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ABSTRACT

Does College Location Affect the Location Choice of New College Graduates? Evidence from China

Based on a representative survey of new college graduates in China, we examine the impact of college location on their location choice upon graduation. We use a discrete choice model and the BLP method to solve the endogeneity problem of housing cost and to estimate the unobservable location features. Furthermore, we allow for different distributions of city preference for graduates studying in different regions to address the self-selection problem of college location. Empirical results show that the graduates are significantly more likely to stay in where they attended college, to return to their hometown, and to avoid cities with high housing costs. Simulation exercise shows that the impact of college location on migration varies considerably across cities, and there is significant heterogeneity for students from universities of different tiers and from rural vs. urban areas. Reduced form evidence suggests that internship in the local labor market plays an important role in raising the probability of staying. College education increased the students' interaction with the local economy and reduced the costs of job search.

JEL Classification: J13, J16, J61, J24

Keywords: higher education, regional development, location choice, human capital

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1 Introduction

Human capital is crucial for regional economic development, with large and successful cities usually having a larger share of college-educated workers (Morreti, 2004; 2011; Glaeser et al. 1995). Research also shows that cities with a larger share of college-educated workers in the early period experienced higher population growth later on (Glaeser et al. 1995). The positive role of human capital in regional development is partly due to the externalities of educated workers, which provides a rationale for local governments to attract educated workers. Also interestingly, in the past two to three decades, there was a significant regional divergence (rather than convergence) in education levels within a number of countries (Moretti, 2012). Attracting skilled workers has become a major challenge for many local governments.

In recent years of China, while the growth of less educated rural-to-urban migrants has lost momentum,[1] 6 to 7 million new college graduates entered the labor market annually whose location choice not only reflects but also influence the competitiveness of different regions. Recognizing the pivotal role of talents in regional development, especially in the process of industrial upgrading, local governments began to compete for college graduates in the labor markets. For example, some cities offer preferential policies such as lowering the requirement of getting local hukou (household registration permit) and/or providing settlement subsidies.

As cities endowed with colleges and universities are believed to have an advantage in obtaining talents,[2] some local governments subsidize higher education institutions, expecting that college education can increase the probability of graduates choosing to stay after graduation. In this paper, we explore whether this conjecture has concrete empirical evidence.

The migration of college graduates has major implications for the incentives and arrangements of local and central governments to finance higher education. If college education could improve the graduates' chance of staying in college city by a sizable margin, it is reasonable for the local government to subsidize local

[1] A number of studies argue that China has already reached the Lewis turning point, a stage when a labor abundant agricultural country is running out of the surplus labor (Zhang et al. 2011; Knight et al. 2011).

[2] This belief is consistent with the casual observation that education levels and the number of colleges/universities are positively correlated across regions.

higher education. On the other hand, if college graduates' employment location is independent of their location of college education (due to the high mobility of educated workers), it makes more sense for the central government to shoulder the financial burden.

There are several reasons that education locality can influence the job location of graduates. From the supply side, the cost of job search near the enrolled university is lower than if the college students search for employment elsewhere. As college education usually takes 3 to 4 years, the students have more information on the local than on non-local labor markets upon graduation. Time and distance limitations confine the interaction between individuals and the labor market within a certain scope of a region. Meanwhile, local experience helped an individual accumulate human and social capital specific to the locality of his/her education. For example, many college students take internships that are located within the city of their enrolled universities. Lower searching cost and region-specific human capital may increase the expected wage if a graduate chooses where he/she went to college. The graduates may also get used to the lifestyle of the education location, which increases their willingness to stay after graduation.

From the demand side, employers may adapt to the supply by creating demand for the locally produced college graduates. The ability of the local labor markets to absorb college graduates depends on the elasticity of demand for educated workers. Facing the wage decrease induced by increased labor supply, regions with elastic demand can absorb college graduates more than those with inelastic demand. When the local demand for educated workers is inelastic or when the college graduates search for employment beyond the local labor markets, the number of locally produced college graduates will be uncorrelated or weakly correlated with the education levels of the local labor force.

In this paper, we use a survey data on new college graduates to examine their location choice upon graduation. The data description shows that the graduates tend to stay at where they went to college. The reduced-form regression analysis suggests that this tendency varies considerably across individuals. We also find that the locally available internship opportunity is one major reason for the dependence of employment location on education location.

Although the correlation is readily observed, identifying the causal effect of college location on job location choice is challenging. The major difficulty is the non-random allocation of individuals among colleges. In particular, one may choose college education in a city where he/she intends to work. Or, individual heterogeneity in the preference for regions may influence his/her choice of location for education and employment successively.

We then construct a discrete choice model that allows for the unobservable individual preference for cities to be correlated with education locations, which addresses the self-selection problem of college location in a way different from existing studies such as Groen (2004). The estimation results show that attending college in a city significantly increased the chance of working there and that the graduates are more likely to return to home regions. We find significant heterogeneity of the relationship between education and employment location choice for different cities, universities of different ranks, and individuals of different gender, with a different number of siblings and from different (rural vs. urban) areas.

The simulation exercise shows that the differential in the impact of college location on a graduate's propensity to stay in the college city across cities is large. For example, the chances of choosing Guangzhou after graduation will increase by 85 percentage point if a graduate studied there rather than in other places. For cities like Haerbin and Guiyang, however, the increase will be less than one percentage point. The results also indicate that the students from top tier universities are less likely to be tied to their education location. This finding is consistent with the facts that high ability individuals are more mobile and that elite universities are less integrated with the local economy. These results suggest that a city's capacity to attract educated workers through developing higher education depends on many other factors. Policymakers should take into account local amenities and economic conditions when they consider such policies.

This paper proceeds as follows. Section 2 reviews the related literature briefly; Section 3 introduces the college graduates survey; Section 4 provides reduced-form evidence regarding the factors that can affect graduates' tendency to choose the city of college education; Section 5 builds up a discrete choice model of employment location and discusses the estimation method; Section 6 reports the estimation results of the discrete choice model and some counterfactual analysis results; Section 7 presents some channels of the effect; Section 8 concludes.

2 Literature Review

Higher education is an industry that receives considerable (and varying) amount of subsidies from local governments. One rationale for this practice is that such policies produce educated workers for the local economy (Schmidt, 1998).[3] However, many scholars are skeptical about the effectiveness of such policies in attracting educated workers. Using U.S. data aggregated at the state level, Bound et al. (2004) showed that the education level of the labor force is at most weakly dependent on the number of educated workers locally produced. Generally speaking, educated workers are more likely to migrate in response to changes in the regional economic situation, possibly because they are more capable of processing information and adjusting to different local labor markets (Bound and Holzer, 2000; Topel, 1986). These findings imply that financing education is fiscally unjustified for local government, at least if the purpose is to attract educated workers.

However, this view is challenged by some studies using individual level data. Groen (2004) asked the same question as we do in this paper. Using two samples of U.S. undergraduate students, he estimated a conditional logit model and finds a modest impact of education location on the place of working. Kennan (2018) also showed that cross-state differences in public college financing have substantial effects on college enrollment and that these effects are not dissipated through migration.

For China the picture on the mobility of educated workers is mixed. Lu and Xing (2018) found that educated workers are more likely to leave China's rust belt (regions that have been experiencing adverse economic situations partly because its economy is dominated by heavy industry). In general, however, the mobility of educated workers are not high, at least not as high as less educated rural workers (Luo and Xing, 2016). This is because, for educated workers to move, they often need to sacrifice the welfare benefits associated with local Hukou (official household registration). It is, therefore, worthwhile to examine the location choice around the time of graduation, which is probably the most mobile period in a college graduate's whole career life.

Focusing on new college graduates also sheds lights on the process in which the youths transfer from schools to the labor markets. China has reformed the central

[3]Goldin and Katz (1999) argue that local governments subsidize local higher education because it provides local public goods and services

planning mechanism of assigning graduates to work units since the 1990s. In the post-reform period, both employers and employees have gained autonomy in the job matching process, for which the graduates' location choice is a major aspect. Understanding this aspect becomes increasingly important as youth unemployment among college graduates rose in recent decades, especially after the sharp higher education expansion since the late 1990s (Freeman 2010; Li et al., 2013; Li et al., 2014). While existing studies have paid attention to various aspects of youth employment such as labor force participation, employment status, occupation, and wages, little has been done to examine location choice and its correlation with the education location.

3 Data and Summary Statistics

The data analyzed in this paper is from the 2011 Employment Survey of College Graduates conducted by the Institute of Education Economics, Peking University (IEE PKU). Starting from 2003, the IEE PKU conducted a large-scale survey of the employment status of graduates every other year. The graduating students were the subjects of interview and the survey was conducted in June shortly before they left campus. The questionnaires focus on four aspects: (1) personal and family background, (2) higher education received, (3) job-seeking process, and (4) employment results. The sampling procedure guarantees that the sample is representative in fields of study, types of universities, and regions.

