Impact of the College Expansion on Skilled Labor Market in China

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Abstract

An unprecedented expansion in the Chinese higher education system began in 1999, bringing a large number of skilled workers into the market. In this paper, we study the short-term response of the labor market to this college expansion. Using the number of provincial college admissions as a measure of college expansion, we identify the impacts of the college expansion on the college premium, unemployment, and skills used in first jobs. In the short run, the college expansion decreased the college premium and increased the likelihood of unemployment for new college graduates. Also, the college expansion reduced the cognitive skills used in college graduates' first jobs. The negative impact of the college expansion on labor outcomes is smaller on older college graduates. Our results are consistent with findings published in the 1970s focusing on the effects of the U.S college expansion.

Key words: College expansion, College Premium, Unemployment, China

JEL classification: I23, I28, J24, J31

1 Introduction

The Chinese higher education system had been suspended during the Cultural Revolution (1966-1976) and started to recover and gradually expand beginning 1978. However, the growth was slow, and in 1999, fewer than 10% of those age 18-22 were enrolled in colleges and few people in the employed labor force had college degrees (3.5% of the employed workers had college degrees in 1998). Starting from 1999, China began an unprecedented expansion of its higher education system. According to official descriptions, the Chinese government adopted suggestions of Chinese economist Min Tang to double the college admission in China in 4 years and maintain a high annual rate of increase in college admission after that point[1].

According to basic economic theories, a large increase in college admission will bring more college graduates to the labor market, which creates a positive supply shock and affects labor market outcomes. Many papers have studied the impact of the increase in number of college graduates in the early 1970s in the US affected the labor market outcomes. Freeman (1975) found the increase in supply of college graduate workers relative to demand in the U.S during 1970s reduced the relative wage of college graduates, reduced the rate of return to investing higher education, and reduced employment opportunity for college graduates. Freeman (1977) further showed that the negative impact was more serious for young workers than older workers. Goldin et al. (2007) also attributed the decline in relative wage between college and high school graduates in the U.S in 1970s to the increase of relative supply. More empirical analysis on the impact of the increase in college graduates in the US can also be found in Welch (1979) and Katz and Murphy (1992). Aamodt and Arnesen (1995) found empirical evidence in Norway that the college

[1]Min Tang, Xiaolei Zuo (1998). A Suggestion for Doubling the College Enrollment. Retrieved from: http://finance.sina.com.cn/review/20041023/15201102716.shtml (in Chinese), accessed July 18, 2020

expansion starting in 1989 in Norway increased the likelihood of unemployment for college graduates six months after their graduation.

In the long run, it is been argued that a positive supply shock of skilled labor can also stimulate companies to develop skill-complementary technology and thus increase the productivity as well as the premium for skill labor (Acemoglu, 1998, 2007). Carneiro et al. (2018) find the college expansion in Norway in 1970s increased the productivity of skilled labor and investments in R&D.

Some studies have discussed the impact of the college expansion in China on labor market outcomes. Several studies have focused on the short-run market responses to the college expansion. Li et al. (2014) used 2000 and 2005 1% population survey data and found that the college expansion increased the probability of college attendance among high school graduates and increased the unemployment rate among young college graduates. He et al. (2015) conducted a descriptive study based on administrative data from the Chinese higher education system and labor market. He argued that the quality of a college education decreased due to the college expansion, which may have caused college graduates to find lower-paid jobs or become unemployed. Knight et al. (2017) summarized the relative wages, probability of unemployment, and likelihood of obtaining "good jobs" (technical, professional, government or enterprise management) for college graduates using survey data from 2002 to 2008. These papers studied the impact of the college expansion either in descriptive ways (He et al., 2015, Knight et al., 2017), or compared single-year outcomes before and after the college expansion (Li et al., 2014, Knight et al., 2017). They did not develop measures to quantify the college expansion, and, as a result, they are not able to provide precise estimates of the impact of the college expansion on labor market outcomes.

Xing et al. (2018) studied the mid-run impact of the college expansion on the probability of unemployment for college graduates. Their study used census data for 2000, the 1% population survey for 2005, and the census data for 2010. Using a difference-in-difference identification strategy, they found that although the unemployment rate for young people increased between 2000 to 2005, the likelihood of unemployment for young people in 2010 was not statistically different from 2000. Yao (2015) use municipal level data in China to study the long-term impact of college expansion on regional economies. His results suggest the increase in college construction had a positive effect on regional average wage and real GDP per capita in the long term.

In this paper, we study the short run impact of the college expansion on the college premium, unemployment, and the skills used in first jobs in China. Our paper contributes to the previous literature in several ways.

First, we use the number of students admitted to college to quantify the college expansion and study its impacts on labor market outcomes for younger and older workers. We interpret our estimated results as the impact of a positive supply shock on the labor market. Since the increased rate of college admission is based on pre-established government policies, our measure of the supply shock in skilled workers allows us to separate supply and demand effects when on the college premium.

Second, we study the impact of the college expansion on the college premium within industry and occupation. By controlling industry fixed effect and occupation, we identify a decline in the college premium within industry and occupation due to the college expansion.

Third, we study the impact of the college expansion on skills used in a first job. We combine individual occupation data from the CGSS with O*NET codes to calculate the scores of cognitive and manual tasks used in first jobs. This analysis suggests that the decrease in the college premium may also be attributed to the movement of skilled labor between occupation.

This paper is structured as follows: Section 2 introduces the background for the college expansion and considers the role of college graduate workers in the labor market. Section 3 describes the data we use. Section 4 describes the identification strategy used in this paper. Section 5 reports the estimated impact of college expansion on the college premium, unemployment, and types of tasks used in first jobs. Section 6 summarizes the paper.

2 Background

2.1 The College Expansion in China

College enrollment in China has increased substantially since the Cultural Revolution, especially after 1999. The average annual increase rate for the number of students admitted to colleges was around 8.5% from 1978 to 1998. In 1999, the Chinese government announced a decision to accelerate the expansion of higher education in order to increase human capital accumulation, stimulate domestic demand, and improve employment options for young people and workers laid off from State Owned Enterprises. The college admissions increased at an annual rate of more than 10% from 1999 to 2012. This period of extraordinary growth came to an end in 2012, when the Ministry of Education of China (MOE) issued guidelines slowing the growth of higher education enrollment, indicating the need to guarantee quality of instruction (MOE, 2012).

Figure 1 shows the number of students admitted to regular and adult 4-year colleges[2] and 2- or 3-year colleges[3] in China from 1992 to 2015. The number of students admitted to regular colleges (sum of the line with triangle markers and the line with round markers) increased by more than 45% in 1999, and the college admission grew at an average rate of 20% per year from 1999 to 2008. In 2008, 6 million students were admitted to regular colleges, about 5.5 times the number in 1998. The level of admission to 2- or 3-year colleges was similar to that for 4-year colleges before the college expansion but it increased at a lower rate than 4-year college admission in the beginning years of the college expansion.

Although the number of students admitted to regular colleges was about the same as the number of students admitted to adult colleges before the college expansion, the admissions in regular colleges increased much faster than the admissions in adult colleges during the college expansion period. In 2008, the number of admissions into adult college was only about one-third of the admissions into regular colleges. The 2- or 3-year adult college admissions increased in the beginning of the college expansion but decreased by 540 thousand from 2002 to 2006, followed by a modest growth. The admissions for 4-year adult colleges was less than 12,000 up through 1998, and although proportional growth was large after that point, the total contribution to enrollment was modest compared to that of regular 4-year colleges.

[2] The 4-year colleges are also called the undergraduate colleges, and students receive bachelor's degrees. Students who graduate from 2 or 3-year colleges receive associate's college degrees.

[3] Regular higher education institutions provide full-time higher education instruction. It includes 4-year universities and colleges, 2 or 3-year colleges, vocational colleges and independent colleges (see footnote 2). Adult higher education institutions mainly admit part-time adults based on the adult college entrance exam.

After 2008, the government slowed down the expansion rate for college admission. The annual growth rate for overall admissions into colleges (both regular and adult) shrank to about 3% between 2008 to 2015.

The growth rates of college admissions differ across provinces during the college expansion period. Figure 2 shows the average annual increase rate of college admissions in each province of China from 1998 to 2012[4]. Most provinces increase at more than 10% per year from 1998 to 2012. Provinces with the highest density of higher education initially, like Beijing and Shanghai, along with other provinces in northeastern and northwestern areas have the lowest rate of increase in college admissions. Less-developed provinces in general have higher rates of increase than more developed provinces.

The proportion of the population age 18-22 enrolled in colleges (both regular and adult colleges) increased from 9.8% in 1998 to 23.3% in 2008 (Figure 3, the circle line). The 18-22 year-old population (Figure 3, the cross line) increased at a rate of 5% in 1998-2009 and decreased at 6% per year in 2009-2015, a result of China's one-child policy. Thus, it suggests that the college admissions increased at a faster rate than the 18-22 population in 1998-2009, and the continued growth in proportion of college enrollment among those aged 18-22 in 2010-2015 reflects both the continuous declines in the 18-22 population and increases in the number of students attending college.

Although college admissions started to surge in 1999, the funding, facilities and other resources for higher education did not increase proportionally in the beginning of the college

[4] The equation to calculate the increase rate is: $IR = (\sqrt[14]{(AD_{2012}/AD_{1998})} - 1) * 100\%$, where IR is the average annual increase rate of college admissions, and AD is the national college admissions.

expansion. Figure 4 shows the national public budget levels for regular higher education institution, as well as the student-teacher ratio[5] for 4-year and 2- or 3-year regular colleges in 1996-2015. As can be seen from the graph, the budget (the cross line) increased almost linearly at an annual rate of 12.7% from 1999 to 2008 but grew faster (15.6% per year) from 2008 to 2015. Since the annual growth rate for regular college admissions (20%) was much higher than the growth rate for the public budget, the student-teacher ratio (circle line) increases dramatically during the initial period of college expansion.

For adult higher education institutions (Figure 5), both of the public budget and student-teacher ratio increased in 1996-2015. It's worth noting that the public budget allocated to adult colleges was much smaller than that to the regular colleges, especially after the college expansion. The adult college budget was only about 1/66 of the budget level for regular colleges in 2015, although the adult college admissions was about 1/3 of the admission in regular colleges. The student teacher ratio is more than ten times that for regular colleges. Thus, in the college expansion, the government allocated more resources to regular colleges than adult colleges, although the admissions into adult colleges also substantially increased.

The number of 2- or 3-year colleges began to increase with the college expansion and had tripled by 2008, as shown in Figure 6 (cross line), while the number of 4-year colleges (circle line) increased only sightly in the beginning of the college expansion but then increased by a more than 45% in 2008. The sudden increase of 4-year colleges in 2008 is a result of increase in dependent

[5] The student-teacher ratio is calculated as number of students in colleges divided by the number of full-time teachers in colleges.

colleges[6] which are private 4-year colleges affiliated with regular public colleges. The 2- or 3-year colleges increased in an annual rate of 16% from 1999 to 2005 but only 2.1% per year after 2005.

Accompanying the college expansion, MOE decentralized its control of many colleges to province governments and allowed more private funded colleges to be established. This led to a large increase in the number of colleges under the provincial governments (triangle line in Figure 7) and a decrease in the number of colleges under the central government (circle line in Figure 7. Also, the number of private colleges[7] (cross line in Figure 7) grew starting in 2001 and surged in 2008 due to the creation of independent colleges, as noted above.

In summary, the unprecedented expansion in Chinese higher education has greatly increased the chance that young people receive a college education. College admission for both 4-year and 2- or 3-year colleges has increased at a very high rate in 1999-2012. Although the number of colleges, number of college teachers and national expenditures on higher education all increased after 1999, they did not increase proportionately with the college admission in the beginning of the college expansion. The major expansion happened in 2- or 3-year colleges, locally controlled colleges and private colleges. The lack of resources for college expansion at the beginning of the period of growth, and the unbalanced expansion toward less elite colleges may have resulted in a decrease to the quality of higher education.

[6] The independent colleges in China are 4-year institutions that were created from units of regular colleges and funded jointly by non-government organizations or individuals and regular colleges. The *Measures for the Establishment and Administration of Independent Colleges* was published in 2008 (MOE, 2008), which officially established the legal status of independent colleges.

[7] Private colleges in China are either 2, 3 or 4-year colleges, which are funded by non-public sources. The average tuition for private colleges is 3-4 times the average tuition for public colleges. Private colleges are under the control of provincial ministry of education. Due to lack of separate statistics for private colleges before 2002 in the Education Yearbook, we plot the number of private colleges in 2002-2015. The number of private colleges before 2002 is included in the number of colleges under provincial governments (triangle line in Figure 7).

2.2 College Graduates in the Chinese Labor Market

The large increase in the number of students admitted to college will increase the supply of skilled labor in the market, and we expect it may change the relative price and employment status for skilled workers.

Figure 8 shows the educational distribution for employed workers in 1996 to 2015 according to China Labor Statistical Yearbook. The area from the top to the bottom represents the proportion of workers whose highest education is at least college degree, high school degree, middle school, and primary school degree (6-year or 5-year), and less than a primary school degree, respectively. As can be seen from the graph, the proportion of college graduate among all workers has increased from 2.8% in 1996 to 17.5% in 2015, while the proportion with a primary education or less declined from 48.3% in 1996 to 20.6% in 2015. This implies an overall skill upgrading among employed workers in China.

Figure 9 shows the change of college worker proportions from 1998 to 2012. We can see that most provinces increase by 10-15 percentage points, indicating a large upgrading in labor force in most provinces. The increase of the proportion of college worker in south-western area, where least-developed provinces located, is the smallest. The greatest increase occurred in most-developed provinces, like Beijing, Shanghai, Jiangsu, and Zhejiang.

Table 1 shows the logarithmic annual growth rate for the total number of employed workers and the number of college graduate workers by age group and workplace region. The total number of employed workers decreases by about 2% for those who were 30-39 years old in these 15 years. This is probably related to the family planning policies that began in late 1970s and early 1980s, which reduced the number of births. People born in this period started going into their 30s in

2001-2015, thus the number of employed workers is smaller than people the earlier cohort. Next, we look at the annual logarithmic change rate for employed college workers. The increase for college graduate workers is much larger than that for all workers, which implies that skill upgrading is occurring over time in the labor market. Meanwhile, the number of college workers increased at a much higher rate for younger workers (20-29 year-olds) than for older workers, very likely due to the college expansion in China from 1999.

Panel B shows logarithmic annual change in number of employed workers and number of college graduate workers by workplace region. First, the growth rates for college graduates are much higher than those for all employed workers in all regions, indicating skill upgrading across China. The growth rates for both employed workers and college graduate workers are larger in the eastern provinces than in other regions. Since the annual increase in the number of students admitted to colleges in eastern, central, western and northeastern regions in 1992-2011 are 13.5%, 15.2%, 14.2% and 11.4% respectively, this indicates that some people who received their college education in the central and western provinces choose to work in the eastern provinces.

