-752.

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.

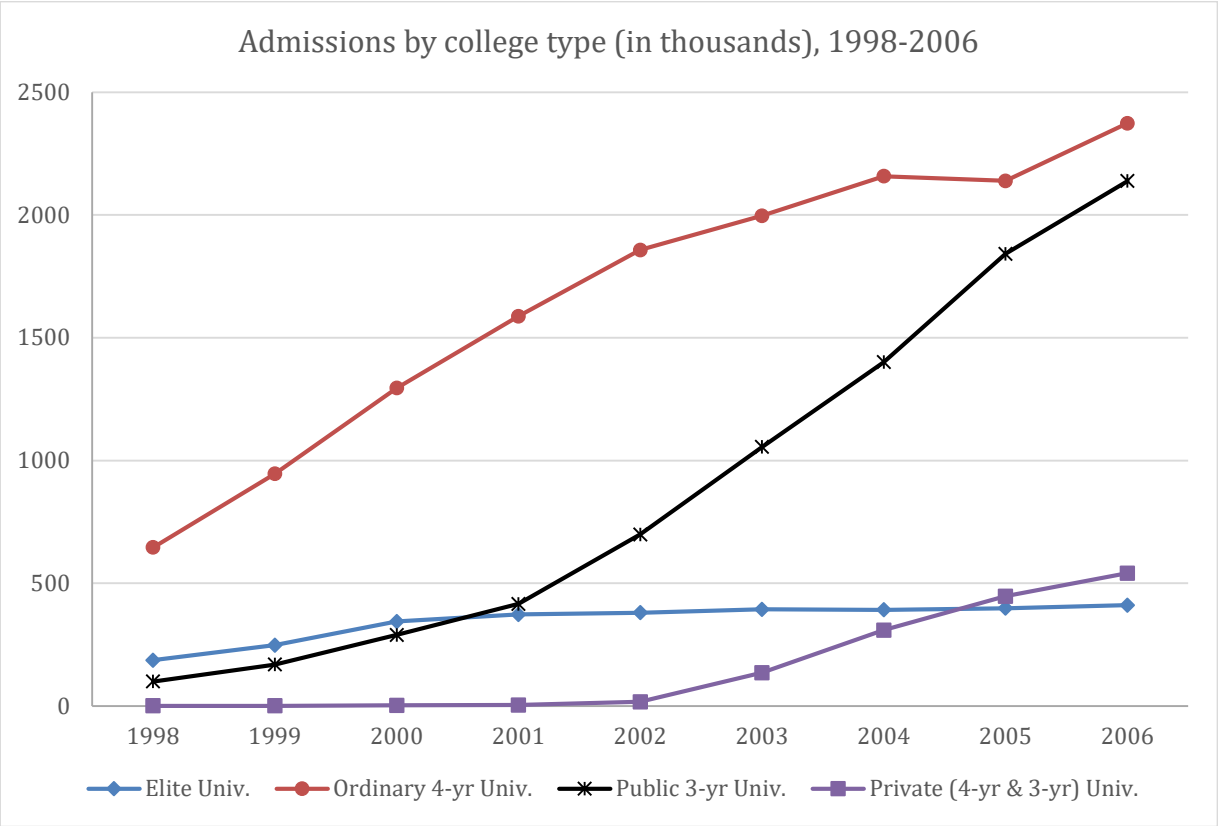
Zimmerman, Seth D. 2019. "Elite Colleges and Upward Mobility to Top Jobs and Top Incomes." *American Economic Revew* 109, no. 1: 1-47.

