Migration Restrictions, College Choices, and Spatial Skill Sorting*

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Abstract

College education is widely regarded as a pathway to local labor markets, particularly where migration frictions limit labor mobility. This paper examines how such frictions shape college choices in China, where mobility is constrained by both formal migration restrictions and informal barriers. Using a national administrative dataset on four-year college admissions from 2005 to 2011, I show that relaxing migration restrictions through *hukou* reforms enabled colleges in reformed cities to attract higher-quality students. The largest gains occurred in colleges located in economically more developed cities relative to students' origins, consistent with the mechanism of improved local labor market prospects. Counterfactual analysis based on a college choice model indicates that easing migration restrictions in major cities strengthens the sorting of stronger students into treated colleges and raises aggregate welfare, though the gains are unevenly distributed. Welfare increases further when students can freely access the highest-paying labor markets. These results highlight the role of both formal and informal migration frictions in shaping spatial skill sorting and welfare.

Keywords: *Hukou* Reforms; College Choices; Student Ranks; Sorting; Welfare
JEL Codes: I23, J68, R13

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1 Introduction

College education is widely considered a pathway to local labor markets. Many students pursue higher education abroad, such as in the U.S., with the expectation of improved employment opportunities at the destination (Rosenzweig et al., 2006; Borjas, 2002). Immigration policy shifts in the U.S. offer notable evidence. In 2025, tightening restrictions on the H-1B visa program—the primary channel through which U.S. employers hire foreign professionals—and a proposed rule to limit the Optional Practical Training (OPT) program raised concerns about the future demand for U.S. higher education among international students (Kapur and Vaishnav, 2025; Anderson, 2025). Earlier evidence shows the sharp reduction in the H-1B visa cap in 2003 led to significant declines in both the number (Shih, 2016) and the quality (Kato and Sparber, 2013) of international student enrollments. Domestic students also consider local labor market conditions, tending to enroll in colleges located in states with stronger economies (McHugh and Morgan, 1984; Morgan, 1983).

Migration frictions explain why local labor market prospects influence college choices. In the absence of such frictions, students would choose colleges to enhance human capital and could freely relocate after graduation to regions offering the highest returns to their skills. In that case, local labor market conditions would not affect college choices. However, when migration frictions are present, students place greater weight on the expected post-graduation returns in the college location. First, studying near the target labor market reduces job search costs by lowering travel expenses and improving access to employer information. Second, students accumulate location-specific human capital during college (Winters, 2011). Their skills, internship experiences, and networks are tied to local economies, and relocating after graduation can diminish the value of these investments. This process is reinforced by firms' recruitment practices, which often concentrate on nearby campuses where they are more familiar with students' qualifications. Taken together, proximity to the desired labor market raises the returns to college education when transitioning into employment.

These considerations suggest that migration frictions constraining labor mobility may shape how students sort into colleges. China provides a valuable setting to examine the role of migration frictions on student sorting. First, domestic labor mobility is constrained by both informal barriers and formal migration restrictions imposed through the *hukou* (household registration) system. The *hukou* system was originally designed to support China's early industrialization by controlling internal migration and binding individuals to their registered place of residence, usually their birthplace. Although it no longer prohibits physical migration, it continues to shape migration through exclusive access to public services and welfare for local *hukou* holders and limited employment opportunities for non-locals. This institutional separation between movement and entitlement is analogous to international migration, where immigrant workers do not automatically acquire citizenship rights (Chan, 2010). In response to calls to reform this two-tier citizenship regime and to stimulate domestic consumption (Chan, 2010), the management of the *hukou* system was largely decentralized in the mid-1990s, allowing cities to set their own criteria for granting local status. In recent years, some cities have further relaxed these requirements, thereby expanding non-locals' access to urban labor markets. The staggered rollout of such *hukou* reforms across cities provides a valuable quasi-experimental setting to study how easing migration restrictions affects the attractiveness of local colleges to prospective students.

Second, China's college admissions system further facilitates analysis. Colleges admit students solely based on their performance in the annual high-stakes National College Entrance Examination (NCEE), making the NCEE rank a credible measure of student quality. Moreover, college admission preferences are effectively one-dimensional, eliminating the need to recover the complex, multidimensional preference structures of colleges observed in systems such as those in the United States (Knight and Schiff, 2022) and France (Fabre, 2023).

This paper addresses the following central questions: How do relaxations of migration restrictions through *hukou* reforms influence student sorting across colleges? What are the resulting effects on aggregate welfare and its distribution? More broadly, how would student outcomes change if students could access the highest-paying labor markets without migration frictions? To address these questions, I combine reduced-form evidence with counterfactual analysis from a college choice model.

In the reduced-form analysis, I estimate the causal impact of *hukou* reforms on admitted student quality using a difference-in-differences (DiD) approach. The analysis draws on the universe of administrative records for four-year college admissions from 2005 to 2011. The baseline analysis employs a regression-based 2×2 DiD framework, comparing outcomes between the first and last years of the study period (2005 and 2011). This design is motivated by two considerations. First, students may need time to learn about policy changes and adjust their college application decisions accordingly; therefore, immediate responses may understate the full effect. Second, recent research suggests that applying ordinary least squares (OLS) to staggered DiD designs with heterogeneous effects can yield biased estimates. To address these concerns and reinforce the credibility of the baseline results, I also implement an event-study design using the methods developed by Borusyak et al. (2024).

A key identification challenge arises from the potential endogeneity of *hukou* reforms. Smaller cities may have been more inclined to implement reforms to offset limited population growth, whereas larger cities may have adopted more relaxed policies in response to strong labor demand. Moreover, although city governments hold primary authority over *hukou* policies, provincial governments may issue overarching guidelines that introduce confounding variation. Accordingly, the baseline specification includes fixed effects to account for unobserved, time-invariant differences across destination cities and also restricts comparisons to similar colleges located in different provinces. Additionally, balance tests show that pre-reform changes in economic indicators do not systematically differ between treated and control cities, reinforcing the validity of the identification strategy. Consistently, the event study reveals no evidence of differential pre-reform trends in student ranks, supporting the parallel trends assumption.

The results suggest that the NCEE ranks of students admitted to colleges in reformed cities improve significantly following the *hukou* reforms. Specifically, the median student rank at treated colleges rises by 2.4 percentage points. This effect is substantial, given that the interquartile range (25th to 75th percentile) spans only 11 percentage points. The findings are robust to restricting the control group to cities that do not compete with treated cities for the same student pool. Moreover, a placebo test examining the correlation between student rank changes during 2005–2011 and future reform shocks occurring between 2011–2013 yields no significant results, further supporting the causal interpretation of the main findings.

I present evidence that *hukou* reforms increase the attractiveness of colleges in reformed cities by improving non-locals' labor market prospects in those cities. The gains in student quality are larger for colleges located in economically more developed cities relative to students' origins, where obtaining local *hukou* in the college city is especially valuable. Within provinces, the share of local students—those from the same city as the college—admitted by treated colleges declines after the reforms, suggesting that increased demand for college seats from non-local applicants crowds out local students.

Furthermore, I develop a college choice model to address questions beyond the scope of the reduced-form analysis. The reduced-form analysis cannot capture patterns of student sorting or welfare changes because students' counterfactual choices in the absence of *hukou* reforms are unobserved. The model allows me to simulate students' college choices and examine sorting and welfare across three scenarios: (1) without *hukou* reforms, (2) with *hukou* reforms, and (3) a broader case in which all students can freely access the highest-paying labor markets without migration frictions.

Students' utility depends on college quality, distance-related costs of attendance, and expected post-graduation returns determined by local wages and *hukou* policies. The estimation relies on equilibrium in the college admissions market, taking wages as given. This simplification is justified because the number of students admitted to a given college is regulated and exogenous, rendering the regional distribution of graduates largely predetermined.

In addition, the counterfactual analysis focuses on *hukou* reforms in two major cities, whose local adjustments are unlikely to affect national equilibrium. Welfare is interpreted as students' ex-ante utility from college attendance rather than realized labor market outcomes.

Under the deferred acceptance mechanism, where admission priorities are determined by students' NCEE ranks, it is reasonable to assume stability: each student is admitted to the most preferred college within their *ex post* feasible set (Fack et al., 2019).[1] This structure allows me to estimate students' preferences within a discrete choice framework, where each student's choice set consists of colleges with cutoff scores below their own NCEE score. The parameters are estimated by maximum likelihood.

I then simulate counterfactual scenarios under alternative migration frictions. The baseline scenario (CF0) approximates the current policy environment in China, where only large cities—specifically Beijing and Shanghai in this setup—maintain *hukou* restrictions. In the alternative scenario (CF1), all cities remove migration restrictions. These counterfactual scenarios provide relevant policy implications for understanding the effects of migration restrictions in large cities.

The results show that when Beijing and Shanghai relax their *hukou* restrictions as the system transitions from CF0 to CF1, local colleges admit higher-quality students, consistent with the reduced-form findings. Student sorting becomes more closely aligned with college quality. Although this sorting pattern is context-specific—given that Beijing and Shanghai host the highest-quality colleges—the mechanism through which relaxing migration restrictions allows local colleges to attract stronger students is broadly generalizable. Aggregate welfare increases overall, although at the expense of students who are crowded out of their preferred colleges in Beijing or Shanghai. Furthermore, when students can freely access the highest-paying labor markets nationwide, aggregate welfare increases further.

This paper contributes to the literature on how migration restrictions shape college choices. Evidence from international contexts shows that tightening immigration restrictions substantially reduces both the number of international student enrollments (Shih, 2016; Trevena, 2019) and the quality of enrolled students (Kato and Sparber, 2013). I extend this line of research to a domestic context and provide consistent evidence that relaxing internal migration restrictions enables local colleges to attract higher-quality students.

By examining frictions that constrain labor mobility, the paper also contributes to the literature on the determinants of college choice. Prior studies highlight several key factors, including tuition and financial aid (Kane, 1995; Dearden et al., 2014), students' access to

[1] The admission mechanism, commonly referred to as the Chinese Parallel mechanism, is a deferred acceptance system in which students submit a ranked list of a limited number of preferred colleges. See Section 2.1 for details.

information about colleges (Hoxby and Turner, 2015), application-related costs (Knight and Schiff, 2022), and the quality signals conveyed by institutions (Eble and Hu, 2024). This study adds to this literature by showing that migration frictions—both formal and informal—constitute an additional determinant that shapes students' choices by influencing how they evaluate local labor market prospects. Beyond the reduced-form evidence, I formalize this mechanism by developing a college choice model that explicitly incorporates expected local labor market conditions, providing a tractable framework for understanding the extent to which students weigh post-graduation opportunities in their decisions. This modeling approach builds on the expanding literature that models college choice decisions (Fabre, 2023; Yang, 2024).

This study further relates to the literature on the geography of opportunity (Chetty et al., 2014; Chetty and Hendren, 2018; Ishimaru, 2020) by focusing on higher education (Hillman, 2016; Ishimaru, 2020; Fabre, 2023; Yang, 2024). Migration frictions amplify geographic inequalities in higher education by discouraging non-local students from enrolling in colleges located in regions where local labor markets yield lower returns for migrants. This study adds new evidence on how such frictions shape student sorting across colleges and redistribute welfare.