Next, we summarize the employed workers and workers with at least college degrees by gender, occupation and industry. Due to the availability of these statistics in administrative source, we only list these statistics for urban residents in Table 2. For males, the growth rate for "clerk and business personnel" increased at a higher rate than for other occupations. For women, "manager and professional" workers increased in a higher rate than other occupations. The number of college graduate workers among both men and women increased at a much higher rate than the increase of all employment within each type of occupation, which further suggests an overall skill upgrading in the Chinese labor market. The increase in college workers among "farmer and

production worker" is larger than for other occupations, which is most likely because there were very small number of college workers doing farming or manufacturing work.

In panel B of Table 2, we see that the number of employed workers in the agricultural industry decreased by about 4.9% per year, while employment increased in the manufacturing and third service industries for both men and women. Joining the WTO in 2001 has greatly stimulated the growth in manufacturing industry, and further stimulated the growth in service industry due to the increase in personal income. For both men and women, the increase rate for college graduate workers in the second industry is much higher than in the agricultural and the service industries.

3 Data

In this paper, we use the Chinese General Social Survey (CGSS) 2003, 2005, 2006, 2008, 2010, 2011, 2012, 2013, 2015 to study the impact of college expansion on the Chinese labor market. The CGSS samples were selected from urban areas and rural areas covering all provinces in mainland China. The sampling frames used for 2003-2006 CGSS, 2008 CGSS, and 2010-2015 CGSS are different.

The 2003–2006 CGSS sampling is based on a four-stage sampling design. It selected 125 counties[8] in China, each covering 4 selected towns or city subdistricts. Then it selected 2 villages or neighborhood committees in each of the selected towns and selected 10 households in each of the selected villages. A person aged 18 and above was randomly selected from each sampled

[8] County unit in China is different from the county unit in the US. It is the third level of the administrative hierarchy in China, under the provincial level (the first level) and prefectural level (the second level, in China it's usually cities). Thus, a county is an administrative level under cities. It is most common in China that a city governs several counties.

household to serve as respondent. There are 10,000 final respondents in the 2003-2006 CGSS samples. To select the 125 counties, they categorized Chinese counties under five categories (municipalities[9], provincial capital cities, other cities in the eastern region, central region, and western region). The CGSS 2008 differs from the CGSS 2003-2006 design in including the selection of provincial capital cities into the last three categories when selecting the sample counties. They cover a total of 6,000 final respondents. In contrast to the CGSS 2003-2008, the 2010-2015 CGSS employed a three-stage sampling frames, which omitted the second stage (selecting towns), and also treated Beijing, Shanghai, Tianjin, Guangzhou, and Shenzhen as self-representative stratum in the first stage (selecting counties). There are 12,000 final respondents in the CGSS 2010-2015 sample[10].

In the study of the college premium, our primary sample is of currently employed workers between 25-65 years of age who were living in urban areas at the time when they took the surveys. The total sample has 20,416 observations and the descriptive statistics for these observations are shown in Table 3 and Table 4.

Male respondents are under-represented in CGSS data. The Chinese Labor Statistical Yearbook shows that the average percentage of male workers is more than 60% in 2003-2015, as compared to about 55% male workers in the CGSS sample. The average age for the employed workers is 35 in the CGSS 2003, 37 in 2005-2008, and 40 in 2010-2015. The average age increases across years, which is similar to the statistics from Chinese Labor Statistical Yearbook (36 in 2003, 37 in 2007, and 38 in 2013). There is a large increase in the percentage of the college graduate

[9] A municipality in China is a "city" with "provincial" power under a unified jurisdiction. As such it is simultaneously a city and a province of its own right (cited from Wikipedia). There are four municipalities in China: Beijing, Tianjin, Shanghai, Chongqing.

[10] For more detailed information on CGSS sampling design, see: http://cgss.ruc.edu.cn/index.php?r=index/sample

workers, from 15% in 2003 to 30% in 2010-2015, which is a result of the college expansion policy. Annual income is the total annual income in the year previous to the survey (e.g. in CGSS 2003, income is for 2002), all adjusted to 2002 Chinese Yuan. We can see that the real income for urban workers increases over time. The percentage of people working in the eastern regions increases over time, while the percentage of people working in the central or western provinces declines. This is due to a migrant flow from central and western regions to eastern provinces during 2003-2015.

In Table 4, we compare the percentage of workers who are college graduates, the college premium, and the percentage of manager, professionals and technicians among workers with college degrees and those with less than college degrees, by gender and age in each of the three survey periods.

We can see from Table 4 that there was a large increase in percentage of college workers for both female and male young workers over time, but the increase for older workers was relatively smaller. For the wage premium, there was a large decrease for young female workers from 3.1 to 1.7 from 2002 to 2004-2007, and for young male workers, the premium decreased from 1.8 to 1.5. But for older workers, the decline in college premium was much smaller. Although the college premium for both male and female young workers increased from 2004-2007 to 2009-2014, it did not reach its original 2002 level. For older workers, their premium greatly increased from 2004-2007 to 2009-2014. Finally, the percentage of workers with at least college degrees of having high occupation (manager, professionals and technicians) decreased for both young and older workers from 2003 to 2008, and it increased from 2008 to 2015. The percentage of workers with less than college of having high occupation increased over time for older male workers, but it decreased over time for older female workers.

4 Empirical Model

Since the college expansion is mainly implemented through increasing the number of admissions to colleges, we use the number of students admitted to college as a measure of the college expansion. We then study impacts of the college expansion on the college premium, unemployment, and skills requirements in first jobs. Although the college expansion beginning in 1999 was a national policy, the implementation of this policy through increasing the college admissions differed across provinces (See Figure 2). Therefore, the impact of the college expansion can be identified by different level of increase in college admissions by province and across year.

The process of college admissions across provinces of China in our sampled period (1999-2014) can be described as followed: (1) The MOE announces a plan for total number of college admissions for the year, including total number of admissions for colleges under provincial government administration in each province and the number of admissions for each college under the central government's administration. These planning numbers are determined mainly based on the national five-year and ten-year plan for higher education, and also consider the national socioeconomic development in each year.[11] (2) Based on the planning number for each province by the MOE, the department of education in each province works with each provincial college to establish admission goals. (3) Each school determines the number of students to be admitted from each of the 34 provinces and then reports its plan back to the provincial department of education

[11] Shuo Zhang (2017, May 11): MOE Set the Agenda for the 2017 Higher Education Admission. *People.cn.* Retrieved from http://edu.people.com.cn/n1/2017/0511/c1053-29267405.html (in Chinese, last visit: Aug.1, 2020)

and publishes the plan prior to the college entrance exam. In order to take account of the effect of economic development on admission planning, we control for provincial economic variables.

We use the following model to estimate the impact of the positive supply shock on several labor market outcomes:

$$y_i = \beta \widetilde{AD_{p,t-4}} + \boldsymbol{\gamma}' \boldsymbol{Edu_i} + \boldsymbol{\tau}' (\boldsymbol{Edu_i} * \widetilde{AD_{p,t-4}}) + \boldsymbol{\lambda}' \boldsymbol{X_i} + \boldsymbol{\varphi}' \boldsymbol{Z_{p,t}} + \delta_p + \delta_t + \varepsilon_i \qquad (1)$$

y_i represents the outcome for a person *i*. We examine three outcomes in this paper: log of annual income (adjusted to 2002 Yuan), a dummy for unemployment[12], the score of skill level for tasks used in the first job. $\widetilde{AD_{p,t-4}}$ is a centered measure of number of admitted student to college (unit: 0.1 million) four years before the year *t* when the person was surveyed (*t* ∈2003, 2005, 2006, 2008, 2010, 2011, 2012, 2013, 2015), where province *p* is the location of the residences of person *i* at the survey time. It was calculated as the number of students admitted to college in province *p* in *t*-4, subtracting the overall mean number of students admitted to college across the years 1998-2010 ($\widetilde{AD_{p,t-4}} = AD_{p,t-4} - \overline{AD}$), and then dividing by 100,000. $\boldsymbol{Edu_i}$ is a vector dummies for educational level, $\boldsymbol{Edu_i} = [Edu_{i1}, Edu_{i2}, Edu_{i3}]$, including a dummy for 4-year college degree, a dummy for 2- or 3-year college degree, and a dummy for less than high school degree (the base group is high school degree). $\boldsymbol{Edu_i} * \widetilde{AD}_{p,t-4}$ is an interaction vector between personal educational attainment and college admissions in the province where the person lived in year *t*-4. $\boldsymbol{X_i}$ is a vector for personal characteristics, including age, age squared and gender. $\boldsymbol{Z_{p,t}}$ is a vector for other time-variant provincial control variables, including log of provincial per capita GDP, per capita exports, per capita imports, fixed capital investment, percentage male, and percentage urban population in the province *p* in year *t*. We also include year fixed effects, δ_t, to control impacts of

[12] "Unemployed" equals 1 for those who did not have any job at the time of survey but had searched for a job in the three weeks prior to the survey.

other national policies, and province fixed effect, δ_p, to control impacts of time-invariant differences among provinces. Since the impact of college expansion may differ by people's age and experience, we estimate the equation (1) separately for those who were 23-29, and those who were 30-65 in the year of survey.

5 Main Results

5.1 Impact of the College Expansion on Skilled Labor Market Outcomes

5.1.1 Impact of the College Expansion on the College Premium

In this section, we estimate the impact on the college premium of the college expansion in 2002-2014 using equation (1). The CGSS surveys solicits the respondent's annual income (including wages, bonus, and other income) for the year prior to the survey. We thus have the income information for a total of 19,637 urban respondents from 31 provinces. We then combine the number of students admitted to colleges in each province and year with the CGSS data to see if the college expansion affects the college premium. The estimated results are shown in Table 5. In this analysis of the impact of the college expansion on the college premium, we use sample only covers urban respondents who were employed as full-time workers and have positive income.

Columns (1) – (4) show the results for younger workers (23-29 years old), who were more likely to be those just graduating from colleges and starting their careers. The estimated standard errors are clustered at the province level. However, since the number of provinces in mainland China is only 31, less than the minimum number of clusters that lead to reliable inference according to "rule of 42" (Angrist & Pischke, 2008), we need to apply wild bootstrap method to construct

reliable statistical tests for our estimated results. In this paper, we use the wild cluster bootstrap test in the Stata (boottest) to determine the p-value for each of the estimated coefficients[13].

In column (1), we control province fixed effects and basic demographic variables (age, age squared, gender). The estimated college premium is 54% ($e^{0.435} - 1$) at the average level of college admission. The increase in college admissions decreases the college premium. As the number of admitted students in a province increases by 0.1 million, the college premium for young workers decreases by 8.8 log points. We also observe a decrease in the income by about 2 log points for 2- or 3-year college graduates relative to the high school graduates, although the estimated results are not statistically significant. To rule out the possible effects from changes in overall labor force, we include annual 15-64 population in each province in column (2). The results change little. In column (3), we add several provincial economic and demographic variables to the model in order to control for changes in other socioeconomic trends in each province, including log annual GDP, log investment, log imports and log exports, percentage male, percentage of population living in urban area in provincial level. Both the college premium and the negative impact of the college graduates decrease slightly, but not in a significant way. In column (4), we further control year fixed effects and the imputed number of retiring college-educated workers,[14] and it does not change the results.

[13] It reports the t-statistic from Wald test and the p-value, which was generated from 999 wild cluster bootstrap samples that are assumed to follow the Rademacher distribution.

[14] The Imputation procedure is described as follows: We use the 2010 census data in each province to obtain the number of people with college degrees between 40-60 years old from 1998-2015, taking death rate into account. For example, college graduates who were 72 in 2010 census was 60 in 1998, assuming the death rate for a given age within a year did not change, then we can infer the population of college graduate of age 60 in 1998 using the population of college graduate of age 72 in 2010. Then, assuming the retirement rate for college graduates at each age is the same in each province across years, we use the 2000 national census data to impute the retirement rates for college graduates in each age between 40 to 60. Finally, we multiply the retirement rate by the number of college workers to obtain the imputed number of retired college workers in each province for each year from 1992 to 2015.

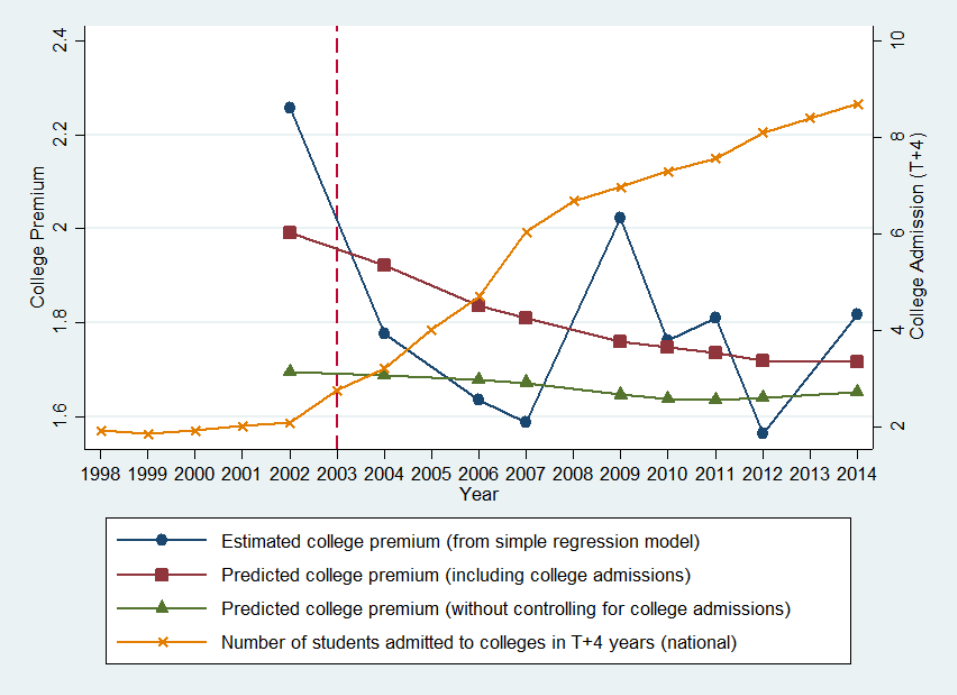

Figure 8 Number of Students Admitted to Colleges and Predicted College Premium in 1996-2014

In Figure 8, we plot the estimated college premium for young workers in 2002-2014 from a simple model which controls only personal characteristics (age, age squared, gender), province fixed effect, and time fixed effect (the line with circle markers), and compare it with the predicted college premium using coefficients from column (4) in Table 5 (the line with square markers), and with the predicted college premium for young workers using equation (1) without including college admissions (the line with triangle markers). We also plot the total national college admission from 1994 to 2010 (unit: million, the line with cross markers, the numbers shown on the graph are for calendar year T–4[15]).