Figure 1: College Admission and Graduation



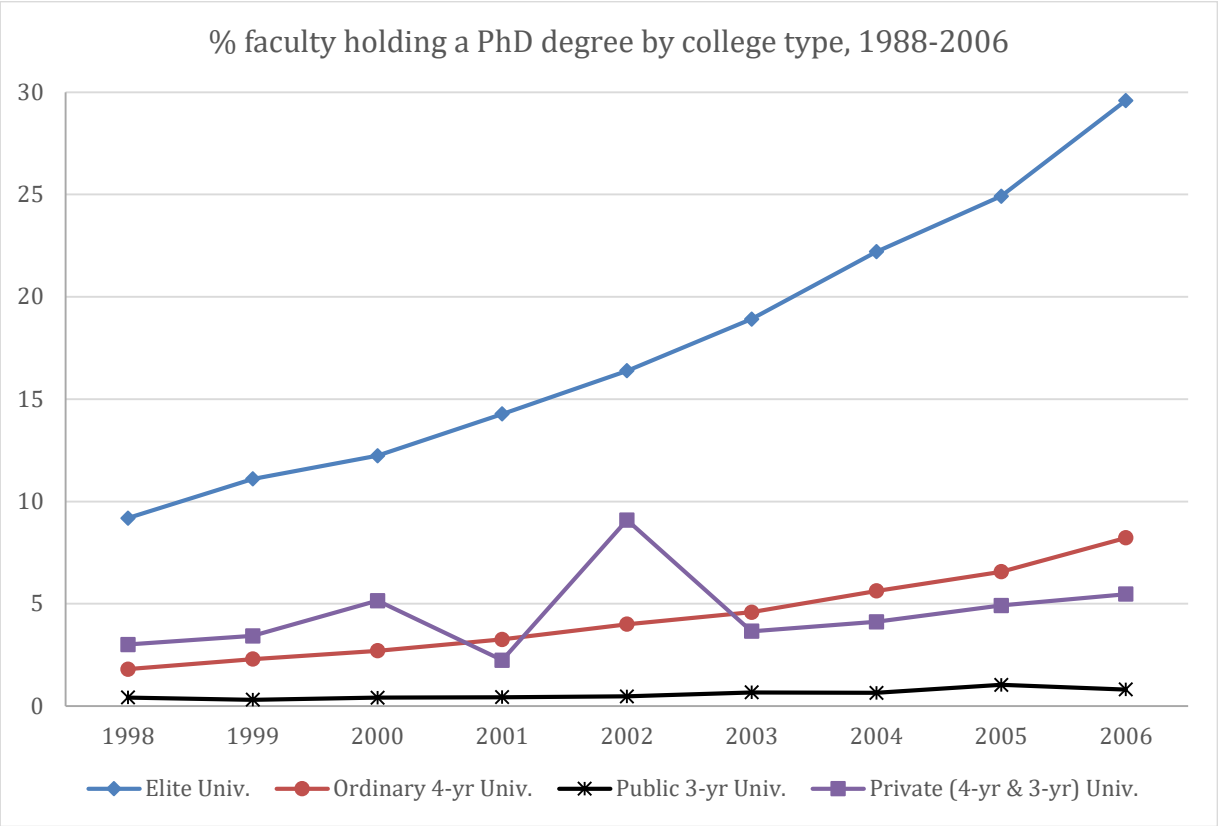
Notes: The top panel plots the annual growth rate of college admission, equal to the increase in the number of students admitted to 3- or 4-year regular colleges between the current year and previous year divided by the number for the previous year, and the annual growth rate of GDP. The bottom panel depicts the total number of students (in million) admitted to regular 4-year programs in colleges and universities and the total number of graduates from regular 4-year college programs. Data come from various issues of China Statistics Yearbook and China Education Statistics Yearbook.

Figure 2: College Admission by College Type



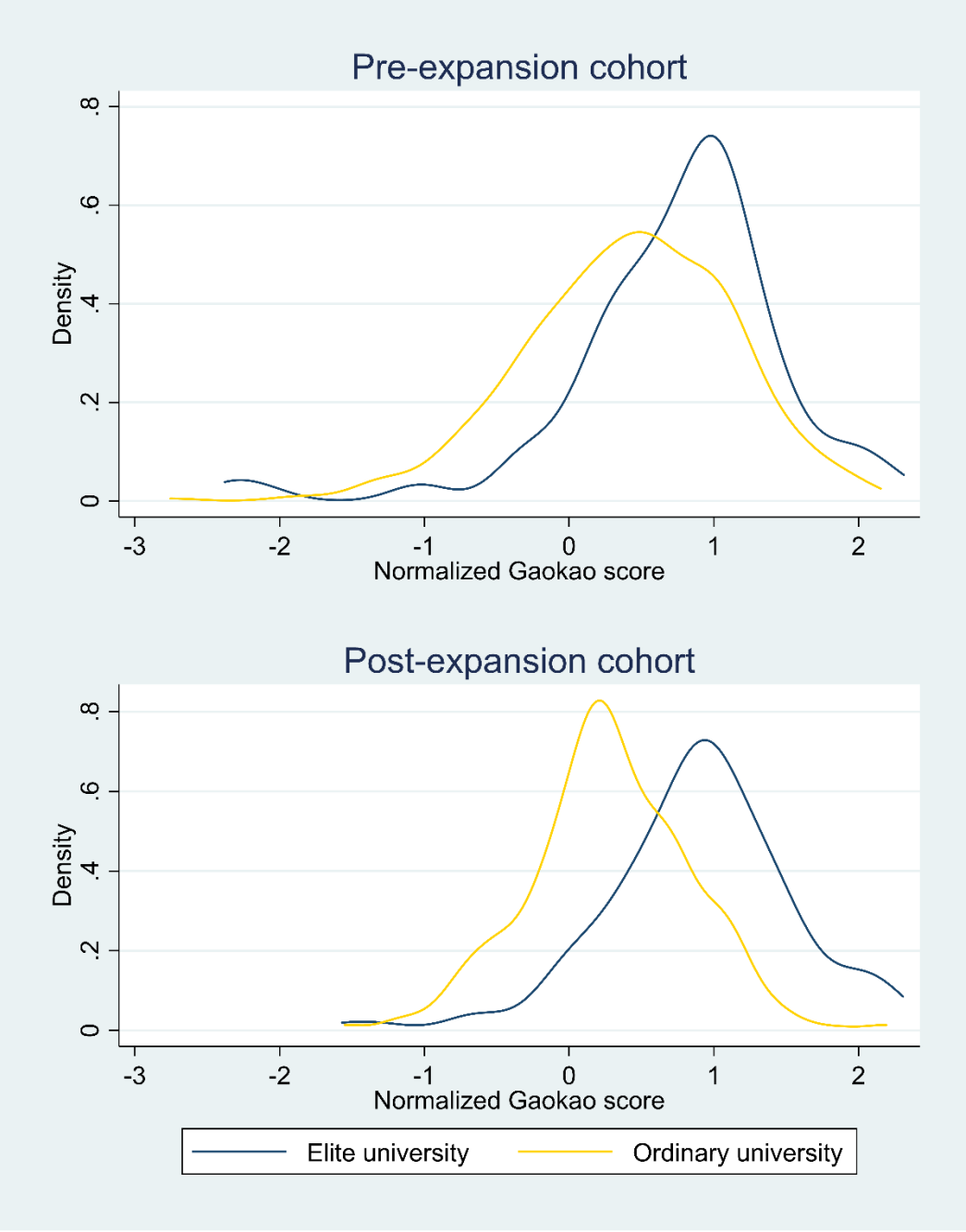
Notes: The figure depicts the total annual number of students admitted (in thousands) by college type. The college types are elite universities, ordinary 4-year universities, public 3-year universities and private universities (offering both 3-year and 4-year programs). Data come from the Ministry of Education of China.