Finally, this paper connects to research on regional policies aimed at attracting and retaining talent. Evidence from the United States shows that state-based merit aid programs have achieved some success in promoting local human capital retention (Sjoquist and Winters, 2014; Fitzpatrick and Jones, 2016; Kennan, 2015). The findings here suggest that reducing migration frictions in access to local labor markets can serve as an alternative and effective mechanism for strengthening regional talent retention.

The remainder of the paper is organized as follows. Section 2 provides institutional background on China's college admissions and the *hukou* system. Section 3 describes the data and presents several motivating facts. Section 4 examines the impact of *hukou* reforms on the attractiveness of colleges, measured by the NCEE ranks of admitted students. Section 5 introduces a college choice model and presents the counterfactual analyses. Section 6 concludes.

2 Institutional Background

2.1 College Admissions in China

This study focuses on four-year colleges. As of 2023, China had 1,275 four-year colleges, the majority of which, including the leading universities, are public. Most top-tier colleges belong to Project 211, launched in 1995 to create key national universities. Among these elite institutions, a distinguished subset belongs to Project 985, initiated in 1998 to advance the development of world-class universities. As of 2023, 115 colleges were designated as Project 211 institutions, of which 39 were also part of Project 985. College admissions are centralized and quota-constrained, with admissions based solely on students' NCEE ranks. Each annual admission cycle proceeds through the following stages.

Quota allocation. Early each year, the Ministry of Education (MOE) determines the total number of students each college may admit. Colleges then allocate these quotas across provinces, subject to approval by both central and provincial authorities (Yu et al., 2012). The finalized provincial quotas are publicly released before the application period begins.

NCEE. Grade 12 students sit for the NCEE in June. The exam includes compulsory tests in Chinese, mathematics, and a foreign language (typically English). Depending on the track chosen in Grade 10, students on the science track also take physics, chemistry, and biology, while those on the humanities track take geography, political science, and history. A few provinces adopt a general track, requiring students to take a common set of exams. The NCEE is designed, administered, and graded at the provincial level. Consequently, scores are not directly comparable across provinces, high school tracks, or examination years.

Application. Students receive their NCEE scores about two weeks after the examination and must complete their applications within a few days. A key reference during this process is the official guidebook, distributed to all students, which provides information on provincial quotas and historical cutoff scores for each college. Typically, students can submit a rank-ordered list of about six preferred colleges.

Admission and offer. A centralized admission mechanism assigns students to colleges within provincial quotas solely based on their NCEE ranks. Competition is intense: each year, about eight to ten million students take the exam (Educational Statistics Yearbook of China, 2005–2010), but only two to three million secure admission to four-year colleges. The quotas thus serve as a binding constraint on admissions.

The system operates under a Deferred Acceptance (DA) mechanism with constrained school choice—commonly known as the Chinese Parallel mechanism.[2] Specifically, in the initial round, each student applies to their top-choice college. Colleges temporarily hold the highest-scoring applicants within provincial quotas and reject the rest. In each subsequent round k, students rejected in the previous round $(k-1)$ apply to their next preferred college. Colleges then reassess all applicants, considering both newly applied students and those temporarily held from earlier rounds. They again reject the lowest-ranked candidates beyond

[2]For a detailed discussion of the evolution of the admission mechanism, see (Bo et al., 2019).

the quotas. This iterative process continues until the number of rounds reaches the length of students' application lists (see Chen and Kesten (2017) for a detailed description). At that point, each college finalizes its admissions by accepting the students it currently holds. Under this mechanism, each student receives at most one offer, and declining an offer means forfeiting the opportunity to enroll in any college that year.

Under a DA mechanism with an *ex ante* priority index, which in this context is students' NCEE rank, it is reasonable to assume stability: each student is admitted to their most preferred college within their *ex-post* feasible set (Fack et al., 2019).[3]

Tuition. Tuition is regulated by the government to ensure affordability for most families. Most colleges charge uniform tuition across students, regardless of their place of residence. Annual tuition at public four-year colleges generally ranges from RMB 4,000 to 6,000 ($\approx$ USD 720) and has remained stable over time. Although non-public colleges set higher and more variable tuition levels, their fees are still subject to government oversight. Consequently, colleges cannot freely adjust tuition in response to changes in admission demand.

2.2 The *Hukou* System

Formally established in 1958, China's *hukou* (household registration) system has been central for regulating internal migration. Under this system, each citizen is assigned a *hukou* linked to a specific administrative unit, typically their birthplace, and classified as either rural or urban. Holding a local urban *hukou* grants access to public goods such as education, housing subsidies, and social security programs (Song, 2014).

From its inception until 1979, the *hukou* system strictly controlled migration, requiring official authorization for relocation and imposing stringent restrictions on *hukou* transfers. This effectively bound people to their place of registration. However, the economic reforms from the late 1970s spurred rapid urban labor demand, making strict enforcement of the *hukou* system impractical. Consequently, many individuals migrated to cities without obtaining local *hukou*, giving rise to a large population of temporary migrants, known as the "floating population". These migrants, however, remain excluded from local public goods and face *hukou*-based labor market discrimination, including lower wages and restricted employment opportunities (Lee, 2012; Démurger et al., 2009; Chen and Hoy, 2011). Although the *hukou* system no longer restricts physical migration, it continues to shape migration by regulating access to entitlements (Chan, 2013). Therefore, reforms that reduce barriers for

[3] A matching is stable if there are no blocking pairs, meaning no student prefers another college over the one they are assigned while the preferred college has an available seat. Stability is a weaker assumption than truth-telling and is more likely to hold in markets with many students and many seats per school (Fack et al., 2019).

non-locals to acquire local *hukou* remain crucial for relocation decisions (Fan, 2019).

Reforms to the *hukou* system began in the early 1980s, when the central government decentralized *hukou* management, granting greater authority to local governments (Song, 2014). Since the mid-1990s, city governments have gained primary control over *hukou* policies within their administrative jurisdictions, while provincial governments may provide general guidelines for cities within their provinces (Chan, 2010; Song, 2014).[4]

The devolution of authority has allowed cities to grant local *hukou* to non-locals who meet specific criteria. In reformed cities, non-locals may obtain a local *hukou* through investment, tax contributions, property ownership, participation in talent programs, or employment (Zhang et al., 2019). This decentralization of *hukou* management has led to significant variation in *hukou* policies across cities.

3 Data and Motivating Facts

3.1 Data on College Admissions

The primary dataset comprises national administrative records of four-year college admissions through the NCEE from 2005 to 2011, covering approximately two million students annually. The data include each admitted student's county of origin, high school track (general, science, or humanities), total NCEE score, and the college of admission.

Student quality. Because the NCEE is administered at the provincial level, scores are not directly comparable across provinces, tracks, or years. To address this issue, I construct provincial percentile ranks for each student by track. These ranks range from 0 to 100, with higher values indicating better performance relative to peers within the same province and track.

College quality. College quality is measured using a one-dimensional index constructed via principal component analysis from multiple input indicators, including the undergraduate faculty–student ratio, faculty educational attainment, campus infrastructure, research grants, and national awards. The index is obtained from Bo et al. (2019). I focus on four-year colleges and standardize the index into a percentile rank ranging from 0 to 100, where higher values indicate higher quality. I refer to this measure as the input-based college quality percentile rank. In addition, I also consider colleges' elite status based on their participation in Project 985 and Project 211.

[4] China's administrative divisions are structured into three levels: provinces, prefectures, and counties. The prefecture level, which is subordinate to the provincial level, includes various jurisdiction types, such as prefectures, autonomous prefectures, prefecture-level cities, and leagues, with prefecture-level cities being the most common. For simplicity, this paper refers to all prefecture-level administrative units as cities.

3.2 Data on *Hukou* Reforms

This paper focuses on *hukou* policies in urban areas, where the labor market for college graduates is concentrated and access to public goods is considerably more valuable than in rural regions. The analysis focuses on *hukou* policies applicable to the general population, excluding those designed specifically for advanced-degree holders with overseas experience or high-tech entrepreneurs.

The evaluation of *hukou* policy openness is based on a narrative approach drawing on official news, laws, and regulations related to *hukou* policies. This approach builds on Fan (2019), who constructed a city-level *hukou* relaxation index up to 2010. The policy documents were collected from two comprehensive databases: the Peking University Law Information Database and Xinhuanet.[5]

The *hukou* relaxation index ranges from 0 to 3, reflecting the degree of policy openness, with 0 indicating the most restrictive policies and 3 representing the most open systems. Specifically, a value of 0 is assigned to cities that grant *hukou* to migrants only through public-sector employment programs, with virtually no access for others. A value of 1 applies to cities where migrants can obtain *hukou* by purchasing an apartment above a specified size or value. A value of 2 corresponds to cities where *hukou* can be obtained either by purchasing an apartment (or renting a subsidized apartment from an employer) without value restrictions, or by working and contributing to social security for more than five years. Finally, a value of 3 is assigned to cities that allow migrants to obtain *hukou* by residing and working locally while contributing to local social security for a relatively short period.

Using the same methodology, I extend this index to 2013. Similar approaches have been widely adopted in studies of China's *hukou* policy, including Kinnan et al. (2018); Zhang et al. (2019).

In this study, a *hukou* reform is defined as any increase in a city's *hukou* relaxation index, reflecting a loosening of requirements for non-locals to obtain local *hukou* status. Figure 1 displays the geographic distribution of treated and control cities in the sample. To maintain a clean DiD design, cities that implemented reforms within three years prior to the study period (2000–2004) are excluded and shown in white.

In the 2×2 DiD analysis, I compare outcomes between colleges in cities that implemented reforms during 2005–2010 (treated) and those that undertook no reform during 2005–2010 (control). The analysis uses the first (2005) and last (2011) years of the college admission data. This classification is based on two considerations. First, using reforms from 2005–2010 ensures that all 2011 college applications were submitted after the last reform in the sample

[5] For further details, see the companion note to Fan (2019). Dataset links: the Peking University Law Information Database (lawinfochina.com) and Xinhuanet (xinhuanet.com).

period. Second, it allows time for students to learn about and respond to the new policies.

Treated cities are shown in blue and control cities in gray, with black dots representing college locations. The final sample for the reduced-form analysis includes 60 treated cities with 265 colleges and 90 control cities with 374 colleges. Table A1 summarizes the treated and control groups at both the city and college levels, categorized by GDP per capita quartiles, highlighting substantial variation in reform exposure across cities with different economic conditions.