The 2011 survey includes 10, 9, and 11 higher education institutions (HEIs) in eastern, central, and western China, respectively. There are 7 "211"-project universities (including 3 "985"-project universities),[4] 9 ordinary universities, and 14 professional colleges which include 7 vocational colleges, 3 affiliated colleges, and 4 privately run HEIs. We classify the students into three groups: 211 university students, non-211 university students, and professional college students.[5] Valid responses were received from 19,643 individuals, of whom 93.4% were undergraduates and the others were master or Ph.D. students. As our focus is the employment

[4]211-project was initiated by the Chinese government in the 1990s that aimed to build 100 world class Chinese universities. 985-project is a later project that subsidized a smaller amount of elite universities.

[5]The former two groups are university students and the third group includes only professional college students. However, students in the last category can also study in a college or school within a 211 or non-211 university.

results of the undergraduates, we exclude the 1,299 individuals in the master and Ph.D. programs. We also exclude 4,736 observations who failed to report home locations (see Appendix Table 16) and another 6,331 who did not report employment location due to reasons such as entering graduate programs and failing to secure a job (see Appendix Table 17).

To analyze the migration of college graduates upon graduation, we need to define the unit of location. The place of employment can only be distinguished between capital and non-capital cities within a province in accordance with data availability. For example, if one chooses to work in Sichuan province, we can only observe whether he/she works in Chengdu (the capital city of Sichuan) or not. We treat all non-capital cities within a province as one unit, disregarding the number of cities in it. Therefore, the region unit in our regression analysis will be capital and non-capital cities in each province. In the data description, we also use province as an optional region unit to examine the migration of college graduates. For convenience, we occasionally refer those who choose to work in their college locations as *stayers*.

Table 1 reports the distribution of the college graduates' location choice, which suggests a strong tendency to stay at the education location and an apparent home bias. 73.7% of the graduates choose to work in their home province, and 68.7% choose the province of college education. It is also true that a majority of the graduates enrolled in colleges that locate in their home province, and over 60% of the sample work in the province of hometown and tertiary education. Only 20.8% of the observations neither return to their home provinces nor stay at the education provinces. When we consider the finer unit of region (i.e. capital or non-capital cities), the shares of graduates who stay at their home cities and at their education cities decline but are still sufficiently high.

Table 1: Graduates prefer going back home or staying

definition of location:	province		city	
	freq.	percent	freq.	percent
hometown & not college location	634	10.51	1,844	30.57
college location & not hometown	337	5.59	1,519	25.18
hometown & college location	3,809	63.15	878	14.56
not hometown & not college location	1,252	20.76	1,791	29.69
Total	6,032	100	6,032	100

The mobility of college graduates differs considerably according to personal characteristics and types of HEIs. In Table 2, we report the proportions for each type of graduates who choose locations other than their hometown and education locations. We find that graduates from “211” universities are more mobile than non-“211” graduates. Meanwhile, male and non-single-child students have higher mobility than female and single-child ones.

Table 2: Mobility measured by choosing location other than home and college

definition of location:	province		city	
	freq.	percent	freq.	percent
211 university	344	32.36	459	43.18
non211 university	276	16.3	467	27.58
professional college	632	19.29	865	26.4
Female	563	17.48	849	26.37
Male	689	24.5	942	33.5
Not only child	931	24.48	1,251	32.9
only child	321	14.4	540	24.23

4 Who Tends to Stay? Reduced Form Evidence

In this section, we define a variable that indicates whether a college graduate is a stayer or not and use it as the dependent variable in a Linear Probability Model (LPM). The independent variables include characteristics of both employment and education regions and universities/colleges, as well as information on individual graduates. Exploring these relationships gives us descriptive evidence of how does college education influence the location choice of the graduates and provides guidance for the model specification in our structural estimation. We are also interested in the interaction between the students and local labor market during study.

4.1 Factors affecting the tendency to stay

The result in Table 3 suggests that the tendency to stay after college education varies considerably according to personal characteristics. Females and the only-child graduates are more likely to stay at the education location, suggesting that they are less likely to explore outside opportunities upon graduation or that they are more likely to face difficulties when seeking employment elsewhere. Students from rural areas are more likely to stay than those from urban areas by 3 to 5 percentage points. This is because (1) rural students are less likely to return to rural areas; (2) they may lack relevant resources to search for the opportunities in urban regions other than the higher education city.

Tier of university and the field of study are also correlated with the tendency to stay upon graduation. Graduates from top tier universities are less likely to stay at the university city. For example, graduates from *"211"* universities are less likely to stay by 12-25% relative to those from professional schools, depending on what variables are controlled for. This correlation might not only reflect the ability distribution of college graduates among universities of various tiers but also reflect the reputation of the universities. The field of study matters as well. Compared to Arts graduates, those majoring in other fields are more likely to find employment elsewhere, possibly because the skills of the later group are less region specific.

Where and what kind of families are the graduates originally from also make a difference. In particular, if a graduate's university is located in his home city, his probability of moving to other cities significantly decreases by over 30%, others being equal. Controlling for home province also influences (most of the time reduces the magnitudes of) the coefficients of other variables previously considered. But the pattern we presented remains largely unchanged.

Finally, the result suggests that the regional difference in economic development influences a graduate's tendency to stay at the education location significantly. Unsurprisingly, a higher level of GDP per capita at the college city increases a graduate's propensity to stay; and the tendency to stay will be lower if the GDP level in his/her home city is higher. However, the effect of GDP at home is small (although significant) and much smaller than the effect of the GDP level of the education city. This is reasonable because we are examining their impacts on an individual's propensity to choose the college city rather than the home city. Therefore, we interact the GDP level only with the education location in our structural estimation in the next section.[6]

[6]We do not consider the interaction between GDP level and home location also because this is not our focus. In addition, The GDP level of the employment region is an outcome of choice, and whether a graduate finds an employment in high GDP region might depend on other factors such as his/her personal characteristics, school quality, and field of study. Therefore, we do not consider it in the reduced form regressions.

Table 3: The impact of internship on the tendency to stay, LPM

	(1)	(2)	(3)	(4)
intern	0.050***	0.038**	0.034*	0.021
	(0.017)	(0.018)	(0.018)	(0.017)
male	-0.039***	-0.036***	-0.032**	-0.010
	(0.013)	(0.014)	(0.013)	(0.013)
rural	0.031**	0.056***	0.051***	0.048***
	(0.013)	(0.013)	(0.013)	(0.013)
han	0.027	0.030	0.004	0.045*
	(0.022)	(0.024)	(0.024)	(0.024)
only child	0.039***	0.027**	0.020	0.014
	(0.013)	(0.013)	(0.013)	(0.013)
household income pc	-0.009***	-0.004	-0.008**	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)
211 univ.	-0.252***	-0.198***	-0.127***	
	(0.017)	(0.018)	(0.019)	
non211 univ.	-0.077***	-0.078***	-0.070***	
	(0.014)	(0.015)	(0.015)	
engineering/medical	0.028**	0.002	-0.007	-0.037**
	(0.014)	(0.015)	(0.015)	(0.016)
art	0.113***	0.105***	0.100***	0.091***
	(0.028)	(0.030)	(0.029)	(0.030)
literature/phil./history	-0.018	0.009	0.015	0.015
	(0.021)	(0.022)	(0.022)	(0.022)
science	0.017	-0.021	-0.010	-0.053
	(0.033)	(0.034)	(0.034)	(0.034)
study at home city		0.301***	0.370***	0.332***
		(0.015)	(0.016)	(0.020)
gdp home			-0.006***	-0.001
			(0.002)	(0.002)
gdp study			0.051***	0.095***
			(0.004)	(0.010)
univ. dummies	no	no	no	yes
Obs.	6,810	5,630	5,630	5,630
R-squared	0.048	0.114	0.136	0.187

[1] *, **, *** represent statistical significance at the 10%, 5%, 1% levels.
[2] Social science and professional college are reference groups.

4.2 Internship and the tendency to stay

Many people (including students) believe that internship smooths the transition from the ivory tower to the labor market, and it is one way of college graduates interacting with local labor market. Due to time and distance constraints, college students usually find intern jobs in cities of their colleges, providing opportunities for both students and employers to learn about each other. In this section, we examine to what extent the intern jobs influence the tendency to stay upon graduation.

In column 1 of Table 3, internship experience significantly increases the probability of stay in the college city for employment by 5%, controlling for individual characteristics, tier of university, and field of study. The coefficient on *intern* in column 2 of Table 3 decreases to 3.8% once we control for whether the the university is located in one's home city, which is positively correlated with internship experience and the probability to stay at the study/home city. Controlling for the level of economic development in the college education and home regions has negligible effect on the coefficient of *intern*. In the last column of Table 3, we control for university fixed effects and omitting the tier variables. The coefficient decreases to 0.021 and is no longer statistically significant.

The LPM results suggest that internship experience increased one's probability of staying after graduation. But this empirical relationship may be subject to endogeneity problem because internship is sometime an individual choice based on their employment considerations. An individual who intends to work in the region of his/her college education may choose to do internship, leading to an upward bias in the estimated effect of *intern*. On the other hand, students may misreport their internship experience so that the true effect of *intern* is attenuated.

We use an instrumental variable approach to deal with the endogeneity issue. To do that, we calculate the share of students with internship experience within each field of study in a university, excluding the observation itself. Using this variable as an instrument relies on the assumption that an individual's internship opportunity is influenced by his/her connection during study, which does not influence the location choice of his/her employment conditional on other variables.