To obtain the predicted college premiums using equation (1), we first predict the income in 2002-2014 for each person between ages 23-29. We substitute in estimated coefficients (using

[15] For example, the number of students admitted to colleges in year 2003 of Figure 8 is the number of students admitted in 1999 (1999=2003-4).

the reported coefficients in column (4) of Table 5), personal characteristics, provincial economic and demographical measures, and the number of students admitted to college in each province and year into equation (1). Then we average the predicted income for all college graduates and for all high school graduates to calculate the average college premium in each survey year.

In Figure 8, we observe decreases in college premium in 2002-2007, 2009-2012 and an increase in 2007-2009 and 2012-2014 for the estimated college premiums using the simple model. The predicted college premiums based on the estimated coefficients in column (4) of Table 5 show continuous decreases from 2002-2014. And the predicted college premiums using the model without including college admissions show a relatively flat line in contrast to both the estimates from the simple model and model including college admissions. That the predicted college premium declines even when the effects of college admission are excluded suggests that the positive supply shock due to college expansion only explains part of the decrease in college premiums, and there may be demand shifters which further decreased the college premiums. However, our model including college admissions still predicts the decline of the college premiums better than the model without college admissions.

The impact of college expansion on older workers is different. The first rows of Columns (5) - (8) report the estimated college premium for older workers is about 80%, which is greater than the college premium for younger workers. Also, we do not observe a decline in the college premium due to the increase in college admission for older workers. In contrast, after controlling for the population age 15-64, we found that the college expansion increased the college premium by about 4 log points for older people who completed college degrees. A possible explanation for the different impact of college expansion on young and older skilled workers is that older skilled workers have more experience, thus new college graduates cannot easily substitute for them.

Moreover, experienced skilled workers can help training the increasing numbers of young skilled workers, causing their incomes to increase in response to the college expansion.

In the robustness check, we use the number of annual new college graduates in each province[16] to proxy the college expansion and estimate equation (1) in Table 3A. The estimated results using the number of college graduates are similar to the results in Table 5, which further confirms our conclusion that the college premium for young college graduates decreased due to the college expansion.

The reduction in the college premium due to college expansion may result from changes of the college premium within occupation and industry, or movement between occupation and industry, or both. Therefore, we control for the industry and occupation fixed effects in equation (1), in order to identify the changes of college premiums within industry and occupation.

Unfortunately, not every year of CGSS surveys has information on the current industry and occupation of employment. To make our results comparable, we use the CGSS 2003, 2006, 2010, 2011, 2012, 2013 (9,463 observations) to conduct this estimation, since these surveys contain full information of the occupation and industry a respondent works in. The survey codes 15 industries and 37 occupations.

The estimated results controlling for industry and occupation fixed effects are shown in Table 1A. In columns (1) (for young workers) and (5) (for older workers) of Table 1A, we do not control industry or occupation fixed effects. In columns (2) and (6), we control for industry fixed

[16] The number of new college graduates by province and year is obtained from table "Summary statistics for regular higher education" and "Summary statistics for adult higher education" in the Chinese Educational Statistical Yearbook.

effect and in columns (3) and (7), we control for occupation fixed effect. Finally, in columns (4) and (8), we control for both industry and occupation fixed effects.

As can be seen from the table, comparing with estimates when no industry or occupation fixed effects have been controlled (the college premium decreases by 20.3 log percentage points), the decline of college premium due to college graduates within the same industry for younger workers due to the increase in college admission is slightly smaller (decreases by 20 log percentage points). When controlling for occupation, we also observe a decrease in college premium by 19.6 log percentage points per 0.1 million increase in college admission, which is slightly smaller compared with column (1). When controlling for both industry and occupation fixed effects, we observe a 19.8 log percentage points decrease in college premium as the college admissions increase by 0.1 million. These results suggest the college admission decreased the college premium within industry and occupation, and it also decreased the college premium between industry and occupation since the estimated impacts are greater when not controlling the industry and occupation fixed effects. We do not find a significant decline in the college premium for older workers due to increase in college admission in any specification.

In summary, we concluded that the impact of college expansion on the college premium differs for young and older workers. It drives down the college premium among young workers while it has no significant negative impact on the college premium on older workers. We also observe a decline in the college premium for young workers within industry and occupation. This is consistent with the view that when there is a positive supply shock of new skilled labor, young skilled workers are more likely than older workers to suffer a substitution effect that reduces their relative incomes. Our results are also consistent with Freeman (1977), who found a decline in

relative wages for young college educated workers during the 1970s due to a large increase of college educated labor in the U.S.

We also use the 2SLS method to identify the impact of a positive shock brought from the college expansion on people's income in appendix section A1 and Table 6A, and the results are similar with what we observe in Table 5.

5.1.2 Impact of the College Expansion on Unemployment

In the previous subsection, we studied the impact of college expansion on the college premium among younger and older workers. In the short run, college expansion may also create a surplus in skilled labor if companies do not alter their hiring of skilled workers. Also, if the quality of college education decreases, the difference between the marginal product produced by college graduates and people with high school degrees may shrink, which may result in a decreased demand of college graduates. Increasing unemployment of college graduates is a phenomenon which has aroused wide concern in China, with popular media accounts and magazines attributing the unemployment of college graduates to the 1999 college expansion.[17]

Figure 10 plots the percentage of college graduates among urban unemployed workers (the solid-square line) and the percentage of college graduates among urban employed workers (the

[17] For example, Zhixian Pan (2005, March 14): Easy to Obtain Admission to Colleges but Hard to Find Jobs Reduces the Motivation for Young People to Go to Colleges. *People Website.* Retrieved from http://edu.people.com.cn/GB/1055/3240291.html
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Unknown author (2009, May 04): It's Easy to Expand Colleges but Hard for College Graduates to Find Jobs. *The New Express.* Retrieved from http://finance.ifeng.com/news/opinion/20090504/617442.shtml
Chunxu Zhang (2013, June 05): Is Chines Universities Producing an Army of Unemployed Workers? *Tencent Review*. Retrieved from https://view.news.qq.com/zt2013/uniworth/index.htm

hollow-square line); as well as the percentage of college graduates among 23-29-year-olds urban unemployed workers (the solid-circle line) and percentage of college graduates among urban 23-29-year-olds unemployed workers (the hollow-circle line). As can be seen from the graph, the percentage of college graduates increase in both employed and unemployed workers, suggesting a trend of overall skill upgrading in the labor force. Before 2003, the percentage of college graduates among employed and unemployed workers are about the same for both young workers and for all workers. However, the percentage of college graduates among unemployed workers started to exceed the percentage of college graduates among employed workers since 2003, which is the graduation year for those admitted to 4-year colleges in 1999, which is the beginning year of the college expansion, and the gap continued to enlarge in the following years. Moreover, the gap in the percentage of college graduates between unemployed and employed workers among young people is greater than the gap between overall unemployed and employed workers. This observation indicates that the sudden increase in skilled labor makes it harder for college graduates, especially for young college graduates, to find a job.

In this section, we use our established model to explore the impact of college expansion on the likelihood of unemployment for college graduates. The dependent variable of equation (1) in this section, $Unemp_{i,p,t}$, is a dummy for unemployment status for a person *i* living in province *p* in year *t*. The model thus becomes a linear probability model (LPM). In the regression, we only include people who were not in school at the time of the survey and exclude those who were out of the labor force (i.e. not seeking jobs).

Table 6 reports the results of unemployment model described above by age group. Alternative specifications are the same as in Table 5. Based on the table, we first observe that both 4-year and 2- or 3-year college graduates are less likely to be unemployed than workers with high

school degrees or below. The probability of unemployment for a young 4-year college graduate is about 6 percentage points less than the probability for a high school graduate, and the probability for a 2- or 3-year college graduate about 8 percentage points less than the probability for a high school graduate, which is less than a 4-year college graduate. For older college graduates, their relative advantage in terms of employment is greater than the advantage for young college graduates. Older 4-year college graduates are 8 percentage points less likely to be unemployed than high school graduates, and older 2- or 3-year college graduates are 10 percentage points less likely to be unemployed than high school graduates.

The college expansion has significantly increased the probability of unemployment for 4-year and 2- or 3-year college graduates in both age groups. For young 4-year college graduates, a 0.1 million increase in provincial college admission increases their probability of unemployment by 3-4 percentage points relative to people with high school degrees (the difference in probability of unemployment between 4-year college graduates and high school graduates decreases by about 58%). Our estimates vary little across different model specifications.

The impact is smaller for older 4-year college graduates. It increases their relative probability of unemployment by 2-3 percentage points (the difference in the unemployment probability between 4-year college graduates and high school graduates decreases by about 22%). The college expansion also increased the probability of unemployment for 2- or 3-year college graduates. For every 0.1 million increase in college admission, the probability of unemployment for a young 2- or 3-year college graduate increased by about 5 percentage points, and it increases the probability for older college graduates by about 3 percentage points. The results suggest that college expansion decreased the probability of employment for both young and older skilled people. Since we do not observe any significant negative impact of the college expansion on the

college premium for older workers, the college expansion affects the older skilled workers mainly through increasing their probability of unemployment. However, the negative impact in terms of unemployment is greater for young college graduates than older college graduates.

We also observe a decrease in the probability of unemployment for people with less than high school education for both young and older workers in response to the college expansion. Young people are more likely to pursue a college degree in the college expansion period since the likelihood of enrolling in college for them is much greater, as the college premium is still large. Thus, a smaller proportion of young people choose to end up with high school degrees or below, which may create a shortage of low-skilled workers and thus increase the likelihood of employment for people with low skills.

We check the robustness of the estimated results in Table 2A. Instead of using the linear probability model, we assume the logistic probability. Table 2A reports the estimated marginal effects using a Logit model applying to equation (1). Similar to the results assuming linear probability (Table 6), we observe that the college graduates (both 2- or 3-year and 4-year) are less likely to become unemployed than high school graduates, while people with less than high school degree education are in general more likely to be unemployed. The college expansion significantly increased the probability of unemployment for young college graduates. The probability increased about 4 percentage points for both young 4-year college graduates and young 2- or 3-year college graduates. The impact of college expansion on the probability of unemployment is not statistically significant for older workers. We also observe a decrease in unemployment likelihood for both young and old people with less than high school degrees. Although the estimates using the logistic probability model slightly differs in magnitude from those of the linear probability model in Table 6, the pattern is essentially the same: we observe an increase in the probability of unemployment

for both young and older college worker as the college admission increases, and the impacts for older college graduates are either small or not statistically significant.

In columns (2) and (4) of Table 3A, we use the number of new college graduates as a measure of the college expansion and re-estimate the impacts of college expansion on unemployment. We observe similar coefficients and pattern as shown in Table 6 that the college expansion increased the relative probability of unemployment for both young and old college graduates, but the impact is greater for young graduates than older graduates.

In summary, our results suggest the college expansion has significantly reduced the advantage in terms of the likelihood of employment for both 4-year and 2- or 3-year college graduates relative to people with high school degrees or less education. The negative impact due to college expansion is greater for younger people than for older people in terms of the percentage decrease in the relative advantage of employment relative to high school graduates. These results further support our explanation that young college graduates are more easily to experience a substitution effect than older college graduates in response to a positive supply shock of young skilled labor, affecting not only the relative income between skilled and unskilled workers but it also their relative probability of employment.

Similar to what we analyze on income, we use the 2SLS method to identify the impact of a positive shock due to the college expansion on people's unemployment in appendix section A1 and Table 7A, and we also observe similar patterns as shown in Table 6.

5.1.3 Impact of the College Expansion on Tasks of First Job

In this section, we study the impact of the college expansion on the skills used in the first jobs individuals obtain, which provides another perspective of how the college expansion affects young workers. We follow previous studies that have considered changes in cognitive and manual tasks required in jobs.

A job that requires intensive cognitive skill usage is more likely to be filled by college workers and is compensated with higher income since college graduates have a comparative advantage in dealing with cognitive tasks, and a job which has more manual tasks is more likely to be filled by noncollege workers since they have a comparative advantage in dealing with manual tasks. When an increased number of college graduates enter the job market, it may be harder for them to find jobs that use their cognitive ability. A decrease in quality of college education due to the increase in college admission also contributes to a reduction in skills learned from colleges, which may therefore decrease the demand for new college graduates. As a result, new college graduates may end up taking jobs that use less cognitive skills.

We use the 2003, 2006, 2008 CGSS data to study the impact of college expansion on the cognitive and manual task scores for the first job, using the method described in Almeida (2018). The CGSS survey for these years[18] provides the information of ISCO-88 codes for respondents' occupations. We convert the occupation codes to the U.S. Standard Occupational Classification (SOC) 2010 using a crosswalk provided by the Institute for Structural Research (IBS)[19]. After the conversion process, we are able to merge the CGSS data with the O*NET evaluation data for each occupation. In the evaluation data, there are "importance scores" from 1 (least important) and 5

[18] Although CGSS 2005 has occupational information for the first job, it is not coded using the ISCO-88 standard.
[19] See http://ibs.org.pl/en/resources/occupation-classifications-crosswalks-from-onet-soc-to-isco/ for more detail.

(most important) for 52 abilities associated with an occupation. Since, in the O*NET data, the importance scores for tasks in an occupation do not change across time, the variation in scores is due to people having different occupations. By connecting CGSS to O*NET, we assume occupations in China have similar activities or at least a similar ranking of tasks as the same occupations in the U.S.

Following Almeida (2018), we group the tasks in each job into four categories: manual precision tasks, other manual tasks, cognitive analytical tasks, and cognitive-communication tasks (Figure 11). We average the importance scores within each category of tasks for every job. We assume that higher average scores for a task in an occupation imply that people within an occupation with particular tasks are more likely to apply corresponding skills in their work.

Normally, people with college degrees are more likely to have jobs that require cognitive skills and less likely to have jobs requiring high scores on manual tasks. However, a large positive shock in the supply of skilled labor may temporarily make it hard for college graduates to find jobs that fully employ their cognitive skills. If the vacancies of jobs that require lower levels of

Manual Tasks		Cognitive Tasks	
Precision	Other	Analytical	Communication
Arm-Hand Steadiness	Reaction Time	Fluency of Ideas	Oral Comprehension
Manual Dexterity	Wrist-Finger Speed	Originality	Written Comprehension
Finger Dexterity	Speed of Limb Movement	Problem Sensitivity	Oral Expression
Control Precision	Static Strength	Deductive Reasoning	Written Expression
Multilimb Coordination	Explosive Strength	Inductive Reasoning	Speech Recognition
Response Orientation	Dynamic Strength	Information Ordering	Speech Clarity
Rate Control	Trunk Strength	Category Flexibility	
	Stamina	Mathematical Reasoning	
	Extent Flexibility	Number Facility	
	Dynamic Flexibility	Memorization	
	Gross Body Coordination	Speed of Closure	
	Gross Body Equilibrium	Flexibility of Closure	
	Near Vision	Perceptual Speed	
	Far Vision	Spatial Orientation	
	Visual Color Discrimination	Visualization	
	Night Vision	Selective Attention	
	Peripheral Vision	Time Sharing	
	Depth Perception		
	Glare Sensitivity		
	Hearing Sensitivity		
	Auditory Attention		
	Sound Localization		

Figure 11 Task Categories Shown in Almeida (2018)

cognitive skills are not yet be filled, college graduates may end up with these jobs. Since the return to cognitive skill is on average greater than the return to manual skills, this mechanism provides another explanation of the reduction in the college premium. Whereas the CGSS does not have information for earnings on first jobs, it asked people the detailed types for their first jobs. In the previous section, we have shown that the effect of college expansion on income and the probability of unemployment is greater for young college graduates than older college graduates. Therefore, in this section, we narrow our analysis on people's first jobs, which were most likely obtained at their earlier age and after finishing their highest education.