In the event study design using the full sample (2005–2011), each *hukou* reform is assigned to its exact year of implementation to estimate dynamic effects over time. This approach captures both the immediate and evolving impacts of reforms, although some were implemented after the college application period in the same year, potentially attenuating the estimated contemporaneous effects.[6]

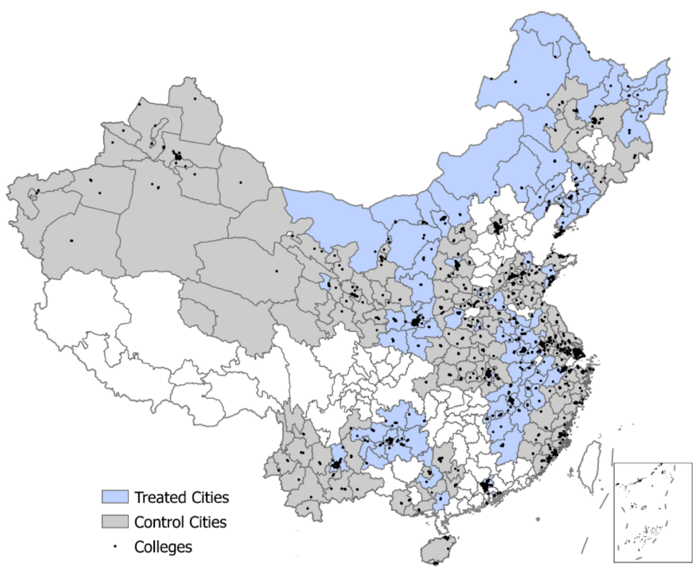


Figure 1: Treated and Control Cities and Colleges in the Sample

3.3 Balance Test: Comparing Pre-Reform Economic Trends Between Treated and Control Cities

A potential concern is that the implementation of *hukou* reforms may be endogenous. Cities experiencing faster economic growth might have adopted reforms to attract additional labor, while slower-growing cities may have implemented them to offset limited population growth.

[6]The NCEE is held annually in June, while the timing of *hukou* reforms varies across cities within a given year and may occur after students have submitted their college applications.

In addition, if students tend to prefer colleges located in economically stronger cities, local economic conditions could confound the estimated effects of *hukou* reforms on college attractiveness.

To address these concerns, Table 1 reports a balance test comparing pre-reform economic trends between cities that adopted reforms during 2005–2010 and those that did not. The results indicate no statistically significant differences in pre-reform growth between treated and control cities across key economic indicators from 1999 to 2003, including log GDP per capita, log nighttime lights per capita, and log urban average wages. Moreover, the estimated magnitudes are economically small relative to the average changes during the same period. These findings suggest that treated and control cities were comparable in their pre-reform economic trends.

Table 1: Comparison of Pre-Reform Economic Changes across Cities

	Reform indicator (2005–2010) coefficient	Mean change (1999–2003)
Dependent variable (1999, 2003)		
Log GDP per capita	0.037	0.522
	(0.069)	
Log nighttime lights per capita	-0.065	0.288
	(0.053)	
Log urban average wages	-0.020	0.522
	(0.027)	

Notes: This table compares changes in economic conditions between treated and control cities during the pre-reform period (1999–2003). All regressions are weighted by the 1999 population and include the province × year fixed effects as well as city fixed effects. Standard errors, clustered at the city level, are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

3.4 Motivating Facts

3.4.1 College graduates tend to remain where they studied

College graduates often work in the same region where they pursued their degrees. Evidence from China, based on the Employment Survey for Graduating Students (2009, 2011, 2013, and 2015, conducted by Peking University), shows that a substantial share of graduates who studied outside their home province remain in the province of their college after graduation. Among 11,085 respondents who had secured job offers before graduation and reported complete information on their home, college, and work provinces, 42% attended college outside their home province. Among these students, 29% stayed and worked in the province of their college after graduation—nearly as many as the 34% who returned to their home province—and comparable to the 36% who dispersed across other provinces.

Similar patterns are observed in other countries. In the United States, attending college in a state significantly increases the likelihood of later residing in that state (Winters, 2011; Groen, 2004). Evidence from France likewise shows that many students who study outside their home region enter the labor market where they studied (Fabre, 2023). This persistence in location at labor market entry, reflecting migration frictions, is therefore a common feature across countries rather than unique to China.

Given these considerable migration frictions, it is rational for students to take local labor market conditions into account when choosing colleges. Ignoring the likely location of post-graduation employment could reduce the labor market returns from the transition from college to work.

3.4.2 Cities with higher wages tend to have higher-quality colleges

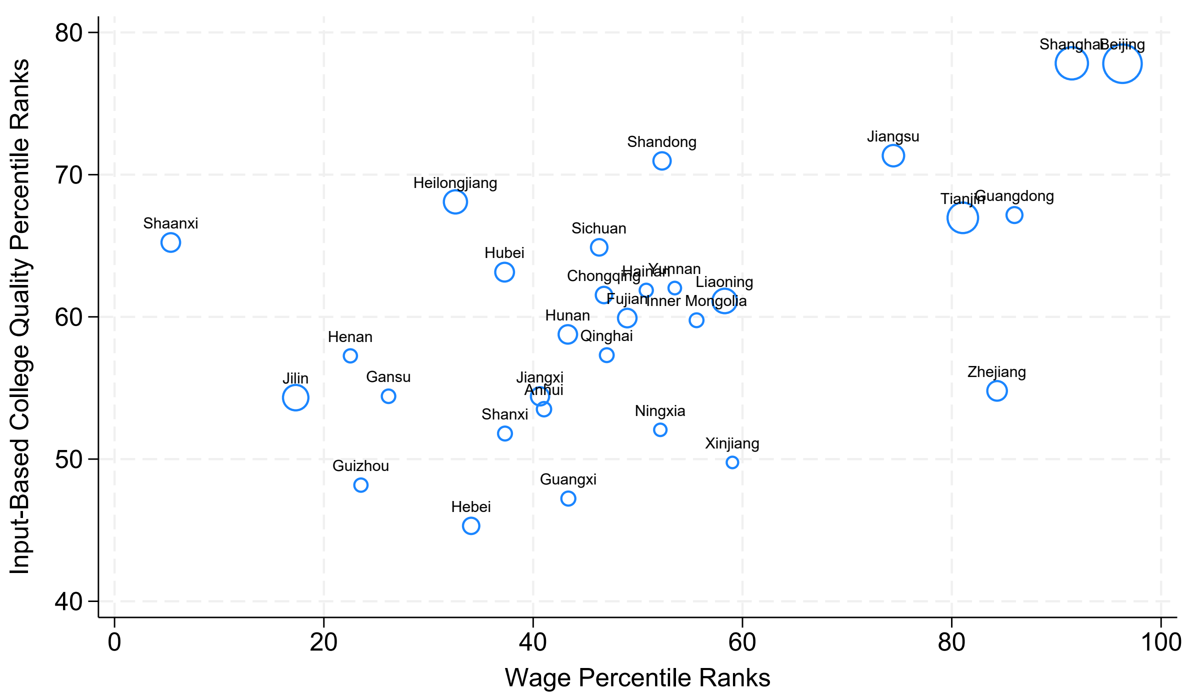


Figure 2: Correlation Between College Quality and Wages

Notes: Provincial wage ranks are constructed from average city-level urban wage percentile ranks, weighted by the total number of college seats in each city. City-level wage percentile ranks are defined as $\pi_d = 100 \times (1 - \frac{Seat_d+1}{Seat+1})$, where $Seat_d$ denotes the exclusive cumulative number of seats in cities with higher wages than city d. Provincial input-based college quality ranks are measured by the average input-based college quality percentile ranks, weighted by college seats. Bubble sizes represent the ratio of total college seats to exam takers within the province.

If students sort into cities with higher wages, they also tend to sort across college quality, given the strong correlation between local wage levels and college quality. To examine this relationship, I compare provincial-level input-based college quality ranks and wage ranks. Provincial wage ranks are constructed from average city-level urban wage percentile ranks, weighted by the total number of college seats in each city, reflecting the relative importance of cities with larger student populations. Provincial input-based college quality ranks are measured by the average input-based college quality percentile ranks, weighted by college seats. Figure 2 illustrates this relationship, revealing a clear positive correlation between city wages and college quality.

This pattern yields two key insights. First, it motivates examining the heterogeneous effects of *hukou* reforms across colleges of different quality, in addition to the direct analysis based on relative economic conditions. If colleges in richer cities benefit more from *hukou* reforms by attracting higher-ranked students, then higher-quality colleges—disproportionately located in those cities—should experience larger gains. Second, it highlights the distinctive roles of Beijing and Shanghai. These two cities combine both the highest wage levels and the strongest colleges while maintaining the most restrictive migration policies. This makes them natural focal points for the counterfactual analysis, where relaxing *hukou* restrictions is expected to induce stronger students to re-sort toward higher-quality colleges.

4 Impact of *Hukou* Reforms on Student Ranks

In this section, I examine whether *hukou* reforms enable local colleges to attract higher-quality students, as measured by the NCEE ranks of admitted students. Appendix B provides a simple model illustrating how admitted student ranks reflect college attractiveness.

The baseline analysis employs a 2×2 regression-based DiD design using the 2005 and 2011 samples. I complement this analysis with an event study based on the approach of Borusyak et al. (2024) to address heterogeneous effects under staggered treatment adoption. I also conduct a series of robustness checks and explore potential mechanisms.

4.1 Main Specification

The baseline analysis adopts a regression-based 2×2 DiD framework, using data from 2005 and 2011—the first and last years of the study period. Focusing on these two years helps address two key concerns. First, students may need time to fully recognize and incorporate the policy change in their college application decisions. Second, recent literature emphasizes the potential biases of applying OLS in DiD designs with staggered treatment adoption and heterogeneous effects. The 2 × 2 DiD specified is given by:

$$y_{okcdqt} = \beta_1 Reform_{dt} + \alpha_{okc} + \lambda_{qt} + \varepsilon_{okcdqt}, \tag{1}$$

where y_{okcdqt} denotes the median percentile ranks of students from origin o (defined at the city level and classified as urban or rural), with high school track k, admitted to college c in destination city d, province q, in year t with $t \in \{2005, 2011\}$.

$Reform_{dt}$ is defined as a binary indicator equal to 0 in 2005 for all observations and 1 in 2011 if city d implemented reforms between 2005 and 2010 (see Section 3.2 for details). The coefficient β_1 captures the effect of *hukou* reforms on the median percentile ranks of students admitted to treated colleges, relative to those admitted to untreated colleges.

α_{okc} represents the origin × track × college fixed effects. These fixed effects serve several important functions. First, they restrict comparisons to students from the same province of origin and high school track, the level at which competition for admission occurs. Second, they control for time-invariant characteristics of colleges (e.g., short-term college quality), allowing comparisons of student quality within the same college over time. Third, they capture persistent factors related to (1) destination-specific attributes, such as amenities in the college city, and (2) stable origin–college pair preferences. For instance, a college may systematically allocate more quotas to certain provinces, or students from specific origins may consistently prefer particular colleges due to historical ties or alumni networks.

λ_{qt} denotes province of destination × year fixed effects, serving two main purposes. First, they account for potential correlations in *hukou* reform implementation across cities within the same province, alleviating concerns about endogenous policy adoption. Second, they absorb province-wide shocks that affect all cities in the destination province uniformly within a given year. Standard errors are clustered at the destination city level.

Regressions are weighted by predicted student flows derived from a gravity model estimated on the 2005–2011 sample using PPML (Silva and Tenreyro, 2006). In the gravity model, observed student flows are regressed on the log of distance between origin and destination, origin × track fixed effects, college × track fixed effects, and year fixed effects. These predicted flows reflect the magnitude of student movements, capturing the relative importance of each observation in the analysis. Using predicted rather than observed flows helps mitigate potential endogeneity arising from unobserved factors that simultaneously affect student flows and admitted student quality.