The first stage results are reported in Table 18 of the appendix. An individual's internship experience is highly correlated with group internship share, and the correlation is insensitive to the control variables included in the regressions. The second stage regression results are reported in Table 4. It turns out that the IV

Table 4: The impact of internship on the tendency to stay, 2SLS

	(1)	(2)	(3)	(4)
intern	0.209***	0.085	0.081	0.002
	(0.073)	(0.082)	(0.081)	(0.101)
male	-0.036***	-0.036**	-0.033**	-0.011
	(0.013)	(0.014)	(0.014)	(0.014)
rural	0.023*	0.052***	0.047***	0.046***
	(0.013)	(0.014)	(0.014)	(0.013)
han	0.015	0.025	-0.002	0.046*
	(0.023)	(0.025)	(0.025)	(0.025)
only child	0.037***	0.021	0.013	0.005
	(0.013)	(0.014)	(0.014)	(0.014)
household income pc	-0.010***	-0.003	-0.007*	0.000
	(0.004)	(0.004)	(0.004)	(0.004)
211 univ.	-0.249***	-0.200***	-0.130***	
	(0.018)	(0.019)	(0.020)	
non211 univ.	-0.071***	-0.074***	-0.065***	
	(0.014)	(0.015)	(0.015)	
engineering/medical	0.039***	0.008	-0.003	-0.036**
	(0.015)	(0.015)	(0.015)	(0.016)
art	0.124***	0.095***	0.092***	0.077**
	(0.029)	(0.031)	(0.031)	(0.032)
literature/phil./history	-0.013	0.003	0.010	0.008
	(0.022)	(0.023)	(0.022)	(0.023)
science	0.019	-0.019	-0.008	-0.051
	(0.034)	(0.035)	(0.034)	(0.034)
study at home city		0.305***	0.375***	0.335***
		(0.016)	(0.017)	(0.021)
gdp home			-0.006***	-0.000
			(0.002)	(0.002)
gdp study			0.051***	0.097***
			(0.005)	(0.011)
univ. dummies	no	no	no	yes
Obs.	6,434	5,336	5,336	5,336
R-squared	0.039	0.118	0.139	0.191

[1] *, **, *** represent statistical significance at the 10%, 5%, 1% levels.
[2] Social science and professional college are reference groups.

estimation produces larger coefficients of *intern* in most cases. Internship experience increases one's probability of staying by 21% when personal characteristics, field of study and university rank are controlled for (see column 1). Controlling for home location, and economic development levels of university and home regions reduces the coefficient to around 10% (see columns 2 and 3). Finally, we control for university fixed effects (excluding the ranking variables) in the last column of Table 4, the coefficient on *intern* becomes small and insignificant. These results indicate that the internship effect identified in the IV estimation is mainly a university level effect.

4.3 Heterogeneous preference for jobs and locations

Students who choose to work in the city of their education cities may have different preference for jobs and cities from those who do not. In other words, they may choose the city of education based on their preference for future jobs, job location being a major dimension. The Employment Survey asked the students about their preference for the prospective jobs, which are summarized in 14 aspects. Each student gave his/her evaluation of each aspect by choosing from the following options: (1) Not important, (2) Not so important, (3) Important, (4) Very important. We run separate regressions to see how do the stayers differ from others, controlling for a rich set of covariates.

Table 5 shows that those who choose to stay in the college city have stronger preference for large cities, reputable employers, and good career prospects, which suggests that they may choose their universities based on city characteristics such as city size (firms in large cities tend to have better reputation and offer more opportunities). The results also show that the stayers value more of the job flexibility and comfortability than the others. However, these features are not directly related to city characteristics. As for other aspects such as the size of the future employers, job stability, expected wages and benefits, personal interests of the job, etc., the stayers do not differ significantly from those who leave their education place. The results here suggest that students may have different individual preferences for cities which may influence both their choice of education and employment. We will address this issue in the following empirical analysis.

If the preference for cities of employment are heterogeneous among students, they may sort into different regions when they choose universities. To assess this possibility, we regress different dimensions of job preference on region dummies.

Table 5: Job Considerations and Decision to Stay

		stayer	s. e.	Obs.	R-squared
(1)	in big city	0.095***	(0.022)	6,512	0.053
(2)	employer has good reputation	0.049***	(0.019)	6,521	0.023
(3)	employer size	0.011	(0.021)	6,488	0.021
(4)	job is stable	-0.002	(0.020)	6,526	0.031
(5)	job is flexible	0.040*	(0.021)	6,492	0.015
(6)	high wages	0.031	(0.019)	6,524	0.021
(7)	generous benefits	0.015	(0.019)	6,553	0.028
(8)	good development prospects	0.029*	(0.016)	6,581	0.025
(9)	job is interesting	0.019	(0.020)	6,542	0.021
(10)	display personal talents	0.024	(0.019)	6,537	0.019
(11)	low work intensity	0.052**	(0.022)	6,484	0.025
(12)	close to relatives/friends	0.033	(0.024)	6,493	0.040
(13)	access to resources	0.009	(0.022)	6,508	0.027
(14)	contribute to society	0.038*	(0.022)	6,527	0.018

[1] Each row represents one regression with the preference for a specific dimension of job as dependent variable. We controlled for gender, ethnicity, rural Hukou, home location, fields of study, university dummies, household income, parents' education, and a constant term.

[2] Standard errors are in parenthesis; *, **, *** represent statistical significance at the 10%, 5%, 1% levels.

The results in Table 6 show that students from different regions have significantly different preference for jobs. For exmaple, students studying in Sichuan or Chongqing (the reference group) seem to have stronger preference for large cities, care more about employer reputation, and care less about living close to friends and relatives. Results that are not reported also indicate that the students from different regions have significantly different preferences. Therefore, it is important to take into account of the preference heterogeneity when we study the impact of college location on the location choice of college graduates. Of course, it is also possbile that the preference heterogeneity among students in different regions may be attributable to their living experiences in their college cities. We will separate these effects using the model in Section 5.

Table 6: Heterogeneous Self-reported Preference for Cities of Employment

		Central China	Shandong	Zhejiang	Northwest	Constant	Obs.	R-squared
(1)	in big city	-0.049*	-0.147***	-0.131***	-0.098**	2.829***	6,512	0.005
		(0.027)	(0.030)	(0.032)	(0.041)	(0.020)		
(2)	employer has good reputation	-0.050**	0.041	-0.067**	-0.100***	3.236***	6,521	0.004
		(0.023)	(0.025)	(0.027)	(0.034)	(0.017)		
(3)	close to relatives/friends	0.022	0.060*	0.092***	0.079*	2.580***	6,493	0.002
		(0.029)	(0.031)	(0.033)	(0.043)	(0.021)		
(4)	access to resources	0.032	0.087***	0.071**	-0.043	2.812***	6,508	0.002
		(0.027)	(0.030)	(0.032)	(0.041)	(0.020)		

[1] Rows (1)-(4) represent separate regressions.
[2] The reference group represented by the constant is the students studying in Sichuan and Chongqing (or Chuan-yu region); "Central China" includes Hubei and Jiangxi; "Northwest" includes Gansu and Ningxia.
[3] Standard errors in parenthesis and *, **, *** represent statistical significance at the 10%, 5%, 1% levels.

5 A Discrete Choice Model of Locations

The reduced form regressions in the previous section (Tables 3 and 4) are incapable of identifying the impact of college education itself on the location choice upon graduation, neither can it address the possibility that college location is endogenously determined. In this section, we construct a discrete choice model to estimate the impact of college education location, which enables us to deal with the endogeneity issues caused by unobservable individual preference and city characteristics. We also consider the heterogeneous effect of college education based on the reduced form evidence in Section 4.

5.1 The Model

To construct the model, we assume that a college graduate chooses a location that gives him/her the highest utility. For a given location j, a college graduate i will choose an optimal consumption bundle of tradeable good (C) and non-tradeable good (or typically housing, H). The utility maximization problem is summarized as follows:

$$\begin{aligned} \max_{C_{ij},H_{ij}} \; & \alpha_c \ln\left(C_{ij}\right) + (1-\alpha_c)\ln\left(H_{ij}\right) + f(L_{ij},T_{ij}) + \alpha_i \xi_j \\ \text{s.t. } & C_{ij} + P_j H_{ij} := I_{ij} = \exp\left(ability_i + I_j^0 + g(L_{ij},T_{ij}) + \eta_{ij}\right) \end{aligned} \tag{1}$$

The first two terms of the utility function ($\alpha_c \ln\left(C_{ij}\right) + (1-\alpha_c)\ln\left(H_{ij}\right)$) is of the standard C-D utility function of private consumption, with α_c being the share parameter that is constant across individuals. The following part ($f(L_{ij},T_{ij}) + \alpha_i \xi_j$) represents an individual's location preference. First, whether a city is one's origin home (T_{ij}) or the location of college education (L_{ij}) will influence her utility because she may have developed social connections and adapted to the lifestyle there. At this stage, we allow them to affect the utility in a flexible way which is captured by $f(L_{ij}, T_{ij})$. Second, we use ξ_j, a composite index of city characteristics, to represent the average attractiveness of city j and α_i, a random coefficient, to represent individual preference heterogeneity. Their interaction $\alpha_i \xi_j$ captures heterogeneous individual preference for locations. This specification is similar to that in Diamond (2016) who allows for a random coefficient on an index of city characteristics, but our paper is different in constructing the index ξ_j.