Figure 3: College Inputs by College Type



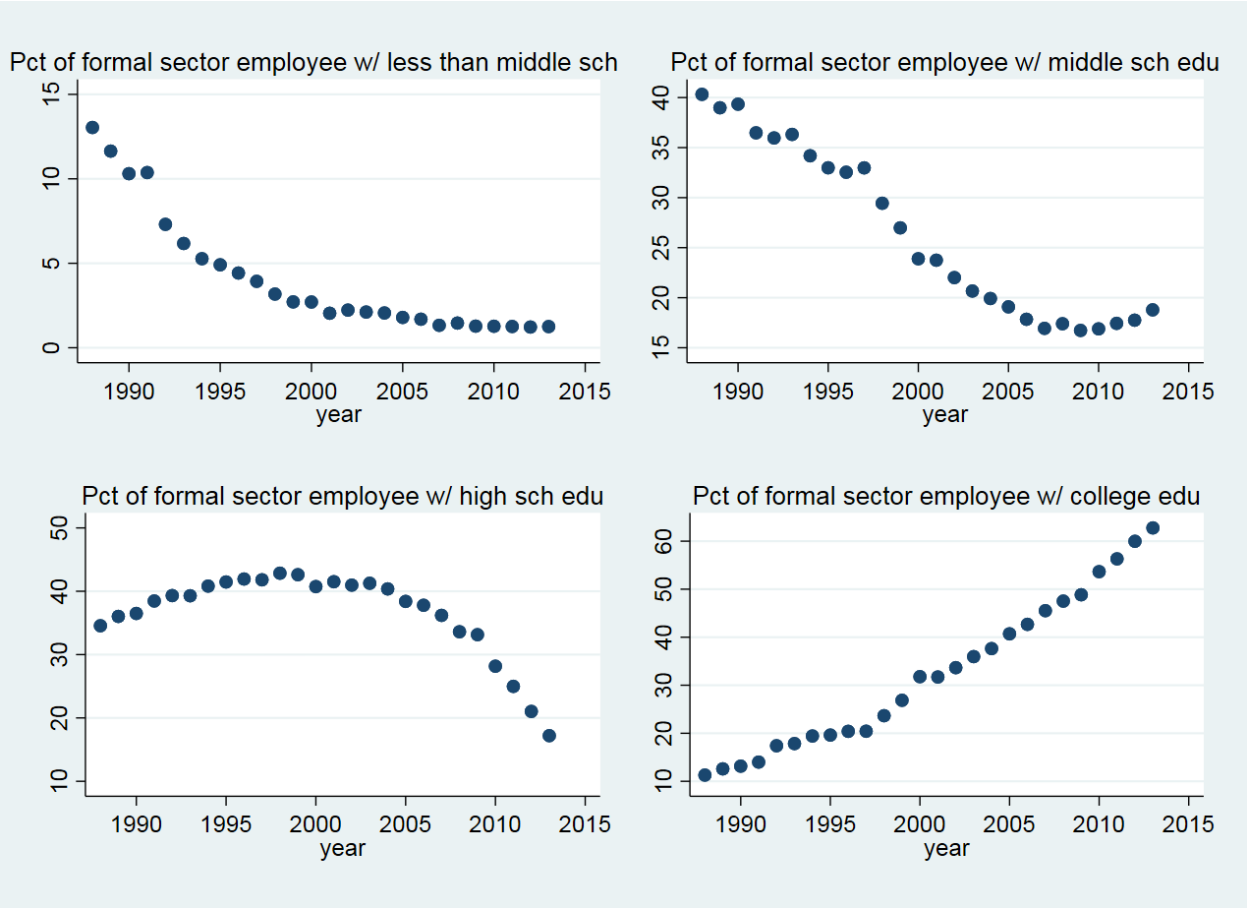
Notes: The figure depicts the share of faculty with a PhD degree by college type. The college types are elite universities, ordinary 4-year universities, public 3-year universities and private universities (offering both 3-year and 4-year programs). Data come from the Ministry of Education of China.