I complement the baseline results with the following event study design:

$$y_{okcdqt} = \sum_{h=-3}^{3} \beta_h \mathbf{1}[t - R_d = h] + \alpha_{okc} + \lambda_{qt} + \varepsilon_{okcdqt}, \tag{2}$$

where y_{okcdqt} is defined as in Equation (1) and measures the median percentile rank of students from origin o with high school track k, admitted to college c in city d, province q, year t. The sample covers $t \in \{2005, 2006, ..., 2011\}$. R_d denotes the first year in which city d implemented *hukou* reforms. The indicator $\mathbf{1}[t - R_d = h]$ equals 1 if city d experienced *hukou* reforms h years prior (or will experience reforms in h years). All other model components are specified as in Equation (1).

4.2 Main Results

Table 2: Effects of *Hukou* Reforms on Median Admitted Student Ranks

Dependent variable: median percentile ranks of admitted students		
	(1)	(2)
Reform indicator	2.378***	2.438***
	(0.707)	(0.753)
Log destination urban average wages		1.195
		(1.294)
Origin × track × college FE	✓	✓
Province of destination × year FE	✓	✓
Interquartile range (25th–75th) of student ranks: 10.912		
Observations	187,792	185,148
Adjusted R^2	0.912	0.912

Notes: Estimates are based on Equation (1) using the 2005 and 2011 samples. All regressions are weighted by predicted student flows derived from a gravity model estimated on the 2005–2011 sample using PPML (Silva and Tenreyro, 2006). In the gravity model, observed student flows are regressed on the log distance between origin and destination, origin × high school track FE, college × high school track FE, and year FE. Standard errors are clustered at the destination city level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2 reports the 2 × 2 DiD estimation results. Column (1) presents the baseline estimates from Equation (1), while column (2) additionally controls for the log of urban average wages in destination cities to address potential confounding between *hukou* reforms and local labor market conditions. The estimated coefficient on the reform indicator remains stable across the two specifications. The subsequent analyses rely on the baseline specification in column (1). Column (1) shows that, after reforms, colleges in reformed cities attract higher-quality students: the median rank of admitted students increase by 2.378 percentage points, significant at the 1% level. Given that the interquartile range (25th to 75th percentiles) spans approximately 11 percentage points, this effect represents a substantial improvement in student quality. The positive effect of relaxing internal migration restrictions on student quality aligns with international evidence that tightening migration restrictions, as in

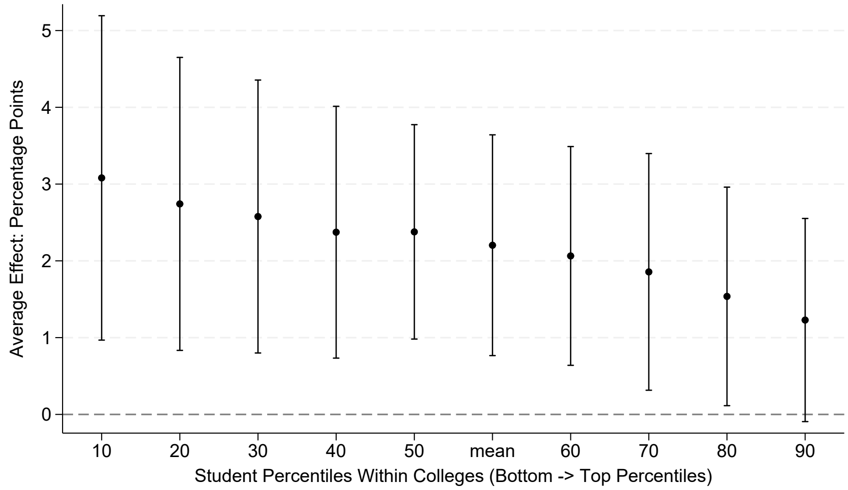


Figure 3: Impact of *Hukou* Reforms Across Student Rank Distribution

Notes: Estimates are based on Equation (1) using the 2005 and 2011 samples. All regressions are weighted by predicted student flows derived from a gravity model estimated on the 2005–2011 sample using PPML (Silva and Tenreyro, 2006). In this model, observed student flows are regressed on the log distance between origin and destination, origin × high school track FE, college × high school track FE, and year FE. Standard errors are clustered at colleges' cities. Confidence intervals are presented at the 95% level.

the 2003 reduction of the U.S. H-1B visa cap, reduced the quality of international student enrollments (Kato and Sparber, 2013).

Using the same specification, I replace the dependent variable in Equation (1) with admitted student ranks across the entire quality distribution within colleges. Figure 3 presents the results. The positive effects are evident throughout the distribution, not only among students near the admission margin, suggesting a general improvement in student quality. Interestingly, the estimated effects decline toward the top of the distribution, indicating that *hukou* reforms have stronger impacts on lower-ranked students within colleges. Table A2 confirms this pattern: the effect at the 10th percentile is 1.851 percentage points larger than at the 90th percentile. A plausible interpretation is that higher-ranked students—who are farther from the admission cutoffs—may have already exhibited strong idiosyncratic preferences for specific colleges and are therefore less responsive to reform shocks.

Figure 4 presents the event-study estimates. The pre-reform coefficients β_h are statistically indistinguishable from zero, indicating no systematic differential trends in student ranks between treated and control colleges before the implementation of reforms. If economically weaker cities had been more likely to adopt reforms in an effort to attract a larger and higher-quality workforce, the pre-reform coefficients would have been negative. Conversely, if stronger local economies had tended to reform earlier, the pre-reform coefficients would

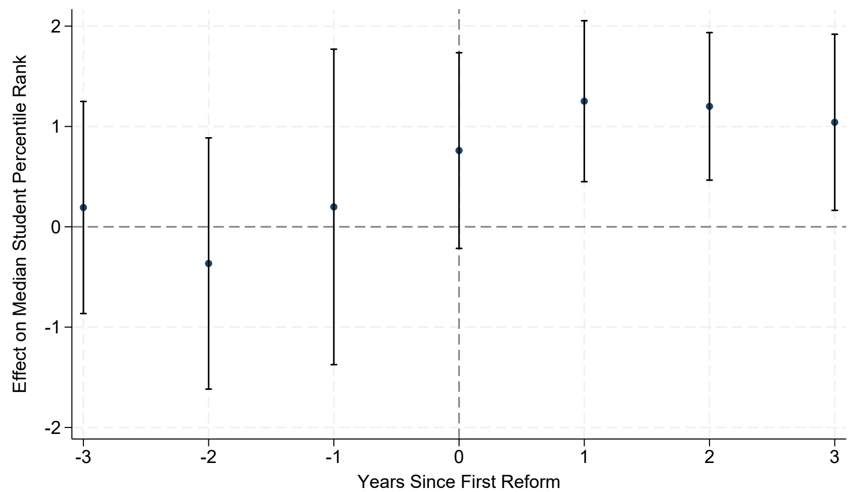


Figure 4: Impacts on Median Student Percentile Rank

Notes: Estimates follow the approach of Borusyak et al. (2024). All regressions are weighted by predicted student flows generated from a gravity model estimated on the full sample from 2005 to 2011 using PPML (Silva and Tenreyro, 2006). In the gravity model, observed student flows are regressed on the log distance between origin and destination, origin × high school track FE, college × high school track FE, and year FE. All regressions include province-of-destination × year FE. Standard errors are clustered at the level of college cities. Confidence intervals are presented at the 95% level.

likely have been positive, as cities experiencing faster growth might already have drawn higher-quality students prior to *hukou* policy changes. The absence of such patterns supports the validity of the parallel-trends assumption and alleviates concerns that the timing of *hukou* reforms is systematically correlated with local economic conditions. The estimated treatment effects become significantly positive only after the first year of reform, suggesting that the policy itself enabled treated colleges to attract higher-quality students.

4.3 Robustness Checks

I conduct a series of robustness checks to assess the credibility of the main findings. First, a placebo test demonstrates that changes in student ranks during the study period are not correlated with future reforms. Second, I show that *hukou* reforms do not affect the allocation of college seats, indicating that the observed effects arise from changes in student demand for seats at treated colleges rather than from shifts in supply. Third, the results remain robust when the control group is restricted to untreated cities that do not compete with treated ones for the same student pool, alleviating concerns about potential spillover effects on student quality.

4.3.1 Placebo test

To further support the causal interpretation of the *hukou* reform effects on student ranks, I conduct a placebo test using "false treatment". Specifically, I examine whether changes in student ranks during the study period (2005–2011) are correlated with *hukou* reforms that occurred later, between 2011 and 2013. The estimation follows the same specification as Equation (1), but the reform indicator $Reform_{dt}$ is redefined so that it equals 1 in 2011 for cities d that implemented reforms between 2011 and 2013. As shown in Figure A1, the estimated coefficients are statistically indistinguishable from zero, with no systematic patterns across the student rank distribution. This evidence suggests that the observed impacts are attributable to the *hukou* reforms during the actual treatment period.

4.3.2 Impacts of *hukou* reforms on quota allocations

A potential concern is that college quota allocations may be endogenously related to local *hukou* policies. For instance, cities that relax migration restrictions to attract a larger and more skilled workforce might also expand student recruitment, particularly from outside the province. To assess this possibility, I estimate the effect of *hukou* reforms on college quota allocations using the following specification:

$$y_{ckdqt} = \beta_1 Reform_{dt} + \alpha_{ck} + \lambda_t + \varepsilon_{ckdqt}, \tag{3}$$

where y_{ckdqt} is either the log total quota allocated to track k by college c (located in city d, province q) in year t ($t \in \{2005, 2011\}$), or the share of that college's quotas allocated to students from outside its province. $Reform_{dt}$ is defined as in Equation (1), taking the value 0 for all observations in 2005 and 1 in 2011 if city d implemented reforms between 2005 and 2010. The specification includes college $\times$ track fixed effects (α_{ck}) and year fixed effects (λ_t). All regressions are weighted by the 2005 baseline total quota.

Table A3 reports the results. The estimates show no statistically significant effect of *hukou* reforms on either the total number of quotas or the share allocated to students from other provinces. These findings suggest that the supply of college seats was not endogenously adjusted in response to local migration policy changes.

4.3.3 Impacts net of spillover effect

Because comparable colleges often recruit from overlapping student pools, improvements in student quality at treated colleges may come at the expense of peer institutions in untreated cities. In other words, spillover effects in student quality may arise, potentially biasing the estimated impacts of *hukou* reforms upward. In the extreme, the true effect on student quality could be half of the estimates reported in Section 4.2.