In the budget constraint, the price of the tradeable good is normalized to unit in all locations, and the housing price P_j varies across locations. An individual i's potential income in location j, I_{ij}, is first determined by i's unobservable ability, $ability_i$, and the base wage level of city j, I_j^0. We allow I_j^0 to be determined by the relative local average salary ($\widehat{avs}_j$) and unemployment rate ($\widehat{unemprate}_j$) in the following way:

$$I_j^0 = \delta_1 \widehat{avs}_j + \delta_2 \widehat{unemprate}_j \tag{2}$$

where $\widehat{avs}_j$ and $\widehat{unemprate}_j$ are the deviations from their national average, i.e. $\widehat{avs}_j = avs_j - \overline{avs}$ and $\widehat{unemprate}_j = unemprate_j - \overline{unemprate}$. Working in the city of college education or hometown can also influence one's potential income either because of better social connection or because of location specific human capital, and we use $g(L_{ij}, T_{ij})$ to represent the impact. η_{ij} is included to represent idiosyncratic shocks.[7]

Solving the utility maximization problem, the indirect utility for graduate i choosing location j, V_{ij}^*, can be expressed as follows:

$$V_{ij}^* = V_{ij} + \eta_{ij}, \tag{3}$$

where

$$V_{ij} = (\alpha_c - 1) \ln P_j + I_j^0 + \alpha_i \xi_j + f(L_{ij}, T_{ij}) + g(L_{ij}, T_{ij}). \tag{4}$$

Equation (4) indicates that both home location and education location can influence one's utility through two channels: the preference channel ($f(\cdot, \cdot)$) and the income channel ($g(\cdot, \cdot)$). In this paper, we do not endeavor to disentangle these two

[7]Instead of using this specification for I_{ij} herein, one can also predict for each individual the expected wages in all cities by estimating wage equations for each city and, possibly, using the correction method of Dahl (2002). We do not follow the latter approach because the survey has neither reliable wage data nor sufficient observations for each employment location.

channels. Thus, the estimated impact of education and home locations will be a gross effect including both preference and income effects. This will not hamper our analysis of their partial effects on the final location decision. To approximate these functions and to consider the heterogeneous effects as seen in section 4, we use the following linear form:

$$\begin{aligned} f(L_{ij}, T_{ij}) + g(L_{ij}, T_{ij}) =& \gamma_1 T_{ij} + \gamma_2 M_i T_{ij} + \gamma_3 S_i T_{ij} + \theta_1 L_{ij} + \theta_2 M_i L_{ij} + \theta_3 S_i L_{ij} \\ & + \theta_4 \widehat{GDP}_j L_{ij} + \theta_5 not211_i L_{ij} + \theta_6 R_i L_{ij} \end{aligned} \tag{5}$$

By including the interaction terms of education (and home) location and gender (M_i), single-child status (S_i), we allow graduates of different demographics to behave differently. We also allow the impact of education location to depend on the relative local economic condition ($\widehat{GDP}_j = GDP_j - \overline{GDP}$), the tier of his/her university ($not211_i$), and whether he/she comes from rural areas (R_i) by including their interactions with L_{ij}.[8]

Several issues arise when we estimate the impact of L_{ij}. First, an individual's preference for different location α_i may be related to his/her location choice of education. For example, an individual who loves working in Beijing may be more likely study in a university nearby than an average person. To deal with the endogeneity problem in the estimation, we allow α_i to be correlated with the location of education L_{ij}. We group locations of higher educations into five clustering regions as shown in tables 16 and 17, assuming that α_i follows normal distributions with different means (μ_r) and variances (σ_r^2) for graduates from different regions r. This assumption distinguishes our model from the standard mixed logit model that assumes independence between random coefficients α_i and other variables.

As a high housing cost is generally supported by favorable amenities, the second issue is that the location feature ξ_j, which is largely unobservable to researchers, might be correlated with housing cost $\ln P_j$ at the regional level. We will explain how to use the iterative BLP approach to consistently estimate ξ_j in the following section.

To complete the specification of our model, the random shock η_{ij} in (3) is assumed to follow iid Gumbel distribution. This assumption makes our model tractable even

[8] Since the results in Tables 3 and 4 suggest that the GDP level at home has negligible impact on one's propensity to choose the city of college education, we do not consider the interaction of GDP levels and one's home city to make our model as parsimonious as possible.

with unobservable α_i and ξ_j.

5.2 Estimation Method

We use a two-step procedure to estimate our model. The first step is itself an iterative procedure of the BLP method that is used to consistently estimate ξ_j. In the second step, we estimate the full model with estimated ξ_j using a random coefficient multinomial logit model that allows α_i to be correlated with the education locality.

There is an identification problem in separating the distribution of α_i and values of ξ_j, because for any constant c, $(c\alpha_i)(\frac{1}{c}\xi_j)$ has the same effect as $\alpha_i\xi_j$. Thus values of ξ_j can only be identified up to scale. We solve this problem by interpreting ξ_j as the average attractiveness of location j and start the initial estimation with α_i being unit. In terms of the iterative BLP procedure, we first assume that there is no individual heterogeneity in the preference for city characteristics, i.e. $\alpha_i = 1$. Then equation (4) can be simplified as:

$$V_{ij} = \pi_j + f(L_{ij}, T_{ij}) + g(L_{ij}, T_{ij}), \tag{6}$$

where π_j is the combination of housing cost, wage related characteristics, and ξ_j:

$$\pi_j = (\alpha_c - 1)\ln P_j + \delta_1 \widehat{avs}_j + \delta_2 \widehat{unemprate}_j + \xi_j. \tag{7}$$

Then an individual i's probability of choosing location j can be expressed as a function of π, a vector of all π_j:

$$P_{ij|\pi} = \frac{\exp(V_{ij}(\pi_j))}{\sum_l \exp(V_{il}(\pi_l))}. \tag{8}$$

The predicted share of the observations who choose location j, $\hat{s}_j$, can be obtained by integrating (8) over all observable individual characteristics. Thus we write $\hat{s}_j$ as $\hat{s}_j = \mathcal{S}_j(\pi, \Theta)$, where Θ includes all the parameters other than π. Let $\hat{s} = \mathcal{S}(\pi, \Theta)$ be the vector of predicted shares and s be the vector of observed shares. Given that Θ is fixed and one of the π_j is normalized to 0, Berry (1994) has proven that the equation system $s = \hat{s}$ has a unique solution for π, which can be estimated using the BLP contraction method (BLP 2015).[9] To implement this method, we start

[9] In our practice we always normalize π_{Chengdu} to be 0.

with some initial guess for π^0, and calculate the predicted share by $\mathcal{S}_j(\pi^0, \Theta)$. The estimate for π_j is obtained by repeating the following iteration:

$$\pi_j^{t+1} = \pi_j^t + ln\left(\frac{s_j}{\mathcal{S}_j(\pi^t, \Theta)}\right). \tag{9}$$

When the predicted share is larger (smaller) than the observed share, $ln\left(\frac{s_j}{\mathcal{S}_j(\pi^t,\Theta)}\right)$ is negative (positive) and adjusts π_j^0 downward (upwards). Repeating this process until π converges, we obtain the estimate of π for given Θ. Therefore we can express π as a function of Θ, namely $\pi(\Theta)$, using the BLP contraction.[10]

Then the choice probability in (8) becomes

$$P_{ij}^0 = \frac{\exp(V_{ij}(\Theta, \pi_j(\Theta)))}{\sum_l \exp(V_{il}(\Theta, \pi_l(\Theta)))}, \tag{10}$$

and the log likelihood function is given by

$$\ell^0 = \sum_i \sum_j Y_{ij} \ln\left(P_{ij}^0\right), \tag{11}$$

where Y_{ij} is an indicator for whether individual i chooses location j. Then we can use maximum likelihood estimation to estimate Θ, namely $\hat{\Theta}$, and $\pi(\hat{\Theta})$ becomes an estimation for π. With $\pi(\hat{\Theta})$, equation (7) can be estimated as a linear model with an endogenous explanatory variable $\ln P_j$.

To estimate equation (7) using GMM, we choose a number of factors from both the supply side and demand side of the local housing markets as the instruments for $\ln P_j$, which are summarized in Table 7. Given this initial estimation result, we can calculate the residuals in model (7) as an estimation for unobservable location features, $\hat{\xi}_j^{1st}$.[11] This initial estimation of ξ_j is unlikely to be consistent because we have not controlled for the individual heterogeneity in location preference, i.e. α_i.

In order to improve the estimation of ξ_j, we introduce the interaction term of preference heterogeneity α_i and the estimated location feature $\hat{\xi}_j^{1st}$ into the model. If the unobservable preference α_i is given, our model is simply a multinomial logit

[10] The BLP contraction algorithm can be slow in some applications. To speed it up, we use the SQUAREM method improved by Reynaerts, Jo and Varadha, R and Nash, John C (2012) instead and it is proved much faster than the BLP contraction.