Figure 4: Distribution of Gaokao Score



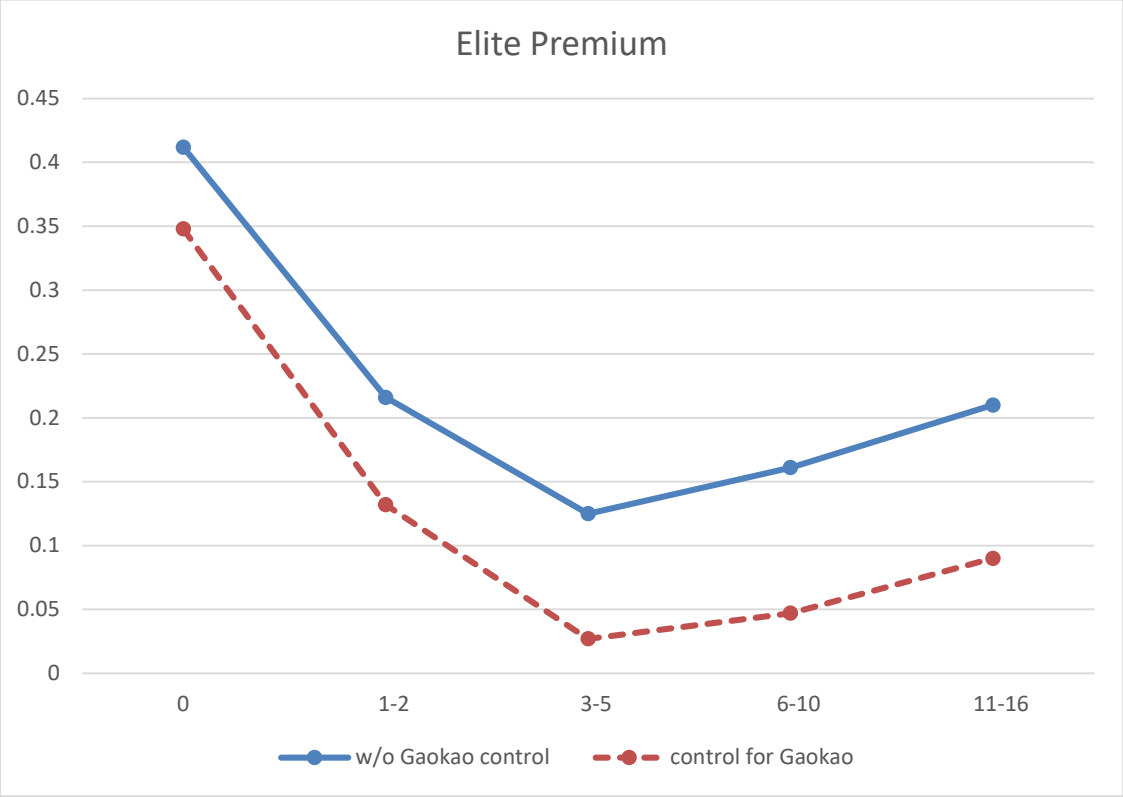
Notes: The sample includes all full-time workers with hourly wage between 1 and 100 Yuan and a four-year college degree, aged 20 to 60. The post-expansion cohort sample refers to individuals born in or after 1980; the pre-expansion cohort sample to individuals born between 1954 and 1979. The Gaokao score is normalized first by the maximum possible score of each test and then transformed to a z-score with mean zero and standard deviation of one. Authors' calculation from the China Household Income Project 2013. Maximum scores come from various Gaokao-related websites.