To address this concern, I construct a subset of control cities that are unlikely to compete with treated cities for the same pool of students. Specifically, I construct a correlation matrix across college cities based on student inflows from each origin city, normalized by origin population. For each treated city, I retain only those control cities whose correlations with the treated city fall between -0.01 and 0.01, thereby minimizing overlap in student recruitment patterns and mitigating potential spillover bias. The estimation builds on the baseline 2×2 DiD specification in Equation (1):

$$y_{okcdqgt} = \beta_1 Reform_{dt} + \alpha_{okc} + \lambda_{qt} + \lambda_g + \varepsilon_{okcdqgt}, \quad (4)$$

where o indexes origin, k high school track, c college, q destination province, g groups of treated and non-competing control cities, and $t \in \{2005, 2011\}$. $y_{okcdqgt}$ denotes the median percentile ranks of students from origin o admitted to college c. All other elements mirror the main specification. The reform indicator $Reform_{dt}$ is an indicator for whether city d implemented *hukou* reforms during the study period. The fixed effects α_{okc} (origin $\times$ track $\times$ college) and λ_{qt} (province of destination $\times$ year fixed effects) are included as in Equation (1). The added term λ_g captures group fixed effects, ensuring that comparisons are made between treated and control colleges within the same group.

Table A4 shows that the estimated coefficients remain consistent with the baseline results. Figure A2 further confirms that the pattern of coefficients across the student rank distribution closely mirrors the baseline findings. This robustness likely reflects the fact that the baseline sample includes only 45% of cities nationwide, leaving out 55% of cities—or roughly 30% of colleges—which may have absorbed much of the potential spillover effects.

4.4 Mechanisms

I hypothesize that *hukou* reforms enable colleges in reformed cities to attract higher-quality students by improving local labor market prospects. I test this mechanism in three complementary ways. First, I examine whether the effects are stronger when the economic gap between destination and origin cities is larger, as access to destination *hukou* should be more valuable to students from less-developed regions. Second, I assess whether, within provinces where the allocation of seats across origins is not binding, the share of local students admitted to treated colleges declines after the reforms, as increased demand from non-local applicants may crowd out local students. Third, I examine heterogeneity by college quality, given that higher-quality institutions are concentrated in economically stronger cities and may benefit disproportionately from reforms that enhance local attractiveness. Finally, I explore how other frictions, such as distance and migration networks, shape students' awareness of and responses to *hukou* reforms.

4.4.1 Heterogeneous effects by destination–origin economic gap

To examine heterogeneity by destination–origin economic gap, I classify each origin $\times$ track $\times$ college observation according to whether the log of urban average wages or GDP per capita in the college city exceeds that of the origin city. I then interact these indicators with the reform variable to test for differential effects.

Panel A of Table 3 reports the results. Median admitted student ranks increase significantly for colleges located in reformed cities with stronger economic conditions relative to students' origins. By contrast, the effects are smaller and statistically insignificant when destination economic conditions are weaker than those at the origin. These findings are consistent with the interpretation that *hukou* reforms are more effective when the local labor market offers higher expected returns, making access to destination *hukou* more valuable for students from less-developed regions.

4.4.2 Effects on the share of local students

If access to local *hukou* becomes more valuable to non-local students after the reforms, their representation among admitted students in treated cities should increase, potentially reducing the share of local students. To test this hypothesis, I estimate the following equation:

$$\begin{aligned} share_{okcdqt} &= \beta_{local}\mathbf{1}(local_{odt})Reform_{dt} + \beta_{nlocal}\mathbf{1}(1-local_{odt})Reform_{dt} \\ &+ \alpha_{okc} + \lambda_{qt} + \varepsilon_{okcdqt}, \end{aligned} \tag{5}$$

where

$$share_{okcdqt} = \frac{N_{okcdqt}}{\sum_o N_{okcdqt}}, \tag{6}$$

and the numerator N_{okcdqt} denotes the number of students from origin o with track k admitted to college c (in city d, province q) in year t. The denominator $\sum_o N_{okcdt}$ is the total number of students with track k admitted to college c.

The indicator $\mathbf{1}(local_{odt})$ equals 1 if the student's origin city coincides with the college city d. The reform indicator $Reform_{dt}$, along with the origin $\times$ track $\times$ college fixed effects α_{okc}, and province of destination $\times$ year fixed effects λ_{qt} are defined as in Equation (1).

Table 3: Heterogeneous Effects of *Hukou* Reforms on Student Ranks

Dependent variable: median percentile ranks of admitted students		
	(1)	(2)
Panel A: Heterogeneous effects by destination–origin economic gap		
Reform indicator ×		
Destination wages ≥ origin	2.233***	
	(0.736)	
Destination wages < origin	0.681	
	(0.870)	
Destination GDPpc ≥ origin		2.211***
		(0.771)
Destination GDPpc < origin		0.440
		(0.849)
Province of destination × year FE	✓	✓
Origin × track × college FE	✓	✓
Wald test p-value	0.000	0.001
Observations	168,198	168,198
Adjusted R^2	0.904	0.904
Panel B: Heterogeneous effects by college quality		
Reform indicator ×		
College quality rank above national median	2.931***	
	(0.723)	
College quality rank below national median	0.820	
	(1.008)	
College quality rank above city-level median		2.905***
		(0.720)
College quality rank below city-level median		0.816
		(1.113)
Province of destination × year FE	✓	✓
Origin × track × college FE	✓	✓
Observations	187,792	187,792
Adjusted R^2	0.912	0.912

Notes: Estimates use the 2005 and 2011 samples. Observations with origin cities the same as destination cities are excluded. All regressions are weighted by predicted student flows derived from a gravity model estimated on the 2005–2011 sample using PPML (Silva and Tenreyro, 2006). In the gravity model, observed student flows are regressed on the log distance between origin and destination, origin × high school track FE, college × high school track FE, and year FE. Standard errors are clustered at the destination city level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Here, β_{local} captures the change in the share of local students in the admitted pool of treated colleges after the reforms, while β_{nlocal} measures the corresponding change in the contribution of non-local students.

Table A5 reports the results. Column (1) includes students from all origins, while column

(2) restricts the sample to origins within the same province as the college. Since college admissions are governed by the provincial quota system, students from outside a college's province face institutional constraints that limit their ability to adjust their admission share in response to the reforms. Therefore, the within-province comparison in column (2) provides a more relevant setting for detecting shifts in the composition of admitted students.

The results in column (2) show that the share of local students in treated colleges falls by 1.7 percentage points after the *hukou* reforms. At the same time, each non-local origin within the province contributes, on average, 1.0 percentage points more to the admitted pool. These findings suggest that local students are partially crowded out by non-local applicants who respond to improved post-graduation prospects in treated cities.

4.4.3 Heterogeneous effects by college quality

Higher-quality colleges are disproportionately located in economically stronger cities and thus are more likely to benefit from *hukou* reforms that improve local labor market attractiveness. If students take post-graduation opportunities into account when choosing colleges, the impact of *hukou* reforms should be greater for more selective institutions.

Panel B of Table 3 supports this prediction. The estimated effects are large and statistically significant for colleges ranked above the national median, but smaller and statistically insignificant for those below it.

Moreover, the results remain robust when comparing colleges within the same city: institutions ranked above the city-level median experience significantly stronger effects. This pattern suggests that higher-quality colleges benefit more from the reforms because they offer greater post-graduation opportunities in local labor markets, which become more valuable once migration restrictions are relaxed.

4.4.4 The role of other frictions

The magnitude of the effects of *hukou* reforms may also depend on frictions that influence students' awareness of the policy and how costly it is for them to act on it. Two factors are particularly relevant. First, greater distance between students' origin and college cities can weaken the impact of reforms through two channels: students farther away are less likely to be informed about reforms in the destination city, and even when informed, attending a more distant college entails higher migration costs at the college stage, reducing the net gain from reforms. Both forces lead to smaller effects for more distant origins.

Second, stronger historical migration flows between locations can amplify the impact of reforms. Migration networks facilitate the diffusion of information about policy changes and lower migration barriers, thereby increasing the net benefits of reforms.

To test these hypotheses, I estimate heterogeneous effects by interacting the reform indicator with measures of geographic distance and historical migration flows. Table A6 presents the results. The estimated effects decline systematically with distance, but increase for pairs with stronger historical migration flows. These findings indicate that both information and cost-related frictions shape students' responsiveness to *hukou* reforms: distance dampens the effects, whereas migration networks enhance them.

5 A College Choice Model and Counterfactual Analysis

This section develops a college choice model to address questions that the reduced-form analysis in Section 4 cannot. The model allows for counterfactual simulations of students' college choices under alternative migration frictions and facilitates analysis of student sorting, aggregate welfare, and its distribution across groups.

Students' utility from attending a college depends on college quality, distance-related costs of attendance, and expected labor market conditions in the college city, which are captured by *hukou* policies and local wages. The estimation relies on equilibrium in the college admissions market while treating wages as exogenous.

Treating labor market equilibrium as a second-order concern is reasonable for two reasons. First, under the provincial quota system, the number of students admitted from each province to a given college is fixed, implying that the supply of college graduates in each city is largely predetermined in local labor markets. Nevertheless, I acknowledge that the model does not capture potential increases in non-locals' likelihood of remaining due to more relaxed *hukou* policies, nor the effects of changes in student quality on local wages. Second, the counterfactual analysis focuses on *hukou* reform shocks in two major cities—Beijing and Shanghai—whose local labor market adjustments are unlikely to substantially influence the national labor market. Welfare in this setup reflects students' ex-ante utility from attending college, rather than realized outcomes after graduation.[7]

[7]The model does not incorporate idiosyncratic matches between students and colleges. A possible extension could introduce such matches along both observed dimensions (e.g., majors) and unobserved ones.

5.1 A College Choice Model

Students' problem

For a student i from origin o, the utility of attending college c located in city d is given by:

$$u_{iocd} = \underbrace{v_c'\beta_1}_{\substack{\text{college} \\ \text{quality}}} + \underbrace{\overbrace{\sum_{i=1}^{3} \beta_2^i \, \mathbf{1}(nonlocal_{od}) \, \mathbf{1}(hk_d = i)}^{\substack{hukou \text{ relaxation index:} \\ hk_d \uparrow, \text{ more open system}}} + \beta_3 \, lwages_d}_{\text{expected local labor market conditions}} + \underbrace{dist_{od}'\beta_4}_{\substack{\text{distance-related} \\ \text{components}}} + \varepsilon_{iocd}. \tag{7}$$

The explanatory variables fall into the following categories:

College quality (v_c). This component captures the academic quality of college c, including its input-based percentile rank and elite status indicators under Project 985 and Project 211.

Expected local labor market conditions. These include: (1) *Hukou* policies, represented by indicators for the destination's *hukou* relaxation index, $\mathbf{1}(hk_d = i)$, where $i \in \{1, 2, 3\}$ and $i = 0$ is the reference group. The *hukou* policies apply only to nonlocals from a different city, indicated by $\mathbf{1}(nonlocal_{od})$. (2) The log of urban average wages, $lwages_d$. If students expect to stay in the college city after graduation, higher wages should raise the utility of choosing colleges there. A significantly positive β_3 would indicate that expected labor market returns affect college choice.

Distance-related costs of attendance ($dist_{od}$). This term is captured by a flexible function of the log of distance between origin o and destination city d, as well as indicators for whether the college is located in the student's home city or home province.

ε_{iocd} denotes an idiosyncratic preference shock, assumed to follow a Type I extreme value distribution. The outside option, representing the utility of not attending college, is normalized to zero.

College admission rule

Colleges' preferences over students—or equivalently, students' admission priorities—are one-dimensional. Under the centralized deferred acceptance (DA) mechanism, each college admits applicants from each province in descending order of their NCEE ranks until the provincial quota is filled.