[11] We also demean the residuals ever since such that the unnecessary mean does not accumulate itself and cause some numerical issues.

Table 7: INSTRUMENTS FOR $\ln P_j$

	Description of instruments
Supply side	Increment in land supply in 2009
	Increment in land supply in 2011
	Investment in house per capita in 2009
	Area of residential land per capita in 2009
Demand side	Share of migration from other towns within the same city in 2000
	Share of migration from other streets within the same city in 2000
	Share of migration from other streets within the same city in 2005
	Share of migration from other provinces in 2010

model and the conditional probability of choosing location j is:

$$P_{ij|\alpha_i} = \frac{\exp(V_{ij}(\alpha_i, \hat{\xi}_j^{1st}))}{\sum_l \exp(V_{il}(\alpha_i, \hat{\xi}_l^{1st}))}, \tag{12}$$

Since α_i's distribution is only affected by i's region of college education, we denote α_i's distribution as $f_r(\alpha_i)$, and individual i's choice probability of location j is given by the following integration:

$$P_{ij}^1 = \int_{-\infty}^{\infty} \frac{\exp(V_{ij}(\alpha_i, \hat{\xi}_j^{1st}))}{\sum_l \exp(V_{il}(\alpha_i, \hat{\xi}_l^{1st}))} f_r(\alpha_i) d\alpha_i. \tag{13}$$

Then the log likelihood function is given by

$$\ell^1 = \sum_i \sum_j Y_{ij} \ln \left(P_{ij}^1 \right), \tag{14}$$

and we can update our estimation of all parameters except the coefficients of housing cost and wage related characteristics.[12]

We use simulation method to calculate the log likelihood function with different parameters since the integration in (13) has no analytical expression. The speed of the algorithm depends on how efficiently we can simulate the integration in (13). For the efficiency of integration, we use Halton sequence method instead of Monte Carlo with random draws to reduce the number of draws of α_i while keep

[12]There is no need to update these parameters right now since we treat the combination of housing cost and wage related characteristics as a term which has been estimated in the previous step.

an accurate approximation.

As ξ_j's estimation and α_i's distribution parameters' estimation are carried out sequentially in this procedure, we cannot guarantee that their initial estimates are consistent. We use an iterative procedure to approach the consistent estimate of ξ_j. We introduce ξ_j^{2nd} in our model to capture any estimation error of ξ_j in the following way:

$$V_{ij} = \pi_j + \alpha_i \xi_j^{1st} + f(L_{ij}, T_{ij}) + g(L_{ij}, T_{ij}), \tag{15}$$

where

$$\pi_j = (\alpha_c - 1) \ln P_j + \delta_1 \widehat{avs}_j + \delta_2 \widehat{unemprate}_j + \xi_j^{2nd}. \tag{16}$$

Based on the estimation results of ξ_j^{1st}, we can estimate π_j and ξ_j^{2nd} using the BLP contraction method and GMM as discussed previously. Then we will have a new estimate for ξ_j, which is $\hat{\xi}_j^{1st} + \hat{\xi}_j^{2nd}$. We continue to update ξ_j's estimate by repeating this procedure until all information on ξ_j has been recovered from equation (16). Notice the updated estimation $\hat{\xi}_j^{nth}$ gives addendum to previous estimations of ξ_j, and gradually $\hat{\xi}_j^{nth}$ becomes constant over locations.[13] Intuitively, the variance of $\hat{\xi}_j^{nth}$ indicates whether $\hat{\xi}_j^{nth}$ contains extra information about variation of location amenity. As its variance decreases, extra information contained by each new iteration diminishes. In our practice the eighth iteration reaches the smallest variance as shown in figure 1 later on. So we stop the iteration at the eighth round and the accumulated information of $\sum_{n=1}^{8} \hat{\xi}_j^{nth}$ gives a consistent estimation of ξ_j.

Having consistently estimated ξ_j, namely $\hat{\xi}_j$, we can estimate the following full model using MLE:

$$V_{ij} = (\alpha_c - 1) \ln P_j + \delta_1 \widehat{avs}_j + \delta_2 \widehat{unemprate}_j + \alpha_i \hat{\xi}_j + f(L_{ij}, T_{ij}) + g(L_{ij}, T_{ij}). \tag{17}$$

The corresponding individual choice probability is

$$P_{ij} = \int_{-\infty}^{\infty} \frac{\exp(V_{ij}(\alpha_i, \hat{\xi}_j))}{\sum_l \exp(V_{il}(\alpha_i, \hat{\xi}_l))} f_r(\alpha_i) d\alpha_i, \tag{18}$$

A MLE similar to (14) produces the final estimation of our model.

[13]Since we always demean the residuals, $\hat{\xi}_j^{nth}$ will become constant 0.

6 Empirical Results

In this section, we first report the estimation results of our reference model, a standard conditional logit model without considering unobservable location features and preference heterogeneity. Then, we report the results for the models that consider both location fixed effects and individual heterogeneity. Finally, we perform some counterfactual exercises to calculate changes in choice probability due to shifting education locality.

6.1 Model Parameters

As a starting point, Table 8 reports the reference estimation results for the model that does not consider unobservable location features and preference heterogeneity.

Table 8: BASELINE MODEL RESULTS

	coefficient	std. err.
$\ln(P_j)$	1.0465***	0.0690
avs_j	0.1501***	0.0105
$unemprate_j$	-0.0098	0.0082
T_{ij}	4.3040***	0.0547
M_T	-0.2984***	0.0638
S_T	0.3520***	0.0658
L_{ij}	2.6261***	0.1112
M_L	-0.2971***	0.0725
S_L	-0.0245	0.0757
GDP_L	0.4727***	0.0265
$not211\_L$	0.0783	0.0988
R_L	0.4848***	0.0700

[1] *, **, *** represent statistical significance at the 10%, 5%, 1% levels.

The result indicates that studying in one locality significantly increased one's probability of working there upon graduation. Strong economic performance of the education location further increases that propensity. Relative to male graduates and those from urban areas, female graduates and those from rural areas are significantly more likely to stay in where their universities are located. The coefficients on the interactions between university location and university tiers and the graduates' only-child status are not statistically significant. But, they indicate that graduates from elite universities and the only-child students are less likely to stay in where they went to college.

The coefficients on hometown location (T) and its interactions with other variables indicate that college graduates are significantly more likely to find employment in their hometown cities. Female graduates and the only-child graduates are significantly more likely to do so. However, cities with higher housing costs are more attractive to college graduates than those with lower housing costs. This is because this baseline model does not control for local amenities. As shown in figure 2 latter, these missing location features are positively related to housing cost as a result of migration equilibrium. If the effects of favorable amenities dominate the negative effect of $\ln P_j$, omitting the location features may result in a positive coefficient of $\ln P_j$.

Table 9 shows estimation result considering the unobservable location features ξ_j but no personal preference heterogeneity, which is the first step in our iterative BLP process described in section 5.2. As explained previously, we first estimate parameters other than π_j using MLE and get $\hat{\pi}_j$ using the BLP contraction method. To estimate the coefficient of $\ln P_j$ and ξ_j, we use the instruments listed in Table 7 for $\ln P_j$. A p-value of 0.69603 in the over-identification test suggests that we cannot reject the exogeneity assumption of these instruments. While the coefficient of housing cost is positive and not statistically significant in the OLS estimation of equation (7), it becomes negative and significant at the 10% level in the GMM estimation. Furthermore, the coefficients of average local income and unemployment rate are significant with the expected sign.

As we have not considered the individual heterogeneity in the location preference, the estimated coefficients reported in Table 9 and the estimated location features are likely to be inconsistent. Thus we apply the iterative procedure as discussed in section 5.2. We use the variance of $\hat{\xi}_j^{nth}$ to assess the accuracy of the estimates for ξ_j. Figure 1 shows that after eighth round of iteration, the variance of $\hat{\xi}_j^{nth}$ approaches zero. This suggests that the location amenities in ξ_j has already been identified out. In this case, both GMM and OLS give consistent estimation of equation (7), which is consistent with the reported result in Table 10. All these clues suggest that our GMM estimation of linear model (7) is acceptable and can give a consistent estimation of ξ_j. We plot these estimated location features against logarithm of

Table 9: Estimation For Location Features ξ_j (1st Iteration)