Figure 5: Projected Employment Demand for Educated Labor in the Formal Sector in Urban China (Nationwide Aggregates)



Notes: The province-specific education demand as a weighted sum of nationwide education distribution by industry weighted by the province-specific industrial employment composition (see text, Eq. 4). 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 6: Elite University Premium By Potential Experience for the Post-expansion Cohort



Notes: The figure depicts the coefficient estimates of interaction terms between the elite dummy and indicators for 0, 1-2, 3-5, 6-10, and 11-16 years of potential experience, using controls similar to those in column 6 of Table 4 and column 1 of Table 5. Full regression results are available from the authors upon request. The panel data sample includes all full-time workers with hourly wage between 1 and 100 Yuan and a four-year college degree, aged 20 to 60. The post-expansion cohort sample refers to individuals born in or after 1980. Dependent variable is the natural logarithm of monthly CPI-adjusted wage, measured in 2013 and in the year when one starts the current job.

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

Panel A: Educational Distribution by Age Cohort (in %)

Education level	Total	Pre-expansion cohort			Post-expansion cohort		
		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
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

Panel B: Public Sector Share of Employment by Education

Education level	% public sector			% of public sector workers in government and institutions		
	Total	Pre-expansion	Post-expansion	Total	Pre-expansion	Post-expansion
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 post-expansion cohort sample refers to individuals born in or after 1980; the pre-expansion cohort sample individuals born between 1954 and 1979. Public sector includes government agencies, institutions, and state-owned enterprises (SOEs). The three columns on the right exclude SOEs. Authors' calculation from the China Household Income Project 2013.

Table 2: Mincer Returns to Individual Skills

	1	2	3	4	5	6
	All	Pre-expansion	Post-expansion	All	Pre-expansion	Post-expansion
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]
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]
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 post-expansion cohort sample refers to individuals born in or after 1980; the pre-expansion cohort sample individuals born between 1954 and 1979. Dependent variable is the natural logarithm of monthly CPI-adjusted wage in 2013. Explanatory variables include potential experience (PE=Age-years of schooling-6) and its square (PE^2), a dummy for male workers, 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 being 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	pre-expansion	post-expansion	all	pre-expansion	post-expansion	all	pre-expansion	post-expansion
Elite	0.142***	0.106**	0.189***				0.091*	0.081	0.058
	[0.040]	[0.052]	[0.066]				[0.048]	[0.062]	[0.081]
Gaokao z-score				0.110***	0.043	0.190***	0.094***	0.037	0.174***
				[0.027]	[0.034]	[0.047]	[0.027]	[0.034]	[0.054]
PE	0.071***	0.054**	0.094***	0.078***	0.054*	0.102***	0.077***	0.058**	0.101***
	[0.008]	[0.023]	[0.034]	[0.008]	[0.028]	[0.037]	[0.009]	[0.028]	[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]
Male	0.142***	0.192***	0.128***	0.156***	0.194***	0.149***	0.153***	0.192***	0.147***
	[0.030]	[0.041]	[0.046]	[0.034]	[0.049]	[0.050]	[0.034]	[0.049]	[0.050]
Constant	7.815***	7.984***	7.844***	7.785***	8.063***	7.761***	7.763***	7.981***	7.751***
	[0.059]	[0.249]	[0.131]	[0.065]	[0.293]	[0.144]	[0.065]	[0.299]	[0.146]
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,474	718	756	1,163	550	613	1,163	550	613
R-squared	0.361	0.335	0.362	0.394	0.359	0.435	0.397	0.361	0.436

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 post-expansion cohort sample refers to individuals born in or after 1980; the pre-expansion 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 variable (*Elite*) for elite university graduates, the *Gaokao score* (normalized first by the maximum possible of the test one took, and then to a z-score with mean zero and standard deviation of one), potential experience (*PE*=Age-years of schooling-6) and its square (PE^2), a dummy for male workers, 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	7	8
	All	Pre-expansion	Post-expansion	All	Pre-expansion	Post-expansion	Pre-expansion	Post-expansion
Elite	0.245*	0.259	0.326***	0.220*	0.041	0.346***	0.145	0.393***
	[0.146]	[0.220]	[0.067]	[0.123]	[0.211]	[0.071]	[0.179]	[0.059]
Elite x PE	-0.014	0.000	-0.066**	-0.017	0.002	-0.069**	0.005	-0.072***
	[0.012]	[0.016]	[0.027]	[0.011]	[0.017]	[0.027]	[0.015]	[0.028]
Elite x PE^2	0.000	-0.000	0.005**	0.001*	0.000	0.005**	-0.000	0.005**
	[0.000]	[0.000]	[0.002]	[0.000]	[0.000]	[0.002]	[0.000]	[0.002]
PE	0.110***	0.143***	0.096***	0.048***	0.024	0.058***	0.036	0.048***
	[0.007]	[0.010]	[0.015]	[0.006]	[0.016]	[0.011]	[0.024]	[0.012]
PE^2	-0.002***	-0.003***	-0.003**	-0.001***	-0.001*	-0.002*	-0.001	-0.001
	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.001]	[0.001]	[0.001]
Male	0.041	0.148***	0.109***	0.136***	0.189***	0.124***	0.151***	0.084*
	[0.032]	[0.032]	[0.042]	[0.025]	[0.024]	[0.040]	[0.029]	[0.049]
$\hat{E}_{rt}^{COL}$				0.023***	0.033***	0.013***	0.030***	0.015***
				[0.002]	[0.003]	[0.005]	[0.006]	[0.004]
Constant	7.362***	6.753***	7.614***	6.410***	6.228***	6.964***	6.199***	6.867***
	[0.053]	[0.070]	[0.058]	[0.079]	[0.061]	[0.258]	[0.104]	[0.254]
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Excluding firm changers	No	No	No	No	No	No	Yes	Yes
Observations	2,829	1,341	1,488	2,818	1,330	1,488	914	1,163
Number of individuals	1,494	723	771	1,494	723	771	505	601