Equilibrium

Under the DA mechanism with an *ex ante* known priority index—students' NCEE ranks—it is reasonable to assume stability: each student is admitted to the most preferred college within their *ex post* feasible set (Fack et al., 2019). The feasible set consists of colleges whose admission cutoffs are below the student's NCEE score.[8] Within this feasible set, each student chooses the college that maximizes their expected utility. Accordingly, the student's problem can be represented as a discrete choice model constrained by the feasible set of colleges C^f:

$$\max_{c \in C^f} \bar{u}_{iocd} + \varepsilon_{iocd}. \tag{8}$$

Given $\varepsilon_{iocd} \sim$ Type I extreme value, the probability that student i chooses college c is:

$$p_{ic} = \frac{\exp(\bar{u}_{iocd})}{\sum_{c' \in C^f} \exp(\bar{u}_{ioc'd})}. \tag{9}$$

Estimation

The model parameters are estimated by maximum likelihood using a 20% subsample of the universe of admission records from the 2005 cohort. Results are reported in Table 4. The main coefficients are robust across alternative specifications, consistently showing that higher college quality, higher urban wages in destination cities, and more relaxed *hukou* policies are significantly associated with higher student utility. Students also display strong home preferences, as attending college in their home city or home province yields substantially higher utility.

Model fit

Student utilities are simulated using the estimated preference parameters from column (3) of Table 4, combined with idiosyncratic preference shocks drawn from a Type I extreme value distribution. The simulated admission mechanism incorporates the following key features: (1) Quotas allocated to each province of origin are constrained to match those observed in the data. (2) Admissions are simulated under a serial dictatorship mechanism for two main reasons. First, in practice, the restriction to a limited ranked-order list of preferred colleges breaks strategy-proofness and discourages truthful reporting (Fack et al., 2019), making it difficult to model students' strategic behavior when submitting preferences. Second, when

[8] In equilibrium, the fulfillment of provincial quotas determines the *ex post* admission cutoffs of colleges for each origin province.

colleges have strict *ex ante* priorities—based on students' NCEE scores—and students are allowed to rank all colleges, both serial dictatorship and deferred acceptance mechanisms are strategy-proof, and truthful preference revelation is a dominant strategy (Abdulkadiroğlu and Sönmez, 2003). The serial dictatorship mechanism, however, is more computationally efficient.

For consistency, all subsequent simulations of admission outcomes are conducted using serial dictatorship to ensure that any observed differences are not mechanically driven by the choice of matching mechanism.

Table A7 compares the means, standard deviations, and sorting patterns between the data and the simulated outcomes. The simulation matches the key moments observed in the data well. It closely replicates the average distance students travel to college (about 450 kilometers) and the share of students studying in their home city (approximately 17%). The shares of students attending college within their home province, the average utility-based college quality rank, and the average urban wage are identical in the data and the simulation. This alignment arises because the simulation respects the provincial quotas observed in the data, thereby preserving the distribution of students from each province across colleges and college cities.

Regarding student sorting, the simulation successfully reproduces the main qualitative patterns observed in the data. The Spearman correlations between student ranks and key variables show that higher-ranked students tend to travel farther, are less likely to remain in their home city or province, and sort into higher-quality colleges and higher-wage cities. The model matches these sorting patterns particularly well along the dimensions of studying outside the home province and sorting into higher-quality and higher-wage destinations, although the simulated correlations are somewhat smaller in magnitude than those observed in the data.

Moreover, Figure A3 assesses the model fit by comparing the median student rank for each province-of-origin $\times$ track $\times$ college observation between the data (x-axis) and the simulation (y-axis). The points align closely with the 45-degree line, indicating that the simulated admitted student quality closely matches the observed data.

Table 4: Parameter Estimates

	(1)	(2)	(3)
A. College quality			
Input-based percentile rank	0.030***	0.029***	0.029***
	(0.000)	(0.000)	(0.000)
Elite colleges: Project 985	1.128***	1.120***	1.125***
	(0.008)	(0.008)	(0.008)
Elite colleges: Project 211	0.716***	0.709***	0.707***
	(0.006)	(0.006)	(0.006)
B. Labor market conditions			
Log urban average wages		0.190***	0.171***
		(0.007)	(0.007)
Local status × urban *hukou* relaxation index			
(= 0 reference group, most restricted)			
= 1			0.128***
			(0.005)
= 2			0.012**
			(0.006)
= 3: fully open			0.164***
			(0.027)
C. distance-related components			
Log distance	-0.110***	-0.112***	-0.098***
	(0.011)	(0.011)	(0.011)
$(\text{Log distance})^2$	0.042***	0.043***	0.040***
	(0.004)	(0.004)	(0.004)
$(\text{Log distance})^3$	-0.006***	-0.006***	-0.006***
	(0.000)	(0.000)	(0.000)
College at home city	0.375***	0.365***	0.448***
	(0.013)	(0.013)	(0.013)
College at home province	2.661***	2.660***	2.669***
	(0.007)	(0.007)	(0.007)
Likelihood Ratio Index	0.248	0.248	0.248

Notes: Parameters are estimated based on Equation (9) by maximum likelihood, using a 20% random subsample of the 2005 data. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.2 Counterfactual Analysis

The counterfactual analysis focuses on Beijing (BJ) and Shanghai (SH) for two main reasons. First, since 2014, many small and medium-sized cities have relaxed their *hukou* restrictions, whereas large cities such as Beijing and Shanghai have tightened them instead (Zhang et al., 2019). These two cities thus provide policy-relevant settings for understanding the effects of migration policies in major cities. Second, Beijing and Shanghai combine the highest wages with the strongest colleges, as shown in Figure 2, offering a clear context for interpreting student sorting patterns—namely, that sorting into richer cities corresponds to sorting into higher-quality colleges.

5.2.1 Admitted student quality across counterfactuals

Table 5 reports the median student ranks in Beijing and Shanghai colleges across alternative counterfactual scenarios. CF0 serves as the baseline, where Beijing and Shanghai maintain the most stringent *hukou* restrictions while other cities adopt the most relaxed rules. CF1 removes all *hukou* restrictions nationwide by setting every city to the most relaxed regime. CF2 further allows all students to freely access the highest-paying labor market without any frictions.

Table 5: Median Student Ranks in Beijing/Shanghai Colleges Across Counterfactuals

	Median student rank in BJ/SH colleges
CF0: Only BJ and SH impose *hukou* restrictions ($hk_d = 0$ for BJ and SH; $hk_d = 3$ for others)	68.642
CF1: No *hukou* restrictions nationwide ($hk_d = 3$ for all)	70.647
CF2: CF1 + free access to BJ/SH wages ($hk_d = 3$ for all; $lwages_d = lwages_{BJSH}$ for all d)	69.435
CF3: CF1 + no distance-related costs ($hk_d = 3$ for all; $\beta_4 = 0$)	76.806
CF4: CF2 + no distance-related costs ($hk_d = 3$ for all; $lwages_d = lwages_{BJSH}$ for all d; $\beta_4 = 0$)	75.939

CF0 versus CF1. Moving from CF0 to CF1 simulates the implementation of *hukou* reforms in Beijing and Shanghai. The results indicate that such reforms would raise the median rank of enrolled students by about 2 percentage points, consistent with the reduced-form evidence.

CF1 versus CF2, CF3 versus CF4. Transitioning from CF1 to CF2 simulates not only the removal of *hukou* restrictions but also the elimination of all frictions that prevent students from accessing the highest-paying labor markets after graduation. The results show that the median student rank in Beijing and Shanghai colleges declines by about 1.2 percentage points. This pattern suggests that, when migration frictions limit post-graduation mobility, colleges in Beijing and Shanghai attract stronger students due to their higher local wages; once these frictions are removed, their relative attractiveness diminishes. A similar pattern emerges when comparing CF3 and CF4, which simulate outcomes without distance-related attendance costs. Again, removing frictions that constrain labor mobility leads colleges in Beijing and Shanghai to enroll lower-quality students.

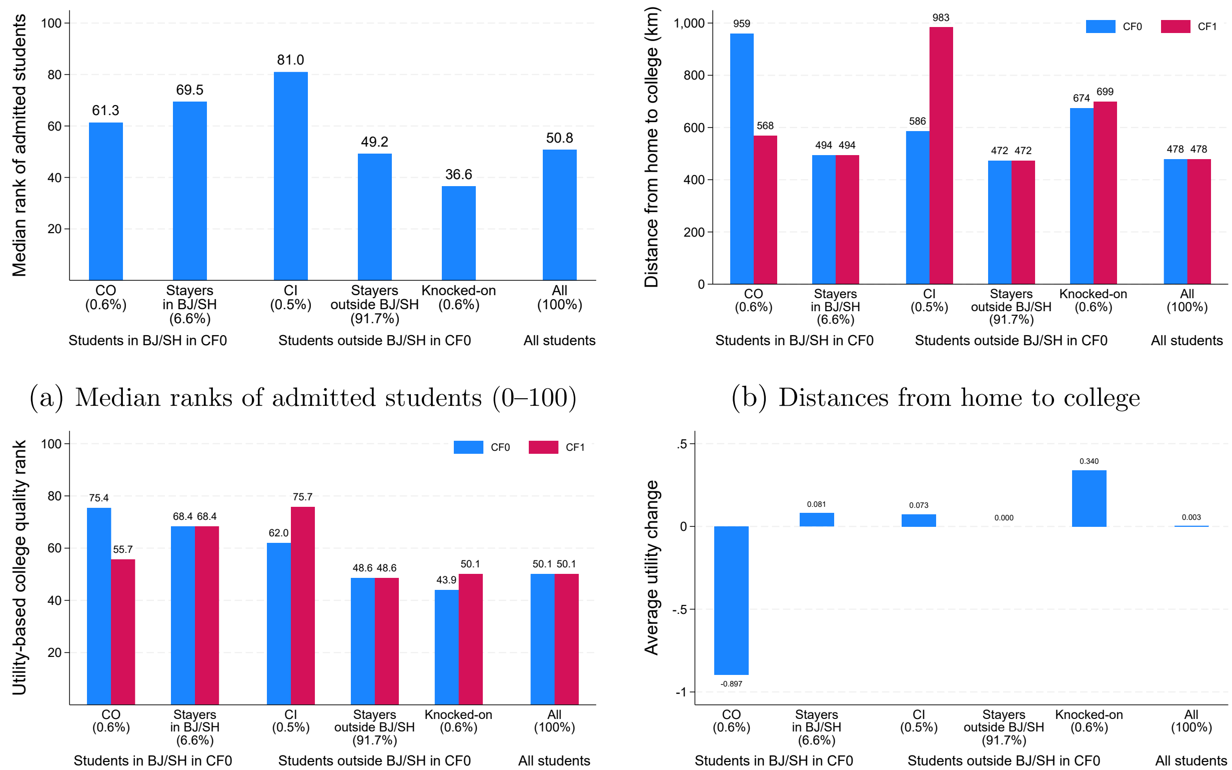
CF1 versus CF3, CF2 versus CF4. These comparisons highlight the role of distance-related costs of attendance. Eliminating such costs substantially raises the quality of students enrolled in Beijing and Shanghai colleges, suggesting that when attendance costs are present, long distances discourage high-performing students from enrolling in colleges located in these two cities.