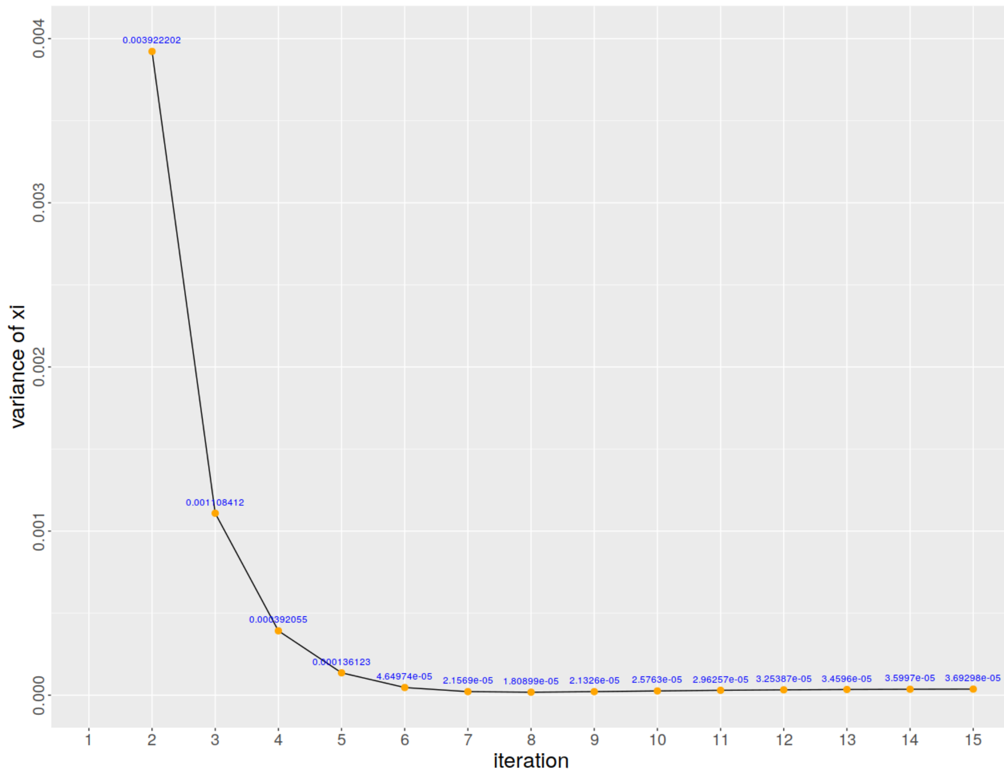
Second Step	GMM	
	coefficient	std. err.
$\ln(P_j)$	-2.2090*	1.2524
avs_j	0.5742***	0.1720
$unemprate_j$	-0.2128**	0.0952
	OLS	
$\ln(P_j)$	0.4005	0.4557
avs_j	0.2635***	0.0880
$unemprate_j$	-0.0753	0.0604
First Step	SML	
T_{ij}	3.7937***	0.0624
M_T	-0.2257***	0.0655
S_T	0.2636***	0.0675
L_{ij}	1.8067***	0.1140
M_L	-0.1620**	0.0709
S_L	-0.0167	0.0744
GDP_L	0.5346***	0.0319
$not211\_L$	0.4287***	0.1010
R_L	0.4263***	0.0690

[1] *, **, *** represent statistical significance at the 10%, 5%, 1% levels.
[2] J-Test for exogeneity: (1) degrees of freedom is 7; (2) P-value = 0.69603.

housing costs in figure 2, which shows a strong positive correlation between them.

Given the consistent estimation of the location features $\hat{\xi}_j$, Table 11 reports the parameter estimation of the full model considering heterogeneous preference α_i with distinct distributions. Of all the five regions of education, Central and Zhejiang areas have average values of α_i larger than unit, and ChuanYu, ShanDong and Northwest areas have average values of α_i less than unit, with the students from the Northwest giving location features ξ_j the least weight of 0.6642. For the dispersion of α_i, ChuanYu and Central areas have larger standard deviations (around 0.36) than the other three regions whose standard deviations in α_i are quite small. This suggests that students in ChuanYu and Central regions have more heterogeneity in their preference α_i than students in other regions.

Figure 1: Information of each iteration is diminishing



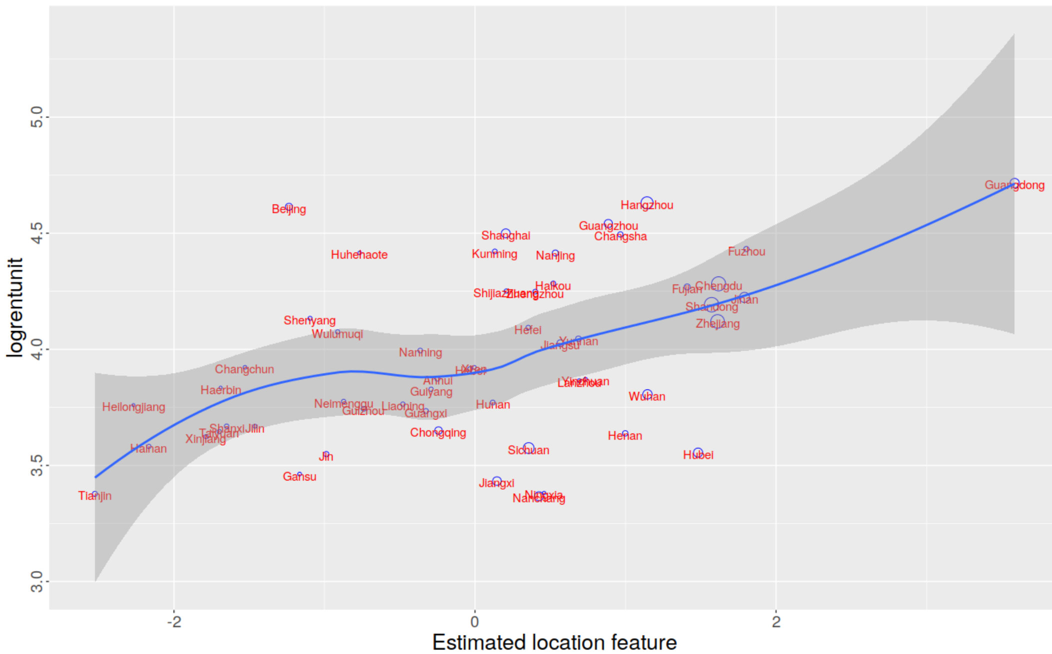
6.2 Counterfactual Analysis

Furthermore we can evaluate the economic significance of the effect of education locality and its heterogeneity by calculating the marginal effects using the estimation results from the full model. As universities are usually located in provincial capitals and they are the favorite destinations of college students, we focus on capital cities. The marginal effect is calculated as the incremental chances of choosing each city if students were assigned to study there relative to the probability of choosing the same city without changing the students' study locality. This effect is calculated for all graduates whose actual locality of graduation is not the target city.[14] Specifically, the marginal effect of studying in city j for individual i is calculated as follows:

$$\Delta P_{ij} = Pr(Y_{ij} = 1 | L_{ij} = 1, X) - Pr(Y_{ij} = 1 | L_{ij} = 0, X), \tag{19}$$

[14]Keep in mind that we didn't calculate the effect for graduates study in the target city already since there is no obvious alternative city to be compared with.

Figure 2: Higher housing costs are complemented by higher level of amenities



where X is a symbol for all observable attributes of graduate i except his/her locality of higher education.

Note that while the second term ($Pr(Y_{ij} = 1|L_{ij} = 0, X)$) is the actual probability, the first term ($Pr(Y_{ij} = 1|L_{ij} = 1, X)$) is a counterfactual that can be calculated using our estimation results in Table 11 and the formula (18) with the unchanged distribution of α_i. By averaging individual effects for all individuals whose actual study locality is different from city j, we obtain the average marginal effect of studying in city j:

$$\Delta P_j = \frac{1}{N_{(-j)}} \sum_{i \in (-j)} \Delta P_{ij} \tag{20}$$

Table 12 collects these causal effects of changing education locality for all capital cities and subgroups of different demographics. The first column reports the overall marginal effect for different capital cities. Clearly, going to college in a city increases the probability of choosing to stay there upon graduation. For example, studying in Lanzhou (the median city) will increase the probability of staying there by 4.4 percentage points. Meanwhile, this effect varies considerably across cities. While studying in Guangzhou, Shanghai, Chengdu and Hangzhou will increase one's probability of staying by over 40 percentage points, the attractiveness of a number of

Table 10: Estimation For Location Features ξ_j (Last Iter.)

Second Step	GMM	
	coefficient	std. err.
$\ln(P_j)$	-2.2168***	0.0050
avs_j	0.5734***	0.0007
$unemprate_j$	-0.2090***	0.0004
	OLS	
$\ln(P_j)$	-2.2269***	0.0019
avs_j	0.5746***	0.0004
$unemprate_j$	-0.2095***	0.0002
First Step	SML	
T_{ij}	3.7762***	0.0519
M_T	-0.2368***	0.0651
S_T	0.2735***	0.0674
L_{ij}	1.8608***	0.1100
M_L	-0.1655**	0.0708
S_L	-0.0170	0.0740
GDP_L	0.5288***	0.0260
$not211\_L$	0.4090***	0.0979
R_L	0.4309***	0.0691
$\mu_{ChuanYu}$	0.9913***	0.0316
$\mu_{Central}$	1.1372***	0.0269
$\mu_{Zhejiang}$	1.1358***	0.0553
$\mu_{ShanDong}$	0.8751***	0.0399
μ_{Xibei}	0.6615***	0.0538
$\sigma_{ChuanYu}$	0.3601***	0.0474
$\sigma_{Central}$	0.3628***	0.0406
$\sigma_{Zhejiang}$	0.0195	0.1020
$\sigma_{ShanDong}$	5.7e-10	0.0002
σ_{Xibei}	0.0057	0.1155

[1] *, **, *** represent statistical significance at the 10%, 5%, 1% levels.