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 post-expansion cohort sample refers to individuals born in or after 1980; the pre-expansion 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 variable indicating elite university graduates (*Elite*), potential experience (PE=Age-years of schooling-6) and its square (PE^2), interaction terms between *Elite* and potential experience (PE and PE^2), a dummy for male workers, time-varying province-specific demand for college graduates ($\hat{E}_{rt}^{COL}$, as a percentage of total labor demand), and city fixed effects. Columns 7 and 8 replicate columns 5 and 6 for the sample of individuals who have never changed firms. 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 to measured skills (post-expansion cohort)

	1	2	3	4
Elite	0.266***	0.328***	0.251**	0.346***
	[0.098]	[0.069]	[0.121]	[0.104]
Elite x PE	-0.081**	-0.088***	-0.089***	-0.089***
	[0.035]	[0.029]	[0.033]	[0.028]
Elite x PE^2	0.006**	0.006**	0.007***	0.006***
	[0.003]	[0.003]	[0.003]	[0.002]
Gaokao z-score	0.195***	0.177***	0.146***	0.172***
	[0.056]	[0.064]	[0.055]	[0.061]
Gaokao z-score x PE	-0.012	0.005		
	[0.017]	[0.024]		
Gaokao z-score x PE^2	0.001	-0.001		
	[0.001]	[0.002]		
Elite x Gaokao z-score			0.055	-0.013
			[0.092]	[0.094]
PE	0.060***	0.054***	0.058***	0.056***
	[0.011]	[0.012]	[0.012]	[0.010]
PE^2	-0.001	-0.000	-0.001	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]
Male	0.138***	0.091*	0.138***	0.089
	[0.046]	[0.055]	[0.045]	[0.055]
$\hat{E}_{rt}^{COL}$	0.012**	0.012***	0.012**	0.012***
	[0.005]	[0.005]	[0.005]	[0.005]
Constant	6.982***	6.942***	6.989***	6.946***
	[0.274]	[0.266]	[0.276]	[0.266]
City fixed effects	Yes	Yes	Yes	Yes
Excluding firm changers	No	Yes	No	Yes
Observations	1,215	946	1,215	946
Number of individuals	626	486	626	486

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 post-expansion cohort sample refers to individuals born in or after 1980. 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 variable indicating elite university graduates (*Elite*), potential experience (*PE*=Age-years of schooling-6) and its square (PE^2), interaction terms between *Elite* and potential experience (*PE* and PE^2), the Gaokao z-score (normalized first by the maximum possible score of the test one took, and then to a z-score with mean zero and standard deviation of one) and its interaction with *Elite*, *PE* and PE^2, a dummy for male workers, time-varying province-specific demand for college graduates ($\hat{E}_{rt}^{COL}$, as a percentage of total labor demand), and city fixed effects. Columns 2 and 4 replicate columns 1 and 3 for the sample of individuals who have never changed firms. 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 (post-expansion cohort)

	1	2	3	4	5
Elite	0.282***	0.259***	0.285***	0.250***	0.277***
	[0.094]	[0.077]	[0.092]	[0.076]	[0.064]
Elite x PE	-0.089***	-0.095***	-0.088***	-0.092***	-0.079**
	[0.033]	[0.029]	[0.033]	[0.030]	[0.032]
Elite x PE^2	0.007***	0.007***	0.006**	0.007***	0.005*
	[0.003]	[0.002]	[0.003]	[0.002]	[0.003]
Gaokao z-score	0.156***	0.158***	0.165***	0.159***	0.174***
	[0.058]	[0.057]	[0.061]	[0.058]	[0.058]
PE	0.058***	0.057***	0.058***	0.056***	0.051***
	[0.012]	[0.011]	[0.012]	[0.011]	[0.015]
PE^2	-0.001	-0.001	-0.001	-0.001	0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Male	0.129***	0.142***	0.129***	0.127**	0.095*
	[0.047]	[0.052]	[0.044]	[0.053]	[0.055]
$\hat{E}_{rt}^{COL}$	0.012***	0.012***	0.012**	0.012***	0.012***
	[0.005]	[0.004]	[0.005]	[0.004]	[0.004]
Constant	0.012***	0.012***	0.012**	0.012***	0.012***
	[0.005]	[0.004]	[0.005]	[0.004]	[0.004]
City fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	No	No	Yes	Yes
Occupation fixed effects	No	Yes	No	Yes	Yes
Sector fixed effects	No	No	Yes	Yes	Yes
Observations	1,213	1,191	1,215	1,189	932
Number of individuals	625	612	626	611	478