Taken together, these results suggest that relaxing migration restrictions through *hukou* reforms enhances the attractiveness of colleges in Beijing and Shanghai, whereas removing all frictions that constrain labor mobility reduces their relative advantage.

5.2.2 Student sorting and welfare under CF0 and CF1

Because the admissions quotas allocated to students from each province are regulated in the actual system and therefore fixed in the simulations to match the observed data, any gain in admissions to a given college for one group necessarily entails a loss for another from the same province, creating both winners and losers. To examine these distributional effects, I compare student characteristics and outcomes across groups between CF0 (the baseline scenario, where only Beijing and Shanghai maintain stringent *hukou* restrictions) and CF1 (a reform scenario where these restrictions are relaxed nationwide).

Students are grouped according to their enrollment patterns across scenarios. Among those who enroll in Beijing or Shanghai colleges under CF0, *crowding-out (CO)* students are those who shift to other colleges in CF1, while those who continue to attend the same colleges are classified as *stayers in Beijing/Shanghai*. Among students who do not enroll in Beijing or Shanghai colleges in CF0, *crowding-in (CI)* students are those who move into colleges in these cities in CF1, while the remaining students stay outside Beijing and Shanghai. The latter group can be further divided into *stayers outside Beijing/Shanghai*, whose college choices remain unchanged between CF0 and CF1, and *knocked-on* students, whose college choices change across scenarios even though they do not enroll in Beijing or Shanghai colleges in either CF0 or CF1.



(a) Median ranks of admitted students (0–100)

(b) Distances from home to college

(c) Utility-based college quality ranks (0–100)

(d) Average utility change

Figure 5: Student Characteristics and Outcomes Under CF0 and CF1, by Group

Notes: Utility-based college quality ranks are derived from estimated utilities that incorporate input-based college quality and elite status (Project 985 and Project 211). The resulting ranks are normalized to range from 0 to 100, with higher values indicating higher quality.

Table 6: Spearman Correlation between College Quality Ranks and Student Ranks

	CO and CI students	CO, CI, and knocked-on students	All students
Share	1.078%	1.726%	100%
CF0	0.388	0.547	0.535
CF1	0.577	0.645	0.536

Figure 5 compares student quality, distance, college quality, and average utility change across groups. Panel (a) shows that CI students have the highest median rank of 81.0, while CO students have a median rank of 61.3. This indicates that CI students are academically stronger and thus pre-qualified for the colleges attended by CO students, yet they choose not to attend colleges in Beijing and Shanghai under CF0.

Panel (b) highlights the role of attendance costs. Under CF0, CI students travel an average of 586 km to attend college. After the *hukou* reform in Beijing and Shanghai (CF1), the utility of attending colleges in these cities rises substantially, incentivizing qualified CI students to enroll there. As a result, their average travel distance increases to 983 km under CF1. This pattern suggests that distance-related costs are an important deterrent preventing higher-quality students from enrolling in these major cities when migration restrictions are in place. Once the *hukou* reform in Beijing and Shanghai raise the utility of attending colleges there, these students become willing to incur longer travel distances. In contrast, CO students, after being crowded out, tend to choose colleges closer to their hometowns, reducing their average travel distance from 959 km under CF0 to 568 km under CF1.

Panel (c) reveals that before the *hukou* reform in Beijing and Shanghai, CI students attend lower-quality colleges (average quality rank of 62.0) compared to CO students (75.4). After the reform, the average quality of colleges attended by CI students rises substantially (75.7). Meanwhile, CO students are displaced to lower-quality colleges, with their average college quality rank falling from 75.4 to 55.7. The reallocation strengthens the alignment between student and college quality: as shown in Table 6, the Spearman correlation between college quality ranks and student ranks increases from 0.388 under CF0 to 0.577 under CF1. A similar pattern of stronger sorting emerges among students whose college choices change, including CO, CI, and knocked-on students. Although this pattern is context-specific, reflecting the concentration of high-quality colleges in Beijing and Shanghai, it nonetheless illustrates how stronger students sort into colleges located in cities where migration restrictions are relaxed.

Finally, the re-sorting of students translates into welfare changes. Panel (d) reports the average utility change from attending colleges across groups. Stayers in Beijing/Shanghai, CI students, and knocked-on students all experience utility gains, whereas CO students incur substantial utility losses. The national average utility change remains modest, reflecting the offsetting effects between winners and losers, as well as the large share of students nationwide whose college choices are unaffected by the relaxation of *hukou* restrictions in Beijing and Shanghai.

5.2.3 Decomposition of utility change from CF0 and CF1

To better understand the sources of these utility changes, I decompose the average utility change for each group. Figure A4 presents the results.

For CO students, utility from college quality declines sharply as they are displaced into lower-quality colleges. Their average utility from *hukou* policies increases, while utility from wages decreases. This pattern reflects that most CO students are displaced into cities with fully open *hukou* systems but lower wage levels than Beijing or Shanghai. Their distance-related utility rises, indicating gains from attending colleges closer to their hometowns.

CI students exhibit the opposite pattern. Their utility from college quality increases as they gain access to stronger colleges in Beijing and Shanghai. They also experience additional utility gains from higher expected local wages in these cities. However, they incur losses in distance-related utility, as attending colleges in Beijing or Shanghai requires moving farther from their hometowns.[9]

For stayers in Beijing/Shanghai colleges, utility increases as non-local students in this group benefit from the relaxation of *hukou* restrictions. In comparison, the utility of stayers outside Beijing and Shanghai remains unchanged because the factors determining their utility do not change.

Overall, average welfare nationwide increases, primarily driven by the relaxation of *hukou* restrictions in Beijing and Shanghai. It is important to note again that this welfare analysis captures students' ex ante utility from college attendance rather than realized outcomes after graduation. The results are based on the assumption that expected local labor market conditions are fixed and do not account for potential general-equilibrium effects of re-sorting on labor market conditions at graduation.

5.2.4 Student sorting and welfare under CF1 and CF2

Building on the previous comparison, I now examine the effects of removing all frictions that limit access to desirable labor markets after graduation. Specifically, I compare student characteristics and outcomes between CF1, where all cities are free of *hukou* restrictions, and CF2, where students can additionally access the highest-paying labor market without cost. The five student groups are defined analogously to those in the CF0–CF1 comparison but are now based on students' college choices in CF1 and CF2.

Figure A5 presents the results. When students are granted free access to the highest-paying labor market (CF2), those who attend colleges in Beijing or Shanghai under CF1 tend to relocate to lower-quality colleges closer to home. These CO students have a median rank of 75.9 (Panel (a)). They attend colleges with an average quality rank of 71.6 in CF1 but switch to lower-quality colleges with an average rank of 62.3 in CF2 (Panel (c)).

[9]For CI students who attend colleges in their home cities under CF0, there are also utility gains associated with the *hukou* reforms in Beijing and Shanghai. Under CF0, these students do not receive additional benefits from the relaxed *hukou* policies in their home cities because they are locals. The home indicators already capture both their home preferences and local wage premiums. When these students move to colleges in Beijing or Shanghai, they benefit from the relaxation of migration restrictions as non-locals, thereby expanding their access to the labor markets in these cities. However, since the share of such students is negligible, the average utility gain from *hukou* policies for the entire CI student group when transitioning from CF0 to CF1 remains minimal.

Their average travel distance decreases from 850 km to 643 km (Panel (b)), suggesting that proximity to home becomes a more dominant consideration once labor market access is no longer tied to college location.

The departure of higher-ranked students from Beijing and Shanghai creates opportunities for CI students—who previously attended lower-quality colleges—to enroll in stronger colleges in these cities. Their average college quality rank rises from 55.6 to 71.5 (Panel (c)), although this improvement comes at the cost of longer travel distances, increasing from 630 km to 894 km (Panel (b)).

Panel (d) shows that both CO and CI students experience substantial welfare gains. Figure A6 decomposes these utility changes and confirms the underlying mechanisms: CO students benefit primarily from reduced travel distance, whereas CI students gain mainly from improvements in college quality. Overall, national average welfare increases, indicating that removing all post-graduation frictions in labor market access enhances student welfare.

6 Conclusion

This paper provides new evidence on how migration frictions shape the spatial sorting of student talent. Exploiting the staggered rollout of China's *hukou* reforms across cities, I show that easing internal migration restrictions enables colleges in reformed cities to attract higher-quality students. The effects are particularly pronounced for colleges located in economically more developed cities relative to students' origins, consistent with improved local labor market prospects as the underlying mechanism. Counterfactual analysis based on a college choice model further shows that relaxing migration restrictions in major cities strengthens the sorting of higher-quality students into colleges located in those cities and increases average welfare. However, these welfare gains are unevenly distributed: heightened competition for college seats in major cities crowds out some students who would otherwise have been admitted. When students are further allowed to freely access the highest-paying labor markets, overall welfare increases even more.

These findings have important policy implications. First, the improvement in student quality following the relaxation of internal migration barriers in China aligns with international evidence on how immigration policies shape the education market. In the international context, tighter immigration rules—such as the sharp reduction in the H-1B visa cap in the United States in 2003—led to declines in the quality of international student enrollment (Kato and Sparber, 2013). Together, these results reveal a consistent pattern across contexts: relaxing migration restrictions enhances the quality of admitted students, whereas tightening them diminishes it. This underscores the sensitivity of the education market to migration policies and highlights how such policies shape the allocation of global talent across regions and education systems.

Second, the results show that both formal and informal migration frictions have far-reaching effects for the spatial distribution of skills. By shaping students' college choices and, consequently, their career trajectories, these frictions determine where high-skilled individuals study, work, and contribute to economic development. Policies that affect such frictions can therefore have significant impacts on the efficiency and spatial distribution of human capital.

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A Additional Tables and Figures

Table A1: Summary of *Hukou* Reforms

	Quartile of GDP Per Capita				
	Bottom Quartile	2nd Quartile	3rd Quartile	Top Quartile	Total
Treated					
Number of Cities	18	5	15	20	58
Number of Colleges	26	13	27	197	263
Control					
Number of Cities	13	27	19	23	82
Number of Colleges	17	55	44	249	365

Notes: GDP data is from 2003 and is unavailable for 10 cities. Most of these 10 cities are autonomous and have fewer colleges, primarily lower-tier institutions.