Whereas the CGSS does not have information for earnings on first jobs, it asked people the detailed types for their first jobs. In the previous section, we have showed that the effect of college expansion on income and the probability of unemployment is greater for young college graduates than older college graduates. Therefore, in this section, we narrow our analysis on people's first jobs, which were most likely obtained in their earlier age and after finishing their highest education.

We use $Tscore_{i,j,p,t}$ as the dependent variable in equation (1) denoting the average scores for a task group j of the first job for respondent *i* who works in province *p* in year t. We exclude respondents who received their college degree after the year when they started their first job (211 observations, 11% of all observations). Table 7 reports the estimation results for equation (1). Presumably, this is tied to the year of the first job, which is different from prior estimation, which used the current income year.

As can be seen from the table, the first jobs for 4-year and 2- or 3-year college degree graduates demand higher levels of cognitive skills and lower levels of manual skills than jobs of those with high school degrees or below. For example, the average cognitive analytical score of

first jobs for 4-year college graduates is 0.05 more than those for people in the same provinces who have high school degrees, which is approximate 0.63 of its standard deviation.

The college expansion decreases the cognitive scores of the first jobs for 4-year college graduates relative to high school graduates. As the number of students admitted to college increase by 0.1 million, the difference of analytical scores between 4-year college graduates and high school graduates decreases by 0.2 standard deviations, and the difference of communicative score goes down by 0.14 standard deviation. Although the relative scores of manual precision and other manual tasks for college graduates increase as college admission increases, the results are not statistically significant. Another interesting finding is that the college expansion decreases the average manual-precision scores of first jobs for people with high school degrees. As the number of college admission increase by 0.1 million, the manual-precision score for the first jobs of high school graduates decreases by 0.26 standard deviation.

In summary, college graduates are losing their advantage over high school graduates in landing jobs requiring higher cognitive skills due to the college expansion. We have identified a possible channel of how the college expansion may reduce the college premium. It reduced the chances for college graduates to find a higher-paid job, which therefore decreased their average income relative to high school graduates. In Table 4A, we estimate the return to cognitive and manual scores among full-time workers, controlling for their educational levels, gender, age, age squared, province fixed effect, and year fixed effect. As can be seen from the table, jobs with higher cognitive scores have a higher average income. In the short term, the vacancies for higher-paid jobs are limited thus some college graduates cannot choose these as their first jobs. Instead, they may be willing to accept lower-paid jobs that require lower levels of cognitive skill. The

college premium reduces correspondingly due to the changes in the occupational distribution for college graduates.

6 Conclusion

The college expansion that began in 1999 has significantly enlarged the skilled labor force in China within a short period. It thus created a positive supply shock of skilled labor which substantially changed labor market behaviors and outcomes. In this paper, we explore short run labor market responses to the college expansion, as well as the market responses to the positive supply shock brought about by the college expansion. We estimate the impact of college expansion on the college premium, unemployment, and skills used in first jobs. We also use the number of students admitted to college as an instrument of supply shock and study its impacts on the college premium and unemployment.

Our results suggest that the college expansion has significantly reduced the college premium for young college graduates (age 23-29) in the short run. A 0.1 million increase in all college admissions (standard colleges and adult colleges) reduces the log college premium for young people by 9 log percentage points. However, we do not observe significant impacts of college expansion on the college premium for older workers (age 30-65). Consistent with other studies, people who just graduated from colleges are more likely to suffer a substitution effect than older workers. We also identify a decrease in the college premium within industry and occupation among young workers due to the college expansion.

College graduates are also more likely to be unemployed in the short run as the college admissions increase. Our results suggest that the college expansion significantly increases the

probability of unemployment for both young and old college graduates. The impact of college expansion on probability for young college graduates is greater than older college graduates, which further supports the substitution effect hypothesis.

The college expansion also reduces the likelihood of college graduates finding their first jobs which require intensive use of cognitive skills. Therefore, the college expansion not only decreased the college premium within occupation or industry, but also implies that new college graduates are more likely to accept occupations requiring lower levels of cognitive skills and lower average salaries.

The results in paper suggest that a positive supply shock on skilled labor bring a negative impact to younger college graduates, but has less negative impact on older college graduates in the short term.

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Tables

Table 1 Annual Increase Rate for Number of Employed Workers and Number of College Graduate Workers

	Total Employed Workers (Annual log change *100)	**Employed College-Educated Workers (Annual log change *100)**
Panel A		
By Age Group		
20 – 24	*0.60*	*12.20*
25 - 29	*1.11*	*11.36*
30 – 34	*-1.74*	*8.59*
35 – 39	*-2.73*	*6.31*
40 – 44	*2.44*	*8.71*
45 – 49	*2.41*	*9.02*
50 – 54	*-0.07*	*7.94*
55 – 59	*2.88*	*7.04*
Panel B		
By Region		
Eastern	*2.30*	*10.98*
Central	*0.29*	*10.01*
West	*-6.00*	*9.98*
Northeastern	*-3.00*	*7.01*

This table reports the logarithmic annual growth rate in 1996-2015 for the total number of employed workers and the number of college graduate workers by age group and work region. The logarithmic annual growth rate is estimated by regressing log number of employed workers or workers with college degrees on a linear time trend.

Table 2 Annual Increase Rate for Number of Employed Workers and Number of College Graduate Workers (Urban)

	Total Employed Workers (Annual log change *100)		**Employed College Graduate Workers (Annual log change *100)**	
	Male	**Female**	**Male**	**Female**
Panel A				
By Occupation				
Manager, Professional	4.34	7.19	6.58	9.57
Clerk, Business Personnel	6.71	5.42	10.43	10.13
Farmer, Production Worker	4.90	1.63	18.64	15.02
Panel B				
By Industry				
Agricultural	-4.84	-4.92	0.76	2.83
Manufacturing	6.20	4.00	12.30	12.22
Service	3.85	4.51	5.27	7.31

This table reports the logarithmic annual growth rate in 1996-2015 for the total number of employed workers and the number of college graduate workers in urban areas by occupation and industry. The logarithmic annual growth rate is estimated by regressing log number of employed workers or workers with college degrees on a linear time trend.

Table 3 Descriptive Statistics of Sample from CGSS 2003-2015 (Urban)

	CGSS 2003 (N=2,926)		**2005-2008 (N=8,116)**		**2010-2015 (N=9,374)**	
	Sample Mean (SD)	**Census 2000 Mean**	**Sample Mean (SD)**	**Census 2010 Mean**	**Sample Mean (SD)**	**Census 2010 Mean**
Male	0.51 (0.50)	0.51	0.47 (0.45)	0.51	0.50 (0.50)	0.51
Age	38.99 (14.33)	32.37	40.77 (13.27)	35.37	41.65 (14.24)	35.37
College	0.12 (0.32)	0.12	0.16 (0.33)	0.17	0.24 (0.33)	0.17
Region						
Eastern	0.38	0.42	0.41	0.45	0.49	0.45
Central	0.23	0.24	0.22	0.23	0.19	0.23
Western	0.28	0.26	0.25	0.22	0.18	0.22
Northeastern	0.11	0.09	0.12	0.09	0.14	0.09
Annual income (¥)	10,592 (13,976)	10,834	18,776 (17,620)	20,021	42,362 (50,902)	45,383

This table reports the mean and standard deviations of basic demographic information, including male, age, college degree attainment, annual income, proportion of resident region for urban sample in the CGSS 2003-2015 by survey period.

Table 4 Statistics for Labor Market Variables in CGSS 2003-2015 (Urban)

	CGSS 2003 (N=2,926)		2005-2008 (N=8,116)		2010-2015 (N=9,374)	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Fraction of College Workers						
20-29	0.18	0.19	0.34	0.35	0.58	0.57
	(0.55)	(0.50)	(0.42)	(0.42)	(0.53)	(0.48)
30-65	0.15	0.12	0.20	0.17	0.23	0.18
	(0.33)	(0.28)	(0.35)	(0.33)	(0.41)	(0.37)
College Premium	**Income in 2002**		**Income in 2004-2007**		**Income in 2009-2014**	
20-29	1.81	3.13	1.52	1.70	1.66	2.21
30-65	1.81	2.14	1.60	2.14	2.41	3.06
% of Manager, Professional, Technician						
(i) College & above						
20-29	0.60	0.51	0.50	0.45	0.58	0.62
	(0.48)	(0.47)	(0.40)	(0.40)	(0.55)	(0.48)
30-65	0.68	0.69	0.49	0.53	0.64	0.66
	(0.33)	(0.30)	(0.43)	(0.41)	(0.47)	(0.44)
(ii) High school & below						
20-29	0.06	0.20	0.21	0.18	0.19	0.20
	(0.38)	(0.55)	(0.38)	(0.36)	(0.40)	(0.39)
30-65	0.10	0.24	0.15	0.15	0.15	0.13
	(0.29)	(0.38)	(0.32)	(0.32)	(0.35)	(0.33)

This table reports the mean and standard deviations for fraction of college graduates among employed workers, college premium, and percentage of manager, professional or technician among people with college degrees and people with less than college degrees. The standard deviations are shown in the parentheses.

Table 5 Regression Results of the College Expansion on Annual Income

	Age 23-29				Age 30-65			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Col	0.476***	0.486***	0.438***	0.435***	0.628***	0.598***	0.569***	0.574***
	(0.036)	(0.040)	(0.046)	(0.040)	(0.062)	(0.027)	(0.026)	(0.026)
Lcol	0.172***	0.190***	0.149***	0.154***	0.349***	0.343***	0.335***	0.334***
	(0.036)	(0.037)	(0.035)	(0.035)	(0.032)	(0.020)	(0.020)	(0.020)
Lhs	-0.093*	-0.094**	-0.158***	-0.153***	-0.260***	-0.268***	-0.286***	-0.287***
	(0.048)	(0.047)	(0.051)	(0.040)	(0.028)	(0.016)	(0.016)	(0.016)
$\widetilde{\mathbf{AD}_{\mathbf{t-4}}}$	0.262***	0.255***	-0.002	-0.065	0.253***	0.191***	-0.014	-0.035
	(0.033)	(0.067)	(0.043)	(0.039)	(0.024)	(0.014)	(0.020)	(0.025)
Col $*\ \widetilde{\mathbf{AD}_{\mathbf{t-4}}}$	-0.086***	-0.096***	-0.088***	-0.088***	-0.009	0.043**	0.040**	0..038**
	(0.016)	(0.024)	(0.026)	(0.029)	(0.026)	(0.019)	(0.019)	(0.019)
Lcol $*\ \widetilde{\mathbf{AD}_{\mathbf{t-4}}}$	-0.005	-0.022	-0.020	-0.019	-0.010	0.012	0.003	0.006
	(0.016)	(0.022)	(0.021)	(0.027)	(0.026)	(0.015)	(0.015)	(0.015)
Lhs $*\ \widetilde{\mathbf{AD}_{\mathbf{t-4}}}$	-0.050**	-0.001	0.006	-0.003	-0.042***	-0.007	-0.005	-0.005
	(0.022)	(0.040)	(0.037)	(0.029)	(0.013)	(0.012)	(0.012)	(0.012)
$\boldsymbol{X_i}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\boldsymbol{\delta_p}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\widetilde{\boldsymbol{TL}}$	No	Yes	Yes	Yes	No	Yes	Yes	Yes
$\mathbf{Z_{p,t}}$	No	No	Yes	Yes	No	No	Yes	Yes
$\boldsymbol{\delta_t}$	No	No	No	Yes	No	No	No	Yes
$\boldsymbol{Ret_{p,t}}$	No	No	No	Yes	No	No	No	Yes
N	3,735	3,735	3,735	3,735	16,852	16,852	16,852	16,852
$\mathbf{R^2}$	0.3364	0.3385	0.3710	0.3838	0.3863	0.3879	0.4054	0.4090

This table reports the regression results for equation (1). The dependent variable is the log of annual income for full-time urban employed respondents. $\widetilde{\mathbf{AD}_{\mathbf{t-4}}}$ is the provincial college admission (both 2- or 3-year and 4-year) in *t*-4, centering around its mean level across all provinces and all years. ***Col, Lcol, Lhs*** are dummies for people with 4-year college degrees, people with 3-year college degrees, and people with less than high school education, respectively. The regression excludes people with more than 4-year college education. Columns (1)-(4) list estimates for young workers (23-29-year-olds), and columns (5)-(8) list estimates for older workers (30-65-year-olds). We control personal demographic variables X_i (age, age squared and gender), and province fixed effect δ_p in columns (1) and (5), controlling changes in overall labor force and its interaction with each education dummies $\widetilde{TL}$ in columns (2) and (6), and adding provincial economic and demographic variables $Z_{p,t}$ (log GDP, fixed capital investment, import and export, percentage of male, percentage of urban population) in columns (3) and (7), and including year fixed effect δ_t and adding imputed number of retired workers with college degrees $\boldsymbol{Ret_{p,t}}$ in columns (4) and (8). Standard errors reported in this table are clustered at province level. The t-statistics are estimated using wild cluster bootstrap method (boottest).