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 column 6 of Table 4 except with added control of Gaokao z-score, and with industry, occupation, and sector fixed effects added separately in columns 1-3 and jointly in column 4. Column 5 replicates column 4 for the sample of individuals who have never changed firms. Robust standard errors clustered at province level are in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Dynamic returns to elite university and to measured skills (post-expansion cohort), controlling for individual fixed effects

	1	2	3	4
Elite x PE	-0.066*	-0.096**	-0.078**	-0.098**
	[0.035]	[0.032]	[0.035]	[0.035]
Elite x PE^2	0.005*	0.007**	0.006**	0.007**
	[0.003]	[0.003]	[0.002]	[0.003]
Gaokao z-score x PE	-0.019	0.003		
	[0.027]	[0.032]		
Gaokao z-score x PE^2	0.001	-0.001		
	[0.002]	[0.003]		
PE	0.033	0.005	0.027	0.005
	[0.022]	[0.022]	[0.023]	[0.023]
PE^2	-0.002	-0.001	-0.001	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]
$\hat{E}_{rt}^{COL}$	0.024**	0.034***	0.024**	0.035***
	[0.011]	[0.010]	[0.010]	[0.009]
Constant	6.361***	5.866***	6.350***	5.827***
	[0.510]	[0.460]	[0.505]	[0.445]
Individual fixed effects	Yes	Yes	Yes	Yes
Observations	1,215	946	1,215	946
Number of individuals	626	486	626	486

Notes: The same as Table 5. Columns 2 and 4 replicate columns 1 and 3 for the sample of individuals who have never changed firms. 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 and skills by region and characteristics (post-expansion cohort)

	1	2	3	4	5	6
	coastal	inland	≥median service share	<median service share	<median agriculture share	≥median agriculture share
Elite	0.376***	0.179	0.287***	0.226	0.312***	0.278
	[0.050]	[0.177]	[0.078]	[0.152]	[0.075]	[0.202]
Elite x PE	-0.123***	-0.047	-0.104***	-0.071	-0.137***	-0.038
	[0.031]	[0.059]	[0.034]	[0.071]	[0.038]	[0.059]
Elite x PE^2	0.009***	0.003	0.007**	0.006	0.010***	0.002
	[0.002]	[0.005]	[0.003]	[0.005]	[0.003]	[0.004]
Gaokao z-score	0.209***	0.112*	0.274***	0.034	0.240***	0.048
	[0.056]	[0.059]	[0.037]	[0.062]	[0.044]	[0.057]
PE	0.077***	0.044***	0.068***	0.050**	0.098***	0.020
	[0.013]	[0.010]	[0.012]	[0.020]	[0.017]	[0.023]
PE^2	-0.002	-0.001	-0.002	-0.001	-0.004**	0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]
Male	-0.001	0.242***	0.078**	0.198**	0.126**	0.156***
	[0.060]	[0.038]	[0.032]	[0.083]	[0.058]	[0.054]
$\hat{E}_{rt}^{COL}$	0.011*	0.011*	0.013***	0.009	0.011*	0.013**
	[0.007]	[0.007]	[0.005]	[0.007]	[0.006]	[0.006]
Constant	0.011*	0.011*	0.013***	0.009	0.011*	0.013**
	[0.007]	[0.007]	[0.005]	[0.007]	[0.006]	[0.006]
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	529	686	616	599	563	652
Number of individuals	268	358	315	311	288	338

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 individuals from respectively, coastal provinces (Beijing, Jiangsu, Shandong, Guangdong) and inland provinces (Shanxi, Liaoning, Anhui, Henan, Hubei, Hunan, Chongqing, Sichuan, Yunnan, Gansu); columns 3 and 4 are samples of cities where the share of GDP from the service sector 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 below or above the national median in 2011. Model specifications are the same as that in column 6 of Table 4, with added control of Gaokao z-score. Robust standard errors clustered at province level are in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Returns to elite university by regional external investment (post-expansion cohort)