[2] J-Test for exogeneity: (1) degrees of freedom is 6; (2) P-value = 0.70178.

cities increases only slightly after providing college education. This heterogeneity is expected because the effect of college locality is significantly affected by a number of other factors including economic development level and city amenities. It is obvious

Table 11: Estimation Results Using Estimated ξ_j

	coefficient	std. err.
$\ln(P_j)$	-2.2313***	0.1153
avs_j	0.5754***	0.0169
$unemprate_j$	-0.2099***	0.0105
T_{ij}	3.7751***	0.0568
M_T	-0.2366***	0.0651
S_T	0.2734***	0.0675
L_{ij}	1.8587***	0.1116
M_L	-0.1651**	0.0709
S_L	-0.0170	0.0743
GDP_L	0.5294***	0.0269
$not211\_L$	0.4100***	0.0984
R_L	0.4308***	0.0691
$\mu_{ChuanYu}$	0.9940***	0.0381
$\mu_{Central}$	1.1403***	0.0360
$\mu_{Zhejiang}$	1.1381***	0.0582
$\mu_{ShanDong}$	0.8782***	0.0467
$\mu_{Northwest}$	0.6642***	0.0579
$\sigma_{ChuanYu}$	0.3612***	0.0482
$\sigma_{Central}$	0.3638***	0.0418
$\sigma_{Zhejiang}$	0.0195	0.1021
$\sigma_{ShanDong}$	5.7e-10	0.0002
$\sigma_{Northwest}$	0.0057	0.1155

[1] *, **, *** represent statistical significance at the 10%, 5%, 1% levels.

that the top cities are those with dynamic economies and attractive amenities. It remains true that the effect varies considerably across cities when we consider different subgroups. It is also interesting to notice that these effects are polarized over these capital cities. The casual effect can be as large as 0.85 in Guangzhou and as small as 0.005 in Guiyang and these values decrease very fast. This finding can also be regarded as evidence of regional divergence as mentioned by Moretti (2012).

To further explore the heterogeneous effect, we report the average marginal effect for different subgroups in the following 8 columns. Columns 2 and 3 compare the effects for graduates from elite ("211") and non-elite (non-"211") universities. It remains true that college education increases one's probability of staying. However,

Table 12: Average Marginal Effects of Location of Higher Education of 29 Capital Cities Without Assimilation

	Overall	211	Non-211	Male	Female	Single	Non-single	Rural	Urban
Guangzhou	0.8495	0.8204	0.8557	0.8434	0.8548	0.8264	0.8630	0.8817	0.8292
Shanghai	0.6042	0.5620	0.6132	0.5935	0.6135	0.5550	0.6330	0.6725	0.5610
Chengdu	0.4816	0.4244	0.4939	0.4712	0.4916	0.4282	0.5099	0.5512	0.4377
Hangzhou	0.4488	0.3772	0.4678	0.4349	0.4609	0.3989	0.4759	0.5225	0.4011
Beijing	0.3998	0.3831	0.4034	0.3927	0.4060	0.3476	0.4304	0.4699	0.3555
Changsha	0.3468	0.3031	0.3562	0.3368	0.3556	0.2992	0.3748	0.4157	0.3033
Jinan	0.2947	0.2437	0.3039	0.2852	0.3026	0.2535	0.3196	0.3577	0.2563
Wuhan	0.2220	0.1855	0.2307	0.2132	0.2297	0.1848	0.2433	0.2759	0.1862
Hefei	0.2017	0.1749	0.2074	0.1952	0.2072	0.1671	0.2219	0.2520	0.1698
Nanjing	0.1996	0.1680	0.2063	0.1920	0.2062	0.1654	0.2197	0.2505	0.1674
Tianjin	0.1747	0.1751	0.1746	0.1715	0.1775	0.1443	0.1925	0.2169	0.1481
Nanchang	0.0976	0.0825	0.1011	0.0936	0.1010	0.0794	0.1095	0.1274	0.0793
Yinchuan	0.0759	0.0588	0.0792	0.0715	0.0797	0.0612	0.0845	0.0999	0.0605
Fuzhou	0.0682	0.0526	0.0715	0.0641	0.0718	0.0559	0.0754	0.0884	0.0554
Lanzhou	0.0448	0.0341	0.0472	0.0417	0.0475	0.0360	0.0502	0.0599	0.0355
Shenyang	0.0415	0.0375	0.0424	0.0400	0.0429	0.0332	0.0464	0.0543	0.0335
Chongqing	0.0364	0.0302	0.0372	0.0331	0.0391	0.0301	0.0401	0.0503	0.0278
Zhengzhou	0.0325	0.0257	0.0340	0.0307	0.0342	0.0256	0.0366	0.0431	0.0259
Nanning	0.0289	0.0237	0.0300	0.0272	0.0304	0.0228	0.0325	0.0381	0.0231
Taiyuan	0.0280	0.0248	0.0287	0.0273	0.0286	0.0217	0.0317	0.0367	0.0225
Changchun	0.0247	0.0237	0.0249	0.0236	0.0256	0.0196	0.0277	0.0321	0.0200
Huhehaote	0.0202	0.0179	0.0207	0.0194	0.0209	0.0158	0.0228	0.0267	0.0161
Shijiazhuang	0.0196	0.0155	0.0205	0.0187	0.0204	0.0153	0.0221	0.0257	0.0158
Kunming	0.0190	0.0143	0.0200	0.0178	0.0201	0.0151	0.0214	0.0257	0.0148
Xi'an	0.0146	0.0111	0.0153	0.0138	0.0153	0.0113	0.0165	0.0197	0.0114
Wulumuqi	0.0125	0.0106	0.0129	0.0116	0.0132	0.0099	0.0140	0.0165	0.0099
Haikou	0.0107	0.0073	0.0115	0.0099	0.0114	0.0085	0.0120	0.0144	0.0084
Haerbin	0.0097	0.0085	0.0100	0.0092	0.0101	0.0077	0.0109	0.0129	0.0077
Guiyang	0.0049	0.0031	0.0053	0.0045	0.0053	0.0037	0.0056	0.0070	0.0036

Note: Cities are in descending order according to the overall average effects.

the effects for the graduates from elite universities are significantly less than for those from non-elite universities. There are several potential reasons for this difference. First, elite universities tend to be comprehensive and research based, which makes their linkage with local economy weaker. In contrast, non-elite universities are more likely to cater the local demand for workers. Second, graduates from elite universities are of higher ability and they have more outside options.

Columns 4 and 5 show that female graduates tend to choose staying at where they got college education to a greater extent than male graduates do. But the gender difference is relative small, ranging from 0 to 3 percentage points. Columns 6 and 7 show that the only-child graduates are less likely to stay relative to non-only-child graduates, which could be explained by the fact that single child graduates prefer to return home. Finally, columns 8 and 9 suggest that the effect of college education on their tendency to stay at the education city is significantly larger for students from rural areas than those from urban areas.

7 Search and Work in the College Education City

In this section, we discuss why college education can increase an individual's chance of working in the college education city. First, we show that working in the city of a college education has an advantage in obtaining job-related information. In Table 13, we compare the frequencies of using various channels for those who have chosen the college city and those who have not. Each row is a regression of the frequency of using one specific channel (four values of 1, 2, 3, and 4 for Never, Rarely, Fair often, Often) on whether one chooses his/her education city (a dummy variable of stayer) and a set of covariates. The results show that those who choose to stay in the college city use various information channels including intermediary agency, employer advertisement, job fairs, internet, and internship more often than those who do not. There is no significant difference in the use of social network between these two groups. The results in Table 13 suggests that going to college in one city increased the chances of interacting with the local employers when the students conducted a job search.

Table 13: Use of information channel

		stayer	s. e.	Obs	R-squared
(1)	university (department) provided	0.032	(0.024)	5,887	0.183
(2)	intermediary agency	0.070***	(0.026)	5,795	0.073
(3)	written advertisement from employers	0.064**	(0.026)	5,772	0.053
(4)	specialized job fairs	0.094***	(0.027)	5,795	0.069
(5)	information from job fairs	0.055**	(0.028)	5,549	0.082
(6)	media advertisement	0.098***	(0.027)	5,795	0.087
(7)	parents and relatives	-0.020	(0.026)	5,777	0.146
(8)	friends and aquaintance	0.033	(0.025)	5,763	0.097
(9)	internet	0.047*	(0.027)	5,799	0.064
(10)	internship employers	0.052*	(0.029)	5,497	0.079

[1] We controlled for gender, ethnicity, rural Hukou, home location, fields of study, university dummies, household income, parents' education, and a constant term.
[2] *, **, *** represent statistical significance at the 10%, 5%, 1% levels.

Table 14 shows that the numbers of job positions applied and interviews before a job was found were lower for the stayers than those who choose to work elsewhere. As a result, although the stayers use various information channels more often than the other group as shown in Table 13, their total cost of job search is actually lower.