Table 6 Regression Results of the College Expansion on Unemployment

	Age 23-29				Age 30-65			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Col	-0.066***	-0.079***	-0.070***	-0.063***	-0.102***	-0.109***	-0.090***	-0.081***
	(0.012)	(0.012)	(0.014)	(0.014)	(0.009)	(0.009)	(0.009)	(0.009)
Lcol	-0.075***	-0.086***	-0.082***	-0.081***	-0.100***	-0.101***	-0.097***	-0.102***
	(0.014)	(0.011)	(0.012)	(0.012)	(0.009)	(0.010)	(0.010)	(0.009)
Lhs	0.078***	0.075***	0.078***	0.076***	0.081***	0.084***	0.083***	0.080***
	(0.021)	(0.020)	(0.020)	(0.020)	(0.009)	(0.009)	(0.008)	(0.008)
$\widetilde{\mathbf{AD}_{\mathbf{t-4}}}$	-0.051***	-0.067***	-0.028	-0.011	-0.078***	-0.066***	0.017	0.015
	(0.008)	(0.016)	(0.019)	(0.019)	(0.013)	(0.020)	(0.016)	(0.011)
Col $*$ $\widetilde{\mathbf{AD}_{\mathbf{t-4}}}$	0.025***	0.042***	0.041***	0.037***	0.026***	0.031***	0.025***	0.018***
	(0.006)	(0.009)	(0.010)	(0.010)	(0.004)	(0.006)	(0.005)	(0.006)
Lcol $*$ $\widetilde{\mathbf{AD}_{\mathbf{t-4}}}$	0.026***	0.049***	0.049***	0.049***	0.026***	0.030***	0.032***	0.035***
	(0.008)	(0.009)	(0.009)	(0.009)	(0.005)	(0.008)	(0.007)	(0.007)
Lhs $*$ $\widetilde{\mathbf{AD}_{\mathbf{t-4}}}$	-0.025**	-0.049***	-0.049***	-0.049***	-0.029***	-0.044***	-0.041***	-0.043***
	(0.010)	(0.016)	(0.016)	(0.016)	(0.004)	(0.007)	(0.007)	(0.007)
$\boldsymbol{X_i}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\boldsymbol{\delta_p}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\widetilde{\mathbf{TL}}$	No	Yes	Yes	Yes	No	Yes	Yes	Yes
$\mathbf{Z_{p,t}}$	No	No	Yes	Yes	No	No	Yes	Yes
$\boldsymbol{\delta_t}$	No	No	No	Yes	No	No	No	Yes
$\boldsymbol{Ret_{p,t}}$	No	No	No	Yes	No	No	No	Yes
N	5,334	5,334	5,334	5,334	24,738	24,738	24,738	24,738
$\mathbf{R^2}$	0.0702	0.0787	0.0843	0.0954	0.1116	0. 1129	0.1337	0.1537

This table reports the regression results for equation (1). The dependent variable is the dummy for unemployment for urban respondents. $\widetilde{\mathbf{AD}_{\mathbf{t-4}}}$ is the provincial college admission (both 2- or 3-year and 4-year) in *t*-4, centering around its mean level across all provinces and all years. ***Col, Lcol, Lhs*** are dummies for people with 4-year college degrees, people with 3-year college degrees, and people with less than high school education, respectively. The regression excludes people with more than 4-year college education. Columns (1)-(4) list estimates for young workers (23-29-year-olds), and columns (5)-(8) list estimates for older workers (30-65-year-olds). We control personal demographic variables X_i (age, age squared and gender), and province fixed effect δ_p in columns (1) and (5), controlling changes in overall labor force and its interaction with each education dummies $\widetilde{TL}$ in columns (2) and (6), and adding provincial economic and demographic variables $Z_{p,t}$ (log GDP, fixed capital investment, import and export, percentage of male, percentage of urban population) in columns (3) and (7), and including year fixed effect δ_t and adding imputed number of retired workers with college degrees $Ret_{p,t}$ in columns (4) and (8). Standard errors reported in this table are clustered at province level. The t-statistics are estimated using wild cluster bootstrap method (boottest).

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Table 7 Regression Results of the College Expansion on Task Scores of First Job

	Cognitive Analytical	**Cognitive Communicative**	**Manual Precision**	**Manual Others**
Col	0.045***	0.294***	-0.181***	-0.063***
	(0.004)	(0.019)	(0.015)	(0.005)
Lcol	0.032***	0.225***	-0.141***	-0.054***
	(0.004)	(0.027)	(0.018)	(0.005)
Lhs	-0.035***	-0.216***	0.116***	0.034***
	(0.006)	(0.031)	(0.020)	(0.006)
$\widetilde{\mathbf{AD_{t-4}}}$	0.011	0.040	-0.066***	-0.009
	(0.007)	(0.031)	(0.022)	(0.006)
$\mathbf{Col} * \widetilde{\mathbf{AD_{t-4}}}$	-0.015***	-0.051*	0.018	-0.010
	(0.005)	(0.028)	(0.022)	(0.006)
$\mathbf{Lcol} * \widetilde{\mathbf{AD_{t-4}}}$	-0.007	-0.018	0.019	-0.002
	(0.006)	(0.026)	(0.021)	(0.006)
$\mathbf{Lhs} * \widetilde{\mathbf{AD_{t-4}}}$	0.004	0.003	0.014	-0.001
	(0.008)	(0.032)	(0.028)	(0.006)
$\boldsymbol{X_i}$	Yes	Yes	Yes	Yes
$\boldsymbol{\delta_p}$	Yes	Yes	Yes	Yes
$\widetilde{\mathbf{TL}}$	Yes	Yes	Yes	Yes
$\mathbf{Z_{p,t}}$	Yes	Yes	Yes	Yes
$\boldsymbol{\delta_t}$	Yes	Yes	Yes	Yes
$\boldsymbol{Ret_{p,t}}$	Yes	Yes	Yes	Yes
Mean	0.452	3.447	1.212	0.471
SD	0.072	0.367	0.251	0.075
N	1,705	1,705	1,705	1,705
$\mathbf{R^2}$	0.2203	0.2758	0.2038	0.2318

This table reports the regression results for equation (1). The dependent variable is the average score of a skill *j* used in the first job of the respondent in 1998-2008. We exclude respondents who received their college degree after the year when they started their first job. All of the variables listed in the table have the same definition as shown in Table 5 and Table 6. To conduct this analysis, we use the CGSS 2003, 2006, 2008. We control the provincial economic and demographic variables, province fixed effect, changes in overall labor force and its interaction with each education dummies, year fixed effect, and imputed retired workers with college degree in province *p* in year *t.* Standard errors reported in this table are clustered at province level. The t-statistics are estimated using wild cluster bootstrap method (boottest).

Figures

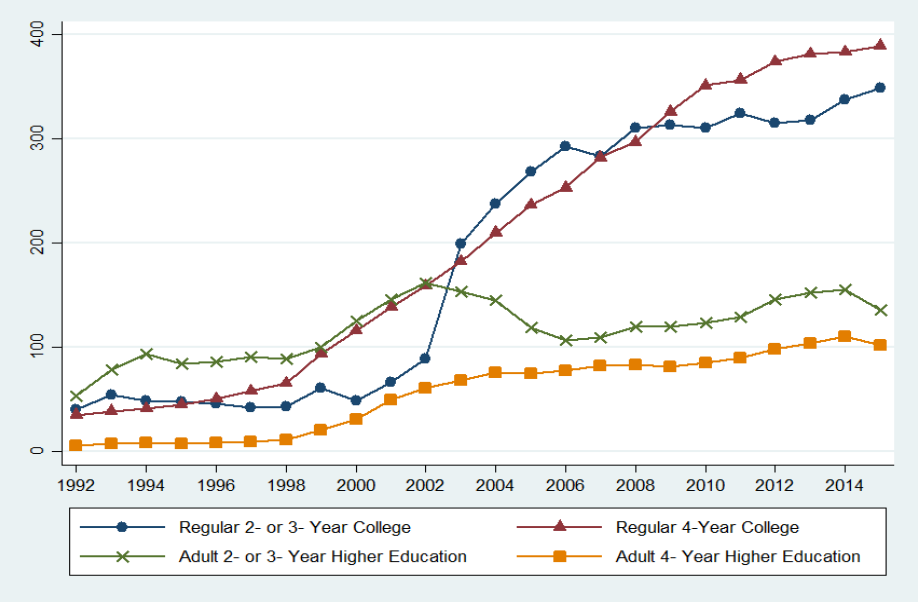

Figure 1 Number of Students Admitted to Regular and Adult 4-Year and 2- or 3-Year Higher Education Institutions in 1992-2015 (Unit: 1,000; Source: Educational Statistics Yearbook of China)

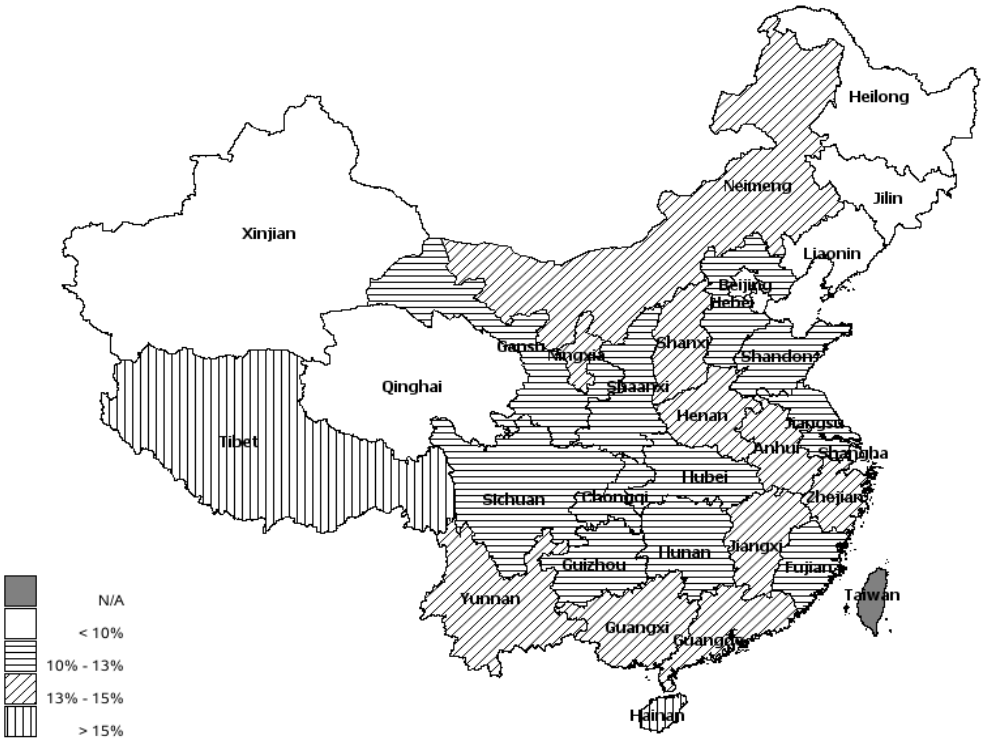

Figure 2 Average Annual Increase Rate of College Admissions, 1998-2012 (Source: Educational Statistics Yearbook of China)

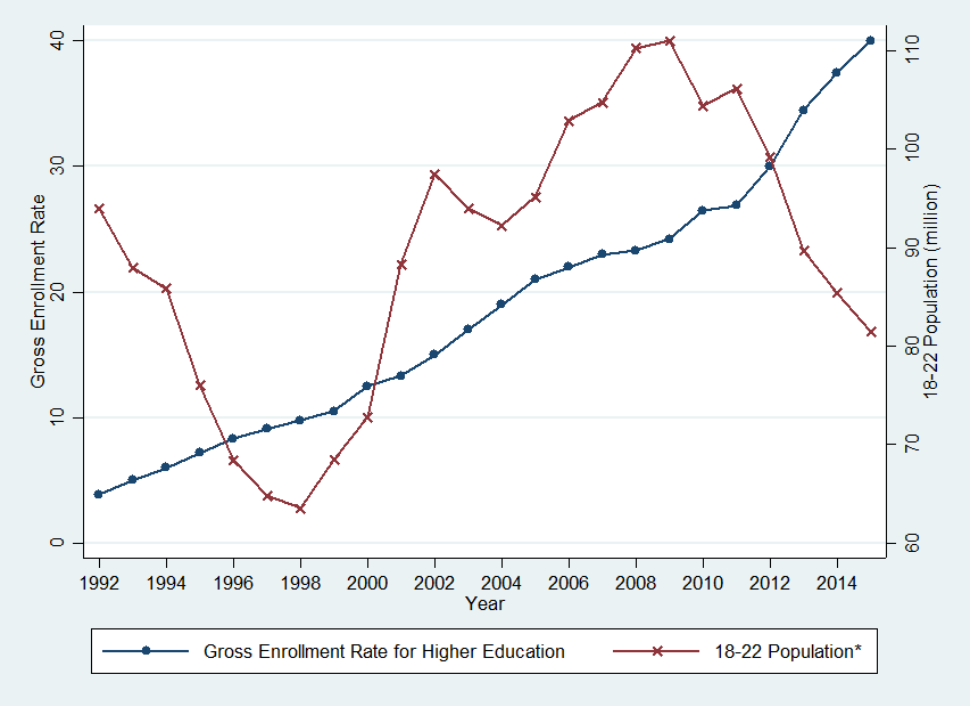

Figure 3 Gross College Enrollment Ratio in 1992-2015 (Source: Educational Statistics Yearbook of China) *Notes:* The 18-22 Population on the Figure 2 is derived using the number of in-school higher education students, divided by gross enrollment rate for higher education.

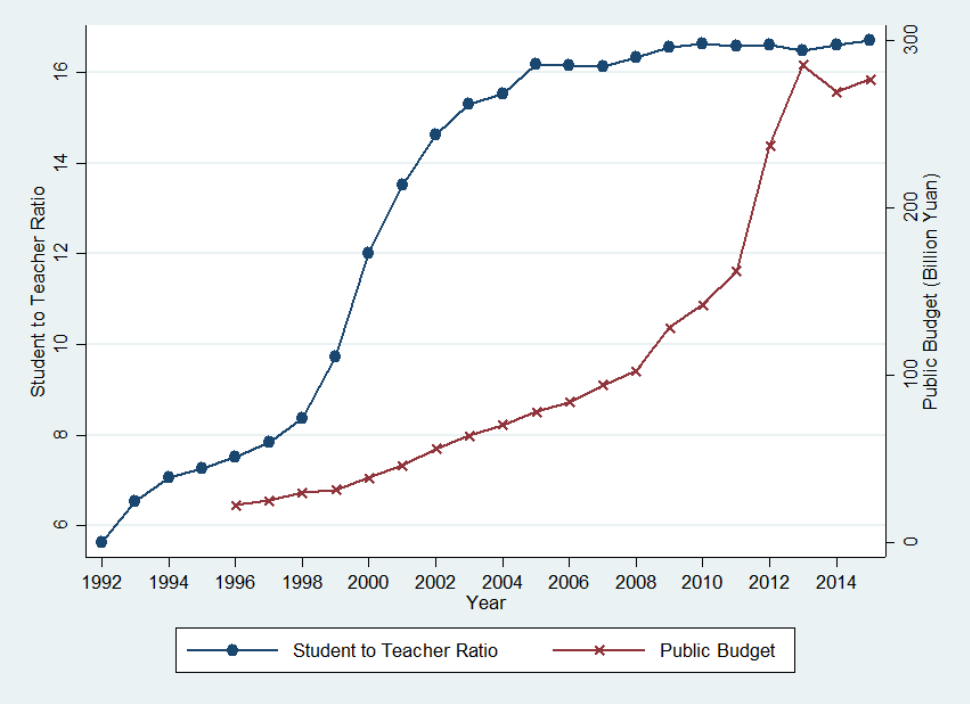

Figure 4 National Public Budget for Regular College Education (1996 Yuan: Billion) and Ratio of Number of Students to Number of Teachers in Regular Colleges (Source: Educational Statistics Yearbook of China)