	1	2	3	4
	≥median FDI VA %	<median FDI VA %	≥median FDI number %	< median FDI number %
Elite	0.214**	0.401**	0.309***	0.246
	[0.094]	[0.169]	[0.052]	[0.213]
Elite x PE	-0.088***	-0.103*	-0.109***	-0.075
	[0.032]	[0.057]	[0.026]	[0.065]
Elite x PE^2	0.006*	0.008*	0.008***	0.006
	[0.003]	[0.004]	[0.003]	[0.005]
Gaokao z-score	0.267***	0.015	0.244***	0.046
	[0.037]	[0.049]	[0.038]	[0.062]
PE	0.064***	0.049***	0.076***	0.039***
	[0.011]	[0.019]	[0.012]	[0.013]
PE^2	-0.001	-0.001	-0.002	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]
Male	0.070*	0.210***	0.042	0.248***
	[0.042]	[0.063]	[0.049]	[0.046]
$\hat{E}_{rt}^{COL}$	0.012**	0.011	0.011*	0.011*
	[0.006]	[0.007]	[0.006]	[0.006]
Constant	0.012**	0.011	0.011*	0.011*
	[0.006]	[0.007]	[0.006]	[0.006]
City fixed effects	Yes	Yes	Yes	Yes
Observations	608	607	604	611
Number of individuals	310	316	307	319

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 column 6 of Table 4, with added control of Gaokao z-score. Robust standard errors clustered at province level in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 10: Returns to elite university and skills by job sector (post-expansion cohort)

	1	2	3
	Government agencies+ public institutions	private + SOE	private firms
Elite	0.149	0.358***	0.394***
	[0.174]	[0.096]	[0.143]
Elite x PE	-0.047	-0.124***	-0.149***
	[0.059]	[0.033]	[0.054]
Elite x PE^2	0.002	0.011***	0.011**
	[0.004]	[0.003]	[0.005]
Gaokao z-score	0.173*	0.206***	0.192***
	[0.100]	[0.060]	[0.074]
PE	0.041	0.070***	0.061***
	[0.031]	[0.012]	[0.015]
PE^2	-0.000	-0.002***	-0.001
	[0.002]	[0.001]	[0.001]
Male	0.037	0.185***	0.165**
	[0.060]	[0.055]	[0.075]
$\hat{E}_{rt}^{COL}$	0.019***	0.008	0.006
	[0.006]	[0.005]	[0.007]
Constant	0.019***	0.008	0.006
	[0.006]	[0.005]	[0.007]
City fixed effects	Yes	Yes	Yes
Observations	496	719	435
Number of individuals	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 column 6 of Table 4, with added control of Gaokao z-score. Robust standard errors clustered at province level in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 11: Heterogeneity of wage determination by gender (post-expansion cohort)

	1	2	3	4	5
Elite	0.378***	0.369***	0.333***	0.291***	0.251***
	[0.121]	[0.104]	[0.098]	[0.093]	[0.077]
Elite x PE	-0.081**	-0.091***	-0.093***	-0.090***	-0.093***
	[0.040]	[0.033]	[0.030]	[0.033]	[0.030]
Elite x PE^2	0.005*	0.007***	0.007***	0.007***	0.007***
	[0.003]	[0.003]	[0.002]	[0.003]	[0.002]
Male x Elite	-0.175	-0.153*	-0.163		
	[0.166]	[0.082]	[0.102]		
Male x PE	-0.013				
	[0.026]				
Male x PE^2	0.001				
	[0.002]				
Male x Elite x PE	-0.013				
	[0.058]				
Male x Elite x PE^2	0.002				
	[0.004]				
Gaokao z-score	0.164***	0.165***	0.159***	0.232***	0.236***
	[0.057]	[0.056]	[0.056]	[0.048]	[0.038]
Male x Gaokao z-score				-0.125**	-0.140**
				[0.060]	[0.069]
PE	0.064***	0.058***	0.056***	0.058***	0.056***
	[0.019]	[0.012]	[0.011]	[0.012]	[0.012]
PE^2	-0.002	-0.001	-0.001	-0.001	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Male	0.209**	0.174***	0.166***	0.191***	0.188***
	[0.088]	[0.053]	[0.061]	[0.052]	[0.062]
$\hat{E}_{rt}^{COL}$	0.011**	0.012**	0.011***	0.012**	0.011***
	[0.005]	[0.005]	[0.004]	[0.005]	[0.004]
Constant	6.971***	6.981***	7.079***	6.978***	7.081***
	[0.287]	[0.275]	[0.437]	[0.272]	[0.429]
City fixed effects	Yes	Yes	Yes	Yes	Yes
Industry, Occupation and Sector fixed effects	No	No	Yes	No	Yes
Observations	1,215	1,215	1,189	1,215	1,189
Number of individuals	626	626	611	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 similar to Table 5, column 1, additionally controlling for interactive terms between the male dummy and PE, PE^2, Elite dummy, PE x Elite (columns 1-3), and PE x Gaokao z-score (columns 4-5). Columns 3 and 5 replicate columns 2 and 4 with industry, occupation and sector fixed effects. Robust standard errors clustered at province level in brackets. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.