Table 14: Search Cost and Search Results and Decision to Stay

		stayer	SE	Obs.	R-squared
(1)	Ln(minimum acceptable start salary)	-0.039***	(0.012)	6,771	0.265
(2)	number of employers applied	-4.405	(7.052)	6,498	0.013
(3)	number of interviews	-5.656	(6.958)	6,515	0.013
(4)	Ln(cost related to search activities)	-0.124***	(0.046)	5,864	0.129
(5)	employer offer local Hukou	-0.034***	(0.012)	6,995	0.158
(6)	private enterprise employer	0.059***	(0.012)	6,995	0.140
(7)	manufacturing	-0.054***	(0.010)	6,995	0.074
(8)	IT	0.037***	(0.009)	6,995	0.070
(9)	highest education level required	-0.012	(0.020)	6,868	0.156
(10)	mismatch	-0.030	(0.025)	6,838	0.065
(11)	unsatisfied with job found	0.010	(0.021)	6,881	0.058

[1] We controlled for gender, ethnicity, rural Hukou, home location, fields of study, university dummies, household income, parents' education, and a constant term.
[2] See the text for the definition of dependent variables.
[3] *, **, *** represent statistical significance at the 10%, 5%, 1% levels.

In rows 5 to 8 in Table 14, we relate Hukou obtainment (a dummy equal to one if a graduate obtained local Hukou of the work city), ownership type (a dummy for private enterprises), and industry distribution (dummies for manufacturing and IT industries) to the stayer status. The results indicate that the stayers are less likely to be given local Hukou status when they stay in the college city, and they are more likely to be in the private sector. These two patterns are consistent because private sector employers are less likely to provide local Hukou. They also suggest that the demand elasticity of college-educated workers is larger in cities with a higher share of the private sector. In terms of industry distributions, stayers are less likely to be in the manufacturing industry, but more likely to be in the IT industry. This may be because the manufacturing industry is labor intensive and has less demand for skilled workers, while the IT industry is just the opposite case.

In row 10, we use a categorical variable of job match quality as dependent variable which ranges from 1 to 4 with each value representing well matched, matched, somewhat matched, and totally unrelated, respectively. The negative coefficient of *stayer* indicates that the job found by a stayer is less likely to be mismatched with the job seeker's field of study. However, the coefficient is insignificant statistically. There is no significant difference in job satisfaction (the dependent variable ranges from 1 to 5 representing very satisfied, satisfied, so so, unsatisfied, and very unsatisfied, respectively) between stayers and others (row 11).

In Table 15, we consider the relationship between job match quality and stayer status for different groups of graduates. The result indicates that while there is no significant association between stayer status and job mismatch for university students, the extent of mismatch is significantly lower for stayers than for others in the professional college group. As for satisfaction with the job found, 211 university students are more likely to be unsatisfied if the job is in the education city. For students of other groups, there is no significant difference in job satisfaction between stayers and others. These findings are consistent with the fact that university students (especially those from the elite universities) are more willing and able to find employment in a broader scope. By contrast, professional college students are more confined in the city of their college education, and professional colleges are themselves more able to serve the local economy.

Table 15: Stay and Mismatch and Job Satisfaction for Subsamples

	stayer	SE	Obs.	R-squared
job mismatch				
211 university students	0.082	(0.063)	1,157	0.139
non211 university students	-0.005	(0.040)	2,044	0.052
professional college students	-0.078**	(0.036)	3,637	0.043
unsatisfied with job				
211 university students	0.086	(0.055)	1,166	0.077
non211 university students	-0.017	(0.036)	2,057	0.088
professional college students	-0.001	(0.029)	3,658	0.050

1 We controlled for gender, ethnicity, rural Hukou, home location, fields of study, university dummies, household income, parents' education, and a constant term.
2 *, **, *** represent statistical significance at the 10%, 5%, 1% levels.

The results in this section show that studying in one city increases the chances of interacting with the local economy, which in turn increases the probability of the students choosing their education city when they search for employment. However, the ability to absorb college graduates depends on the structure of the local economy. Thus, the results here also support our counterfactual analysis which shows significant heterogeneity in the impact of college location in different cities.

8 Conclusions

The distribution of college-educated workers across regions has a major impact on regional social-economic development. The location choice of college students upon graduation is a major stage that determines the distribution, especially in countries where the higher education institutions are unevenly distributed and the mobility of educated workers is relatively low after graduation. In this paper, we examine empirically the location choice of college graduates in China, paying special attention to their tendency to choose the location of their college education.

We construct a model of location choice, in which individuals choose the one that produces the highest level of utility. As the location of a college education is often endogenously determined by the individual preference for cities, we introduce individual heterogeneity in the model and allow its distribution to depend on the region of education. We find that college education in one place significantly increased one's propensity to remain there for employment. We then examine the heterogeneity of this tendency, finding that non-single-child, female college graduates from lower-tier universities majoring in applied sciences/engineering are more likely to stay. We also find that internship experience during college education is a significant factor that increases one's tendency to stay, highlighting the importance of internship in the transition from school to the labor markets.

The results of this paper have major policy implications for regional economic development. It implies that unevenly distributed higher education resources contribute to the regional gap in education levels. It also suggests that the demand elasticity of college-educated workers is important if the local government tries to produce educated workers through financing or subsidizing higher education institutions. The local universities/colleges should cater to the demand of local economy by forming appropriate fields of study and by establishing close connections with local employers. Elite universities may focus on developing high quality general human capital for the whole society and research or knowledge creation. Thus the central government should cover a larger portion than the local government when finance the elite universities.

Competing interests

The authors declare that they have no competing interests.

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Table 16: Samples attrition due to missing home location

	Chuan-Yu			Central			Shandong		Zhejiang	Northwest	
	Sichuan w/o Chengdu	Chengdu	Chongqing	Hubei w/o Wuhan	Wuhan	Nanchang	Shandong w/o Jinan	Jinan	Hangzhou	Lanzhou	Yinchuan
Sample size	596	2307	897	509	2074	2654	1809	1527	2864	1825	1441
Home location missing	111	422	247	125	752	660	463	318	714	466	457
Ratio	18.6%	18.3%	27.5%	24.6%	36.3%	24.9%	25.6%	20.8%	24.9%	25.5%	31.7%

Table 17: Samples without work location

	Chuan-Yu			Central			Shandong		Zhejiang	Northwest	
	Sichuan w/o Chengdu	Chengdu	Chongqing	Hubei w/o Wuhan	Wuhan	Nanchang	Shandong w/o Jinan	Jinan	Hangzhou	Lanzhou	Yinchuan
Total sample size	485	1885	650	384	1322	1994	1346	1209	2150	1359	984
With working location	313	1092	419	129	699	1367	828	716	1227	301	346
W/O working location	172	793	231	255	623	627	518	493	923	1058	638
Main reasons											
Enter graduate school	18	168	97	76	130	142	132	247	259	165	97
Plan to enter graduate school	7	46	14	22	36	17	29	28	48	30	27
Go abroad	9	54	11	1	24	10	5	17	66	12	7
Haven't find a job	69	279	48	86	217	243	168	70	284	572	317
Job w/o location info	59	192	45	57	167	179	165	106	207	207	131

[1] Much more graduates from Lanzhou and Yinchuan failed to find a job before leaving campus.

Table 18: First stage results for IV estimation (dependent var.=intern)

	(1)	(2)	(3)	(4)
male	-0.017*	-0.016	-0.016	-0.005
	(0.009)	(0.010)	(0.010)	(0.010)
rural	0.011	0.015	0.015	0.012
	(0.009)	(0.010)	(0.010)	(0.010)
han	0.032**	0.027	0.025	0.032*
	(0.016)	(0.018)	(0.018)	(0.018)
only child	-0.018*	-0.021**	-0.021**	-0.028***
	(0.009)	(0.010)	(0.010)	(0.010)
household income pc	0.004*	0.005*	0.004	0.004
	(0.003)	(0.003)	(0.003)	(0.003)
211 univ.	-0.022*	-0.019	-0.014	
	(0.012)	(0.013)	(0.014)	
non211 univ.	0.010	-0.000	0.000	
	(0.010)	(0.011)	(0.011)	
engineering/medical	-0.025**	-0.029***	-0.030***	-0.017
	(0.010)	(0.011)	(0.011)	(0.012)
art	-0.020	-0.009	-0.009	0.011
	(0.020)	(0.023)	(0.023)	(0.024)
literature/phil./history	-0.031**	-0.018	-0.017	-0.015
	(0.015)	(0.016)	(0.016)	(0.017)
science	-0.012	0.001	0.002	-0.015
	(0.023)	(0.025)	(0.025)	(0.026)
study at home city		0.022**	0.026**	0.006
		(0.011)	(0.012)	(0.016)
gdp home			-0.001	0.000
			(0.001)	(0.001)
gdp study			0.003	0.023***
			(0.003)	(0.008)
interniv	0.430***	0.404***	0.404***	0.342***
	(0.022)	(0.024)	(0.024)	(0.026)
univ. dummies	no	no	no	yes
Obs.	6,434	5,336	5,336	5,336
R-squared	0.076	0.070	0.070	0.084

[1] *, **, *** statistically significant at the 10%, 5%, 1% levels.