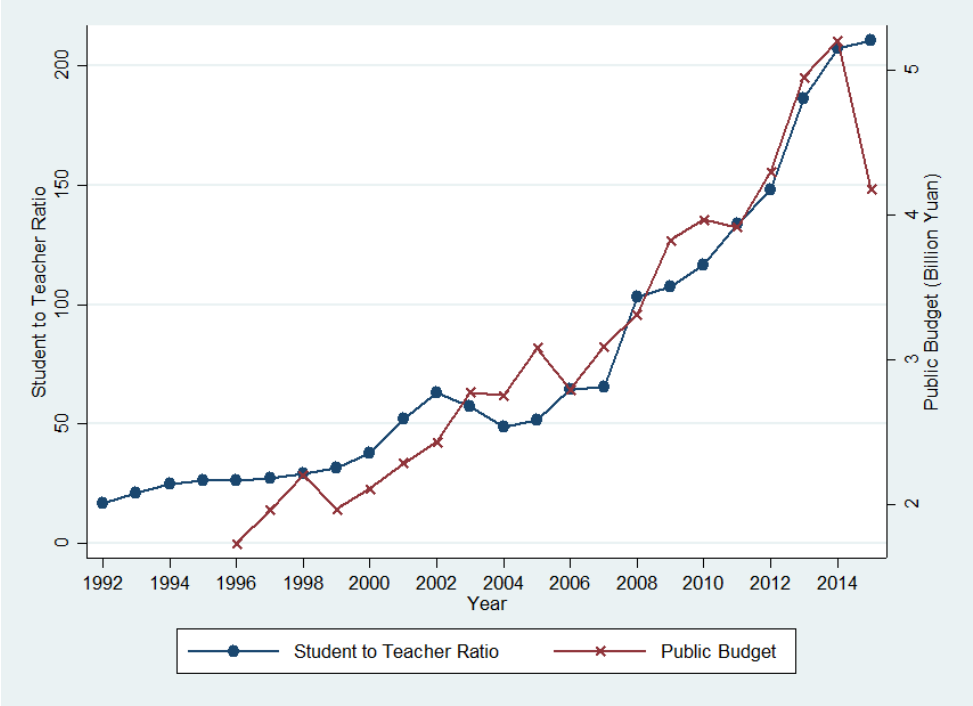

Figure 5 National Public Budget on Adult College Education (1996 Yuan: Billion) and Ratio between Number of Students and Number of Teachers in Adult Colleges (Source: Educational Statistics Yearbook of China)

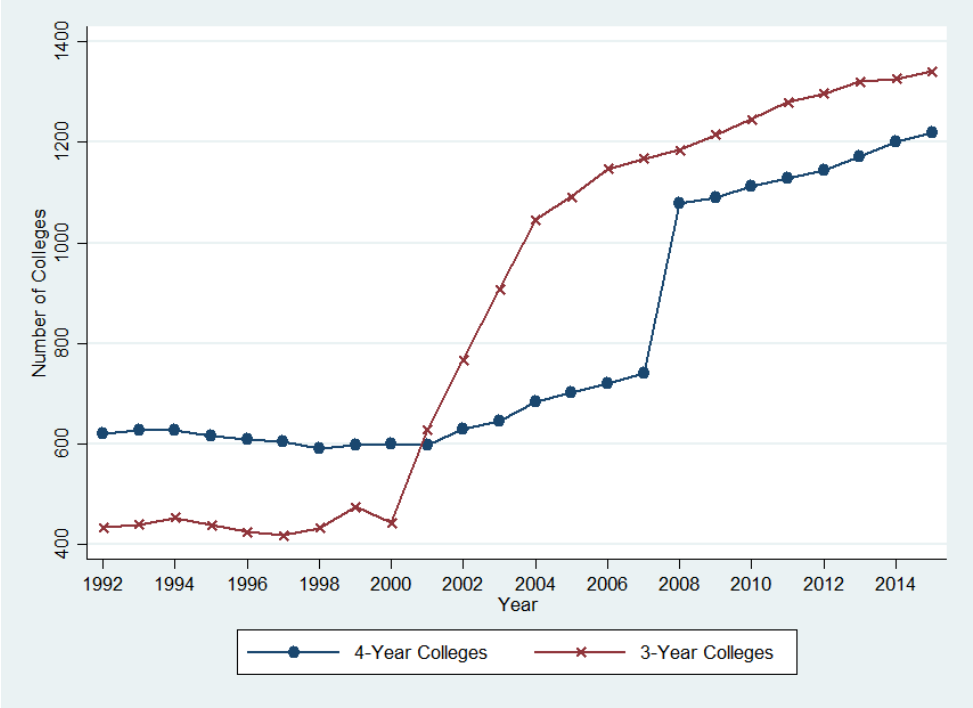

Figure 6 Number of Colleges by Study Years *Notes:* The graph shows the number of 4-year colleges and number of 2 or 3-year colleges in China (Source: Educational Statistics Yearbook of China)

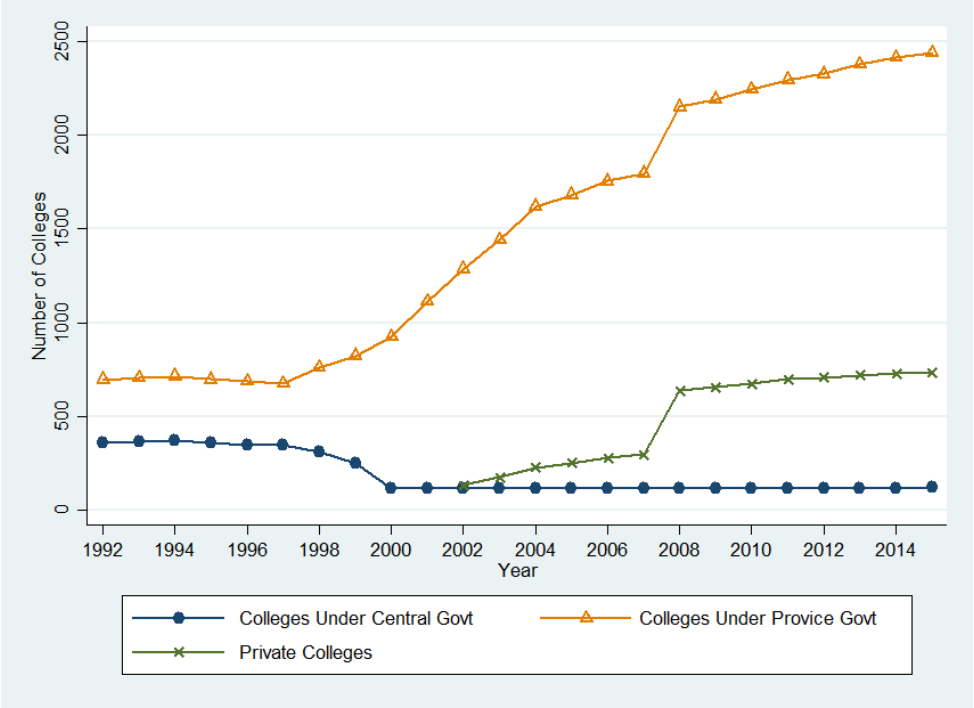

Figure 7 Number of Colleges by Control Agency *Notes:* The graph shows the number of colleges under central government, under local agencies, and private colleges in China. Private colleges are under province government. Due to lack of statistics or private colleges in the education yearbooks, we plot the number of private colleges since 2002. The number of colleges under province in the graph also includes the number of private colleges. The sum of the number of colleges under central government and province government is equal to the sum of 4-year and 2 or 3-year colleges in Figure 6. (Source: Educational Statistics Yearbook of China)

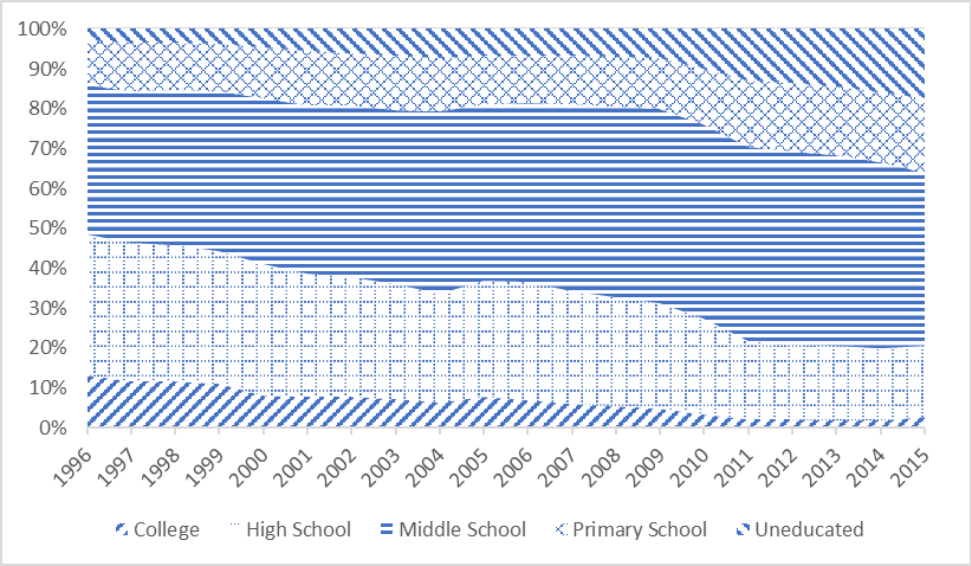

Figure 8 Educational Distribution for Employed Workers in 1996-2015 (Source: China Labor Statistical Yearbook)

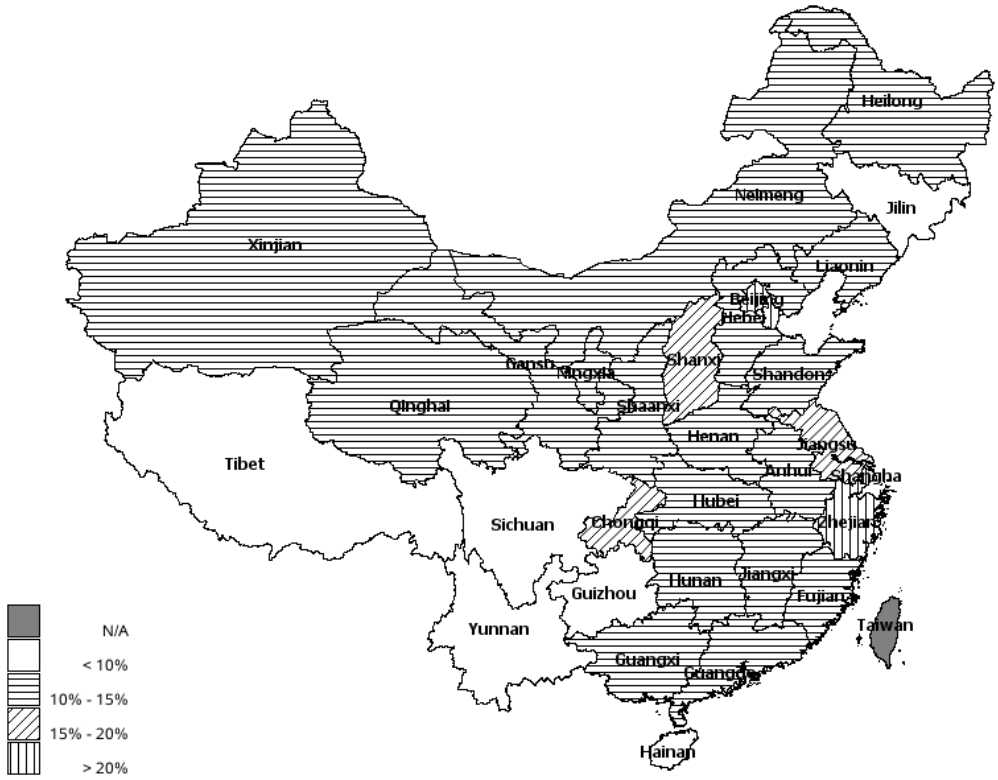

Figure 9 Change of Proportional Rates of College Workers in China from 1998 to 2012 (Source: China Labor Statistical Yearbook)

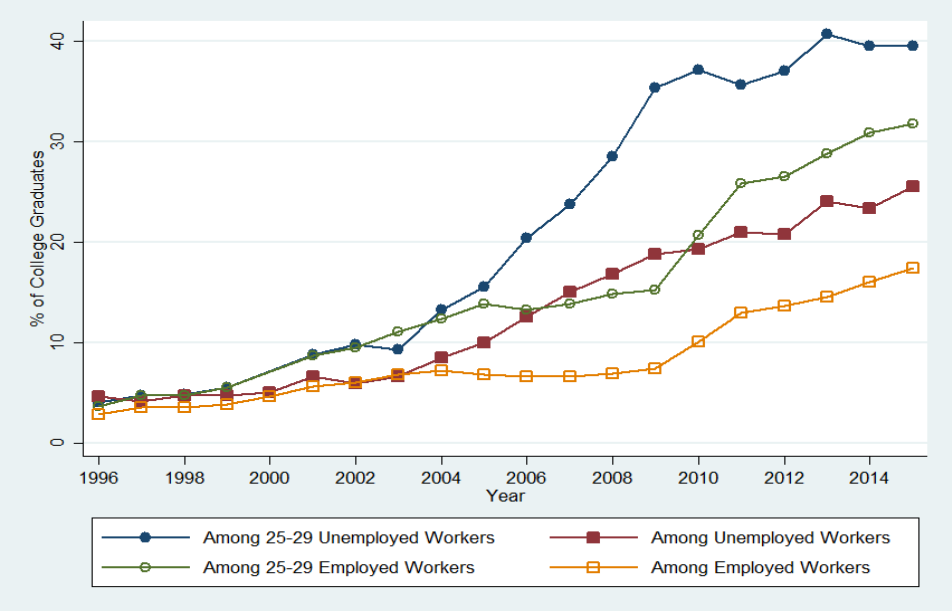

Figure 10 Proportions of College Graduates Among Employed and Unemployed Workers (Source: China Labor Statistical Yearbook) *Notes*: This figure plots the percentage of college graduates among urban unemployed workers (the solid-square line) and the percentage of college graduates among urban employed workers (the hollow-square line); as well as percentage of college graduates among 23-29-year-olds urban unemployed workers (the solid-circle line) and percentage of college graduates among urban 23-29-year-olds unemployed workers (the hollow-circle line).

Appendix

A1. Impact of the Skilled Labor Supply Shock on Labor Market Outcomes Using 2SLS Method

In order to separate the effect of changes in supply from changes in demand, we employ the number of students admitted to colleges as an instrument for the supply shock. The changes in number of skilled workers in a province can be explained by changes in both skilled labor supply and demand. When supply increases, more skilled workers enter labor market given the same wage levels. When demand increases, companies are willing to recruit more skilled workers at any given wage level.

Therefore, using an instrument which measures external changes in supply of skilled labor can help to separate the changes in supply of skilled labor from the changes in skilled labor caused by changes in demand. We can also identify the impact of the college expansion on labor outcomes through increasing the number of available skilled workers by using the IV method. Therefore, we study the impact of a positive supply shock on college premium and unemployment using 2SLS method.

In our analysis using the college admissions as an instrument for the supply shock, we employ a 2SLS method. In the first stage, we check whether the number of college admissions in each province and year is relevant to the positive supply change in skilled labor. We thus use the following model:

$$\Delta Col_{p,t} = \beta AD_{p,t-4} + \boldsymbol{\gamma}' \boldsymbol{Z_{p,t-4}} + \boldsymbol{\rho}' \boldsymbol{Z_{p,t}} + \delta_p + \delta_t + \varepsilon_{p,t} \qquad (2)$$

$\Delta Col_{p,t}$ denotes the change in skilled labor in year *t* and in province *p*, which is the difference between skilled labor in year *t* and *t*-1 ($\Delta Col_{p,t} = Col_{p,t} - Col_{p,t-1}$). $AD_{p,t-4}$ is our instrument for the supply shock, which is the number of students admitted to college in year *t-4* in province *p*. $\boldsymbol{Z_{p,t-4}}$ and $\boldsymbol{Z_{p,t}}$ represents time-variant provincial demand-side factors, including the provincial log of GDP, the log of fixed capital investment, and the log of the imports and exports at year *t*-4 in province *p*, and at year *t* in province *p*, respectively. Including $\boldsymbol{Z_{p,t-4}}$ helps us to control the impact of previous demand change on both the college admissions and the current supply of skilled labor. Including $\boldsymbol{Z_{p,t}}$ helps to control the impact of the concurrent demand on the current supply of skilled labor. δ_p is the province fixed effect and δ_t is the year fixed effect. The provincial data for number of students admitted to college, GDP, import, export and fixed capital investment are obtained from the statistical yearbooks for the 31 provinces[20] in mainland China from 1998 to 2015.

The changes in number of skilled workers in a province can be explained by changes in both skilled labor supply and demand. When supply increases, more skilled workers enter labor market given the same wage levels. When demand increases, companies are willing to recruit more skilled workers at any given wage level.

To measure the raw change in skilled labor in a province *p* of year *t*, $\Delta Col_{p,t}$, we use the statistics reported in the Chinese Statistical Yearbook and Chinese Educational Statistical Yearbook 1998-2015. The Chinese Statistical Yearbook surveyed about 1% of total population in

[20] We imputed the data for Chongqing and Sichuan provinces in 1996 because Chongqing was separated from Sichuan province and became as a municipality (a type of province) since 1997. To impute 1996's values for Chongqing and Sichuan, we calculated the proportions of Sichuan and Chongqing in their summation values of 1997 for each of the variables in equation (1) and multiply these proportions with the 1996 Sichuan (which included Chongqing in that year) data.

each year except for 2000 and 2010. In 2000 and 2010, the government conducted census survey which covered all population except for servicemen.

The full procedure to obtain $\Delta Col_{p,t}$ from the yearbook is as follow: First, we calculate the percentage in college or with at least some college education among people older than 6 in each province and year from 1998-2015, $\%Col_{p,t}$, using the reported tables "Population by Sex, Educational Level and Region" from the yearbooks. Second, we obtain the percentage of people older than 6 in each province and year, $\%Age6_{p,t}$, using the reported tables "Household, Population and Sex Ratio by Region" from the yearbooks. Next, we multiple the resident population in each province and year[21], $Pop_{p,t}$, with the percentage of population older than 6 and percentage of college graduates, $(\%Age6_{p,t} * \%Col_{p,t})$, to obtain the number of college attendees and those who attended at least some college in each province and year (we will call these people "college attendees").

Then, we subtract the number of people enrolling in colleges in each province and year, $Enr_{p,t}$ from the number of college attendees[22] since it changed substantially since the college expansion. We then obtain the information of labor participation rate for college attendees older than 16 years old, $\%LPC_{p,t}$,; as well as the number of people enrolling in colleges as a fraction of number of college attendees outside of labor force, $\%Enr_{p,t}$.[23] We assume the labor participation rate for college attendees, and the ratio between the college attendees outside of labor force other

[21] This data is obtained from the tables "Total Population and Birth Rate, Death Rate and Natural Growth Rate by Region" from the yearbooks.
[22] This statistics is obtained from the Chinese Educational Statistical Yearbook.
[23] The labor participation rates for college attendees are obtained from the table "Employment Status Among 16 and above Population by Educational Level and Gender" in the 2010 census of each province; and the fractions of people enrolling in college in population outside of labor force are obtained from "The total number of people outside of labor force by reason, educational level, and gender" in 2010 census of each province.

than enrolling in colleges versus the number of college attendees in the labor force are both stable across our observed year. Therefore, we multiply the number which subtract numbers of students enrolling in colleges from the total number of college attendees, with the ratio $\frac{\%Lpc}{(1-\%Lpc)(1-\%Enr)+\%Lpc}$ to obtain the estimates for number of skilled workers in each province and year. $\frac{\%Lpc}{(1-\%Lpc)(1-\%Enr)+\%Lpc}$ measures the percentage of college attendees in the labor force in the number of all college attendees subtracting the number of people enrolling in colleges.

Finally, to capture the changes in skilled labor in *t*, we subtract the total number of skilled workers in the labor market in year *t*-1 from the number year *t*:

$$\Delta Col_{p,t} = \Delta[(Pop * \%Age6 * \%Col - Enr) * \frac{\%Lpc}{(1-\%Lpc)(1-\%Enr)+\%Lpc}]_{p,t} \quad (3)$$

In the second stage, we estimate the impact of the predicted changes in skilled labor due to the college expansion, $\Delta\widehat{Col_{p,t}}$, on the college premium and the probability of unemployment using equation (1) (replace $\widehat{AD_{p,t-4}}$ with $\Delta\widehat{Col_{p,t}}$).

The results for the first stage are reported in Table 5A, and we also report the estimated results using different set of control variables. Column (1) shows the estimated coefficient for the instrument without any control variable. Column (2) adds province fixed effect and year fixed effect in the model. Column (3) further control demand variables (GDP, import values, export values, fixed capital investment values) of the current year *t* and province *p*, as well as demand statuses in *t*-4 year at province *p*. We use the predicted results from the last specification in Table 5A to do the second stage estimation.

We estimate the relationship between the college admissions in *t*-4 year and the change of skilled labor in the market in year *t.* As can be seen from the table, an increase of one student in college admission increases the number of skilled workers by about 1.04, controlling for the previous and current changes in several the demand factors. The estimated coefficient suggests the local college admissions 4-year prior can explain a substantial portion of the variation in skilled labor. Compared with results in columns (1) and (2), we can see that adding province fixed effect, year fixed effect, and demand side variables does not significantly affect the estimated relationship between college admission and actual changes in the number of skilled labor. Therefore, our instrument is external to demand changes, fixed provincial changes and fixed year changes in terms of affecting the number of skilled labor.

The results of the second stage regression on the college premium and the probability of unemployment can be found in Table 6A and Table 7A. Columns (1) – (3) and columns (5) – (7) in Table 6A report the regression results using the predicted change in the supply of skilled labor from the first stage, $\Delta\widehat{Col_{p,t}}$ and its interactions with different educational dummies, as the independent variables of interested. Columns (4) and (8) report the regression results using raw number of $\Delta Col_{p,t}$ and its interactions with different education dummies as the main independent variables.

In Table 6A, we observe that the instrumented changes in skilled labor due to the college expansion had a negative impact on the relative income for young college workers. A 0.1 million increase in skilled workers from the college expansion decreased the relative log income for 4-year college graduates by about 3 log percentage points. This indicates that the change in number of skilled workers due to the college expansion decreased the college premium for young skilled

labor. It also suggests the price elasticity of demand for skilled labor is about -32[24], which suggests a highly elastic demand for skilled labor in Chinese market. Compared with the estimated impact of the college expansion in Table 5, the estimated impact of supply shock on college premium using the 2SLS is smaller. The results in column (4) suggests that the impact of the raw change in number of skilled workers on college premium is close to zero. Since the raw change in skilled labor may also be affected by changes in the demand of skilled labor, such as greater usage in skilled bias technology may cause the college premium to increase, the comprehensive impact of change in skilled workers on college premium is thus ambiguous.

The increase in skilled workers due to supply shock has no negative impact on college premium for older workers, as can be seen in columns (5) – (7), which suggests that the effect of having greater number of skilled workers in the market mainly affects young people rather than older people. In column (8), we find that the income premiums for both older 4-year and 2- or 3-year college graduates increase as the number of skilled workers increases. This suggests an increase in demand for experienced skilled labor, which is consistent with the skill-biased technological changes theory.

In Table 7A, we estimate the impact of changes in skilled labor due to the college expansion on the likelihood of unemployment. Similar to Table 6A, columns (1) – (3) and columns (5) – (7) show the estimated results using instrumented variable, and columns (4) and (8) show the results using raw changes in skilled labor as our independent variable of interest. The results suggest that as the skilled labor increases due to the college expansion, the likelihood of unemployment for both young and older college graduates increases relative to high school graduates. A 0.1 million

[24] This number is calculated using the percentage change in quantity, (1/1.05)*100%, where the 1.05 is the average changes in quantity of skilled labor; divided by the percentage change in price, -3%, which is the change in college premium from the regression results for 0.1 million increase in college admission.

increase in local skilled labor caused by the college expansion increases the probability of unemployment for 4-year new college graduates by 1.1 percentage points, and it increased the probability for old graduates by 0.9 percentage points, relative to people with high school degrees. It increased the relative probability of unemployment for 2- or 3-year new college graduates by about 2 percentage points and it increased the relative probability by 1.2 percentage points for older college graduates. Similar to the results in Table 6A, the negative impacts on both young and old college graduates are smaller than the reduced form estimates.

The comparison between the 2SLS estimates and the reduced form estimates on both relative income and probability of unemployment suggests that the overall negative impact of the college expansion on the earning premium and employment for young skilled labor is greater than the estimate using college expansion as an instrument for the number of skilled workers. In other words, the increase in college admission negatively affected young skilled workers' income and probability of employment through increasing the number of skilled workers in the market, it may have negatively affected their labor outcomes through other channels. For example, a decline in college quality may decrease the demand for skilled labor. As shown in Section 3, during the college expansion period, the increase in number of students admitted to colleges grew faster than the increase in college teachers, which may result in a decrease in the quality of college education. If college graduates are on average not as qualified as before, which may decrease their marginal product, then the employer would not provide wages as high as before and may also decrease the demand for skilled labor.

The estimated increase in relative probability of unemployment for college graduates using the raw change in skilled labor are smaller than the 2SLS estimates. Since an increase in number of skilled workers is a mixture results of the changes in both supply and demand, the estimated

impacts using the simple change is therefore ambiguous and cannot be identified as either the impact of supply increase or impact of demand increase.

Table 1A Regression Results for College Premium within Industry and within occupation

	Age 23-29				Age 30-65			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Col	0.552***	0.581***	0.501***	0.514***	0.603***	0.618***	0.539***	0.540***
	(0.110)	(0.114)	(0.114)	(0.120)	(0.052)	(0.057)	(0.056)	(0.057)
Lcol	0.171**	0.204***	0.125	0.144*	0.286***	0.294***	0.224***	0.224***
	(0.074)	(0.077)	(0.084)	(0.086)	(0.032)	(0.034)	(0.034)	(0.034)
Lhs	-0.162*	-0.157*	-0.162*	-0.161*	-0.308***	-0.302***	-0.239***	-0.237***
	(0.095)	(0.091)	(0.093)	(0.093)	(0.033)	(0.034)	(0.033)	(0.033)
$\widetilde{\mathbf{AD}_{\mathbf{t-4}}}$	-0.044	0.012	-0.015	-0.011	0.042	0.036	0.055*	0.049
	(0.012)	(0.075)	(0.075)	(0.076)	(0.031)	(0.031)	(0.031)	(0.030)
Col $*\ \widetilde{\mathbf{AD}_{\mathbf{t-4}}}$	-0.203***	-0.200***	-0.196***	-0.198***	-0.015	-0.019	-0.029	-0.027
	(0.060)	(0.057)	(0.056)	(0.058)	(0.029)	(0.029)	(0.029)	(0.029)
Lcol $*\ \widetilde{\mathbf{AD}_{\mathbf{t-4}}}$	-0.035	-0.043	-0.028	-0.035	-0.003	0.003	0.001	0.004
	(0.048)	(0.046)	(0.046)	(0.046)	(0.020)	(0.020)	(0.020)	(0.020)
Lhs $*\ \widetilde{\mathbf{AD}_{\mathbf{t-4}}}$	-0.016	-0.030	-0.012	-0.017	0.008	0.008	0.002	0.002
	(0.052)	(0.049)	(0.050)	(0.050)	(0.018)	(0.018)	(0.018)	(0.018)
$\boldsymbol{X_i}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\boldsymbol{\delta_p}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\widetilde{\mathbf{TL}}$	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
$\mathbf{Z_{p,t}}$	Yes	Yes	Yes	Yes	No	No	Yes	Yes
$\boldsymbol{\delta_t}$	Yes	Yes	Yes	Yes	No	No	No	Yes
$\boldsymbol{Ret_{p,t}}$	Yes	Yes	Yes	Yes	No	No	No	Yes
$\boldsymbol{\delta_i}$	No	Yes	No	Yes	No	Yes	No	Yes
$\boldsymbol{\delta_o}$	No	No	Yes	Yes	No	No	Yes	Yes
N	1,711	1,711	1,711	1,711	7,752	7,752	7,752	7,752
$\mathbf{R^2}$	0.2739	0.2832	0.3002	0.3087	0.3424	0.3497	0.3734	0.3785

This table reports the regression results for equation (1), controlling for industry fixed effect and occupation fixed effect, using CGSS 2003, 2006, 2010, 2011, 2012, 2013. Columns (1)-(4) list estimates for young workers (23-29-year-olds), and columns (5)-(8) list estimates for older workers (30-65-year-olds). We control industry fixed effect in columns (2) and (6), control occupation fixed effect in columns (3) and (7), and control both industry and occupation effects in columns (4) and (8). The other control variables are the same as described in Table 5. Standard errors reported in this table are clustered at province level. The t-statistics are estimated using wild cluster bootstrap method (boottest).

Table 2A Marginal Effect Estimates Using Logit Model on Unemployment

	Age 23-29			**Age 30-65**		
	(1)	(2)	(3)	(4)	(5)	(6)
Col	-0.074***	-0.069***	-0.065***	-0.204***	-0.175***	-0.169***
	(0.016)	(0.017)	(0.016)	(0.021)	(0.020)	(0.020)
Lcol	-0.080***	-0.077***	-0.075***	-0.126***	-0.118***	-0.118***
	(0.013)	(0.013)	(0.013)	(0.014)	(0.011)	(0.011)
Lhs	0.046***	0.046***	0.045***	0.048***	0.045***	0.045***
	(0.011)	(0.011)	(0.011)	(0.005)	(0.005)	(0.005)
$\widetilde{\mathbf{AD_{t-4}}}$	-0.025*	-0.011	-0.017	-0.073***	0.003	0.028**
	(0.013)	(0.015)	(0.019)	(0.010)	(0.015)	(0.011)
$\mathbf{Col} * \widetilde{\mathbf{AD_{t-4}}}$	0.042***	0.042***	0.041***	0.032***	0.010	0.008
	(0.012)	(0.013)	(0.013)	(0.011)	(0.013)	(0.013)
$\mathbf{Lcol} * \widetilde{\mathbf{AD_{t-4}}}$	0.046***	0.046***	0.044***	0.021*	0.010	0.010
	(0.013)	(0.012)	(0.014)	(0.011)	(0.013)	(0.010)
$\mathbf{Lhs} * \widetilde{\mathbf{AD_{t-4}}}$	-0.029**	-0.029**	-0.027**	-0.016***	-0.019***	-0.019***
	(0.014)	(0.013)	(0.012)	(0.005)	(0.005)	(0.005)
$\boldsymbol{X_i}$	Yes	Yes	Yes	Yes	Yes	Yes
$\boldsymbol{\delta_p}$	Yes	Yes	Yes	Yes	Yes	Yes
$\widetilde{\mathbf{TL}}$	No	Yes	Yes	No	Yes	Yes
$\mathbf{Z_{p,t}}$	No	Yes	Yes	No	Yes	Yes
$\boldsymbol{\delta_t}$	No	No	Yes	No	No	Yes
$\boldsymbol{Ret_{p,t}}$	No	No	Yes	No	No	Yes
N	5,333	5,333	5,333	24,738	24,738	24,738
$\mathbf{R^2}$	0.1114	0.1153	0.1282	0.1507	0.1697	0.1822

This table reports the marginal effect obtained from Logit regression estimates for equation (1). All variables listed in the table have the same definitions as shown in Table 6. Columns (1)-(3) list estimates for young workers, and columns (4)-(6) list estimates for older workers. We control the province fixed effect in columns (1) and (4), adding provincial economic variables in columns (2) and (5), and including year fixed effect in columns (3) and (6). Standard errors reported in this table are clustered at province level. The t-statistics are estimated using wild cluster bootstrap method (boottest).

Table 3A Estimated Results of Equation (1) Using Alternative Measure of College Expansion

	Age 25 - 29		Age 30 - 65	
	(1)	(2)	(3)	(4)
	Income	Unemployment	Income	Unemployment
Col	0.427***	-0.064***	0.576***	-0.078***
	(0.044)	(0.015)	(0.042)	(0.009)
Lcol	0.159***	-0.086***	0.330***	-0.105***
	(0.035)	(0.013)	(0.024)	(0.010)
Lhs	-0.153***	0.087***	-0.286***	0.083***
	(0.051)	(0.020)	(0.023)	(0.008)
$\widetilde{\mathbf{AD_{t-4}}}$	-0.017	-0.021	-0.003	0.016
	(0.034)	(0.017)	(0.036)	(0.013)
$\mathbf{Col} * \widetilde{\mathbf{AD_{t-4}}}$	-0.084***	0.029***	0.032	0.014**
	(0.027)	(0.010)	(0.019)	(0.005)
$\mathbf{Lcol} * \widetilde{\mathbf{AD_{t-4}}}$	-0.030	0.040***	0.011	0.031***
	(0.019)	(0.008)	(0.020)	(0.007)
$\mathbf{Lhs} * \widetilde{\mathbf{AD_{t-4}}}$	0.002	-0.040***	-0.004	-0.034***
	(0.035)	(0.008)	(0.014)	(0.007)
$\boldsymbol{X_i}$	Yes	Yes	Yes	Yes
$\boldsymbol{\delta_p}$	Yes	Yes	Yes	Yes
$\widetilde{\mathbf{TL}}$	Yes	Yes	Yes	Yes
$\mathbf{Z_{p,t}}$	Yes	Yes	Yes	Yes
$\boldsymbol{\delta_t}$	Yes	Yes	Yes	Yes
$\boldsymbol{Ret_{p,t}}$	Yes	Yes	Yes	Yes
N	3,735	5,334	16,852	24,738
$\mathbf{R^2}$	0.3832	0.0916	0.4098	0.1530

This table reports the estimated results of equation (1) on the income and employment using number of new college graduates in each province of each year as a measure of the college expansion. Columns (1)-(2) list estimates for young workers, and columns (3)-(4) list estimates for older workers. Columns (1) and (3) list estimated coefficients and standard errors on income, and columns (2) and (4) list the estimated results on unemployment. We control personal demographic variables X_i (age, age squared and gender), and province fixed effect δ_p and changes in overall labor force and its interaction with each education dummies $\widetilde{TL}$, and provincial economic and demographic variables $Z_{p,t}$ (log GDP, fixed capital investment, import and export, percentage of male, percentage of urban population), and including year fixed effect δ_t and the imputed number of retired workers with college degrees. Standard errors reported in this table are clustered at province level. The t-statistics are estimated using wild cluster bootstrap method (boottest).

Table 5A Estimates of Returns to Task Scores within Education

ln(annual income)	**(1)**	**(2)**	**(3)**	**(4)**
Cognitive Analytical	1.325***	--	--	--
	(0.110)			
Cognitive Communicative	--	0.320***	--	--
		(0.022)		
Manual Precision	--	--	-0.252***	--
			(0.024)	
Manual Others	--	--	--	-0.759***
				(0.069)
Col	0.504***	0.458***	0.529***	0.532***
	(0.024)	(0.024)	(0.023)	(0.023)
Lcol	0.204***	0.169***	0.217***	0.218***
	(0.020)	(0.021)	(0.020)	(0.020)
Lhs	-0.248***	-0.225***	-0.262***	-0.263***
	(0.019)	(0.019)	(0.019)	(0.019)
Gender	0.263***	0.278***	0.274***	0.276***
	(0.015)	(0.015)	(0.015)	(0.015)
Age	0.026***	0.027***	0.026***	0.027***
	(0.007)	(0.007)	(0.007)	(0.007)
Age $*$ **Age**	-0.0004***	-0.0004***	-0.0004***	-0.0004***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$\boldsymbol{\delta_p}$	Yes	Yes	Yes	Yes
$\boldsymbol{\delta_t}$	Yes	Yes	Yes	Yes
N	15,915	15,915	15,915	15,915
$\mathbf{R^2}$	0.2678	0.2715	0.2662	0.2661

This table reports the estimates for returns to task scores within education in current jobs for people in 25-65 years old. The dependent variable is log of annual income one year before the survey year for respondents with full-time employment. Our variable of interest is the score for each type of task for the respondent. The data is from CGSS 2003-2015, excluding 2005. We control province fixed effect and year fixed effect, as well as education dummies, gender, age and age squared in our estimation. Standard errors reported in this table are clustered at province level. The t-statistics are estimated using wild cluster bootstrap method (boottest).

Table 5A Estimated Results of the First Stage in the 2SLS Regression

$\Delta Col_{p,t}$	(1)	(2)	(3)
$\mathbf{AD_{p,t-4}}$	0.982*** (0.148)	0.990*** (0.376)	1.041 ** (0.421)
$\boldsymbol{\delta_p}$	No	Yes	Yes
$\boldsymbol{\delta_t}$	No	Yes	Yes
$\boldsymbol{Z_{p,t-4}}$	No	No	Yes
$\boldsymbol{Z_{p,t}}$	No	No	Yes
F-score	44.03***	6.93***	6.112**
N	527	527	527
$\mathbf{R^2}$	0.0756	0.2344	0.2384

This table reports the results of the first stage of the 2SLS analysis described in equation (2), as well as other two specifications with less control variables. The dependent variable is the change in skilled labor in year *t* ($t \in [1999, 2015]$) and in province *p*. $AD_{p,t-4}$ is the number of students admitted to college in year *t-4* in province *p*. $\boldsymbol{Z_{p,t-4}}$ and $\boldsymbol{Z_{p,t}}$ represents time-variant provincial demand-side factors, including the provincial log of GDP, the log of fixed capital investment, and the log of the imports and exports at year *t*-4 in province *p*, and at year *t* in province *p*, respectively. δ_p is the province fixed effect and δ_t is the year fixed effect. Column (1) shows the estimated coefficient for the instrument without any control variable. Column (2) shows the estimated coefficient for the instrument with province fixed effect and year fixed effect controlled in the model. Column (3) shows the estimated coefficient for the instrument with controls in column (2) and with demand variables in the current year *t* and province *p*, as well as demand status in *t*-4 year.

Table 6A Estimated Results of the Second Stage in the 2SLS Regression on Income

	Age 23-29				Age 30-65			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Col	0.445***	0.382***	0.376***	0.361***	0.624***	0.583***	0.579***	0.598***
	(0.034)	(0.035)	(0.033)	(0.029)	(0.047)	(0.043)	(0.042)	(0.045)
Lcol	0.188***	0.156***	0.157***	0.143***	0.340***	0.332***	0.329***	0.334***
	(0.033)	(0.031)	(0.031)	(0.030)	(0.029)	(0.026)	(0.025)	(0.025)
Lhs	-0.070	-0.145***	-0.144***	-0.148***	-0.265***	-0.288***	-0.289***	-0.291***
	(0.051)	(0.048)	(0.049)	(0.049)	(0.021)	(0.022)	(0.021)	(0.019)
$\Delta\widehat{Col}_t$	-0.028**	-0.026**	-0.029	-0.001	-0.032***	-0.020**	0.005	-0.007***
	(0.011)	(0.011)	(0.029)	(0.004)	(0.009)	(0.009)	(0.040)	(0.002)
$Col * \Delta\widehat{Col}_t$	-0.037***	-0.032**	-0.028**	-0.001	0.012	0.010	0.009	0.009***
	(0.012)	(0.013)	(0.012)	(0.006)	(0.014)	(0.012)	(0.012)	(0.003)
$Lcol * \Delta\widehat{Col}_t$	-0.030*	-0.026*	-0.024*	0.003	0.013	0.011	0.011	0.003
	(0.015)	(0.014)	(0.014)	(0.005)	(0.009)	(0.009)	(0.009)	(0.002)
$Lhs * \Delta\widehat{Col}_t$	-0.012	-0.010	-0.012	-0.003	0.001	0.001	0.001	0.003
	(0.020)	(0.018)	(0.018)	(0.005)	(0.009)	(0.009)	(0.001)	(0.002)
X_i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
δ_p	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\widetilde{TL}$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$Z_{p,t}$	No	Yes	Yes	Yes	No	Yes	Yes	Yes
δ_t	No	No	Yes	Yes	No	No	Yes	Yes
N	3,735	3,735	3,735	3,735	16,852	16,852	16,852	16,852
R^2	0.3245	0.3761	0.3824	0.3821	0.3794	0.4061	0.4101	0.4105

This table reports the second stage results on annual incomes for the 2SLS regression using equation (1), replacing $\widehat{AD_{p,t-4}}$ with $\Delta\widehat{Col}_{p,t}$. The dependent variable is the log of annual income for full-time urban employed respondents. Our variable of interest is the predicted change in skilled workers caused by the supply shock in year *t* of province *p*, and its interaction terms with education dummies. The regression excludes people with more than 4-year college education. Columns (1)-(4) list estimates for young workers, and columns (5)-(8) list estimates for older workers. We control the age, age squared, gender, province fixed effect, effect of changes in total employed workers in columns (1) and (5), adding provincial economic and demographic variables in columns (2) and (6), and including year fixed effect in columns (3) and (7). We also report the estimated results using raw number of changes in college graduate workers in columns (4) and (8). Standard errors reported in this table are clustered at province level. The t-statistics are estimated using wild cluster bootstrap method (boottest).

Table 7A Estimated Results of the Second Stage in the 2SLS Regression on Unemployment

	Age 23-29				Age 30-65			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Col	-0.051*** (0.010)	-0.035*** (0.011)	-0.036*** (0.009)	-0.029*** (0.009)	-0.097*** (0.008)	-0.072*** (0.007)	-0.069*** (0.006)	-0.059*** (0.005)
Lcol	-0.060*** (0.010)	-0.054*** (0.010)	-0.056*** (0.010)	-0.047*** (0.011)	-0.086*** (0.007)	-0.083*** (0.006)	-0.087*** (0.006)	-0.078*** (0.006)
Lhs	0.054*** (0.017)	0.060*** (0.017)	0.055*** (0.017)	0.052*** (0.016)	0.065*** (0.008)	0.066*** (0.007)	0.063*** (0.006)	0.057*** (0.005)
$\widehat{\Delta Col_t}$	-0.007 (0.007)	-0.001 (0.007)	-0.045 (0.033)	-0.001 (0.002)	-0.005 (0.003)	0.002 (0.004)	-0.013 (0.025)	0.003 (0.002)
$Col * \widehat{\Delta Col_t}$	0.012* (0.007)	0.012* (0.007)	0.011* (0.007)	0.001 (0.002)	0.018*** (0.003)	0.009*** (0.002)	0.009*** (0.003)	0.001 (0.001)
$Lcol * \widehat{\Delta Col_t}$	0.018* (0.009)	0.016* (0.009)	0.019** (0.008)	0.005* (0.003)	0.012*** (0.004)	0.011*** (0.004)	0.013*** (0.004)	0.001 (0.001)
$Lhs * \widehat{\Delta Col_t}$	-0.020** (0.009)	-0.021** (0.008)	-0.017* (0.008)	-0.007 (0.004)	-0.017*** (0.003)	-0.017*** (0.003)	-0.017*** (0.003)	-0.004** (0.001)
X_i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
δ_p	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\widetilde{TL}$	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$Z_{p,t}$	No	Yes	Yes	Yes	No	Yes	Yes	Yes
δ_t	No	No	Yes	Yes	No	No	Yes	Yes
N	5,334	5,334	5,334	5,334	24,738	24,738	24,738	24,738
R^2	0.0545	0.0712	0.0874	0.0828	0.0888	0.1288	0.1494	0.1474

This table reports the second stage results on the likelihood of unemployment using equation (1), replacing $\widetilde{AD_{p,t-4}}$ with $\Delta\widehat{Col}_{p,t}$. The dependent variable is the log of annual income for full-time urban employed respondents. Our variable of interest is the predicted change in skilled workers caused by the supply shock in year *t* of province *p*, and its interaction terms with education dummies. The regression excludes people with more than 4-year college education. Columns (1)-(4) list estimates for young workers, and columns (5)-(8) list estimates for older workers. We control the age, age squared, gender, province fixed effect, effect of changes in total employed workers in columns (1) and (5), adding provincial economic and demographic variables in columns (2) and (6), and including year fixed effect in columns (3) and (7). We also report the estimated results using raw number of changes in college graduate workers in columns (4) and (8). Standard errors reported in this table are clustered at province level. The t-statistics are estimated using wild cluster bootstrap method (boottest).