Table A2: Effects of *Hukou* Reforms on Student Rank Distribution Within Colleges

	10th Percentile Rank	90th Percentile Rank	90th–10th Percentile Rank Difference
	(1)	(2)	(3)
Reform indicator	3.080***	1.229*	-1.851*
	(1.069)	(0.670)	(0.943)
Origin × track × college FE	✓	✓	✓
Province of destination × year FE	✓	✓	✓
Observations	187,792	187,792	187,792
Adjusted R^2	0.877	0.900	0.617

Notes: Estimates are based on Equation (2) using the 2005 and 2011 samples. All regressions are weighted by predicted student flows derived from a gravity model estimated on the 2005–2011 sample using PPML (Silva and Tenreyro, 2006). In the gravity model, observed student flows are regressed on the log distance between origin and destination, origin × high school track FE, college × high school track FE, and year FE. Standard errors are clustered at the destination city level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A3: Impacts of *Hukou* Reform on College Seat Allocations

	Dependent variable	
	Log total seats	Share of seats to other provinces
	(1)	(2)
Reform indicator	-0.036	0.018
	(0.062)	(0.024)
Province of destination × year FE	✓	✓
College × track FE	✓	✓
Observations	2,468	2,226
Adjusted R^2	0.886	0.897

Notes: Estimates are based on Equation (3) using the 2005 and 2011 samples. All regressions are weighted by baseline quotas in 2005. Standard errors are clustered at the destination city level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A4: Effects of *Hukou* Reforms on Student Ranks Net of Spillover Effects

Dependent variable: median percentile ranks of admitted students	
	(1)
Reform indicator	2.359***
	(0.687)
Province of destination × year FE	✓
Origin × track × college FE	✓
Group FE	✓
The estimated coefficient of reform indicator of the main result is 2.378.	
Observations	1,943,314
Adjusted R^2	0.968

Notes: Estimates are based on Equation (4) using the 2005 and 2011 samples. All regressions are weighted by the predicted flow values from a gravity model estimated via PPML (Silva and Tenreyro, 2006), incorporating the log of distance between the origin and destination, origin × high school track FE, college × high school track FE, and year FE as explanatory variables. Column (2) restricts the set of control cities to those whose correlations with treated cities in student inflows lie between –0.01 and 0.01. Standard errors are clustered at the destination city level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A5: Impacts of *hukou* Reforms on the Shares of Local and Nonlocal Students

Dependent variable: share of students within a college		
	(1)	(2)
Local student indicator × reform indicator	-0.016**	-0.017***
	(0.008)	(0.005)
Non-local student indicator × reform indicator	0.003	0.010*
	(0.002)	(0.005)
Origin × track × college FE	✓	✓
Province of destination × year FE	✓	✓
Sample restriction	No restriction	Students from within college province
Wald Test p-value	0.0511	0.0056
Observations	187,792	31,742
Adjusted R^2	0.910	0.922

Notes: Estimates use the 2005 and 2011 samples. Local students are defined as those admitted by colleges located in their home city. All regressions are weighted by predicted student flows generated from a gravity model estimated on the full sample from 2005 to 2011 using PPML (Silva and Tenreyro, 2006). In the gravity model, observed student flows are regressed on the log distance between origin and destination, origin × high school track FE, college × high school track FE, and year FE. Standard errors are listed in parentheses and clustered at colleges' cities. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A6: Effects of *Hukou* Reforms on Student Ranks by Distance and Historical Migration Flows

Dependent variable: median percentile ranks of admitted students		
	(1)	(2)
Reform indicator ×		
log distance	-1.448***	
	(0.432)	
log historical migration flows		0.797***
		(0.304)
Province of destination × year FE	✓	✓
Origin × track × college FE	✓	✓
Observations	184,726	184,726
Adjusted R^2	0.901	0.901

Notes: Estimates are based on the 2005 and 2011 samples. Students admitted by colleges in their home city are excluded. Historical migration flows are constructed using 2000 census data at the city level. All regressions are weighted by predicted student flows generated from a gravity model estimated on the full sample from 2005 to 2011 using PPML (Silva and Tenreyro, 2006). In the gravity model, observed student flows are regressed on the log distance between origin and destination, origin × high school track FE, college × high school track FE, and year FE. Standard errors are clustered at the destination city level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A7: Model Fit: Comparison of Moments and Student Sorting

	Distance (km)	College at home city	College at home province	Utility-based college quality rank	Urban wages
	(1)	(2)	(3)	(4)	(5)
Panel A: Mean (Std. Dev. in parentheses)					
Data	448.723	0.173	0.656	50.322	20968.04
	(545.904)	(0.379)	(0.475)	(28.856)	(6781.79)
Simulation	450.729	0.162	0.656	50.322	20968.04
	(544.039)	(0.368)	(0.475)	(28.856)	(6781.79)
Panel B: Spearman correlation with student ranks					
Data	0.164	-0.082	-0.233	0.701	0.223
Simulation	0.070	-0.005	-0.136	0.539	0.178

Notes: The simulation is conducted using the same 20% random sample employed in the estimation. Results are robust when the simulation is performed using the full sample. Utility-based college quality ranks are derived from estimated utilities that incorporate input–output-based college quality and elite status (Project 985 and Project 211). The resulting ranks are normalized to range from 0 to 100, with higher values indicating higher quality.

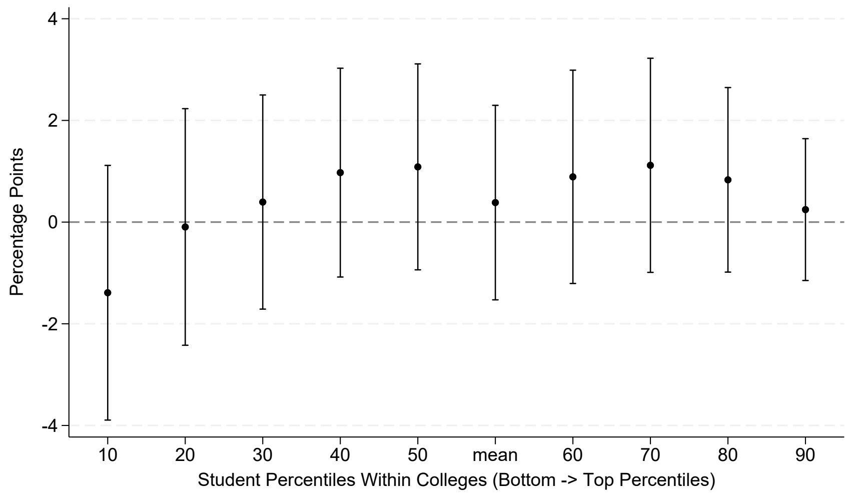


Figure A1: Placebo Test: Correlation Between Changes in Student Ranks (2005–2011) and Future *Hukou* Reforms (2011–2013) across Percentile within Colleges

Notes: Estimates are based on Equation (2) using the 2005 and 2011 samples. The reform indicator equals 1 for 2011 observations if the college city implemented *hukou* reforms between 2011 and 2013. All regressions are weighted by predicted student flows generated from a gravity model estimated on the full sample from 2005 to 2011 using PPML (Silva and Tenreyro, 2006). In the gravity model, observed student flows are regressed on the log distance between origin and destination, origin × high school track FE, college × high school track FE, and year FE. Standard errors are clustered at the destination city level. Confidence intervals are presented at the 95% level.

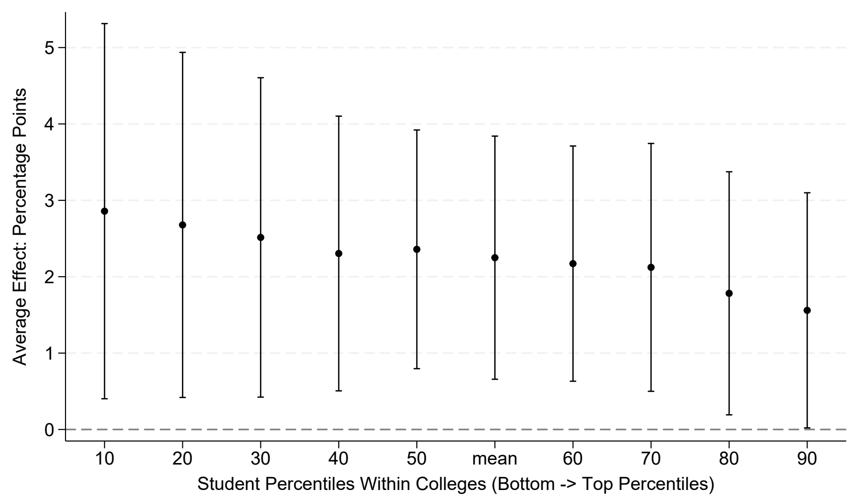


Figure A2: Impact of *Hukou* Reforms on Student Rankings Using Control Cities Not Competing for the Same Student Pool

Notes: The regressions are restricted to control cities whose student admission flows have a correlation of between -0.1 and 0.1 with treated colleges.

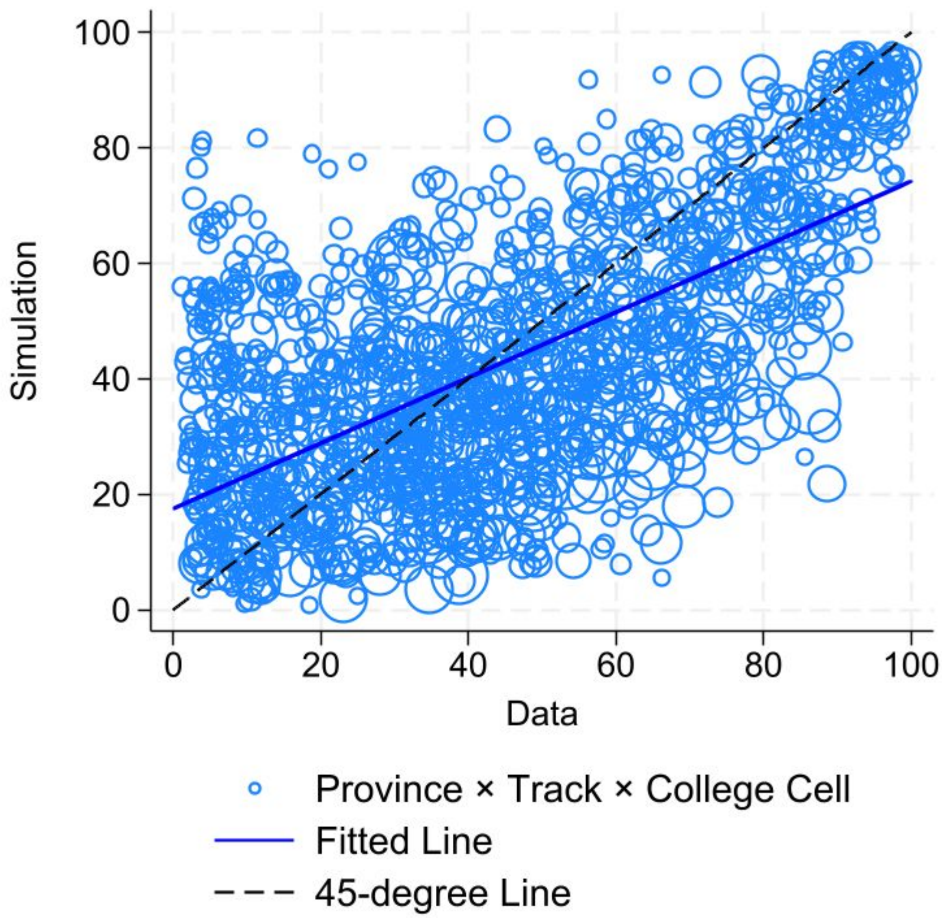


Figure A3: Model Fit: Simulated vs. Actual Median Student Ranks

Notes: Model fit is evaluated using the estimated parameters from column (3) of Table 4, applied to the same estimation sample. The figure reports results for the top 5% of colleges with the largest student quotas. Bubble sizes represent quotas.

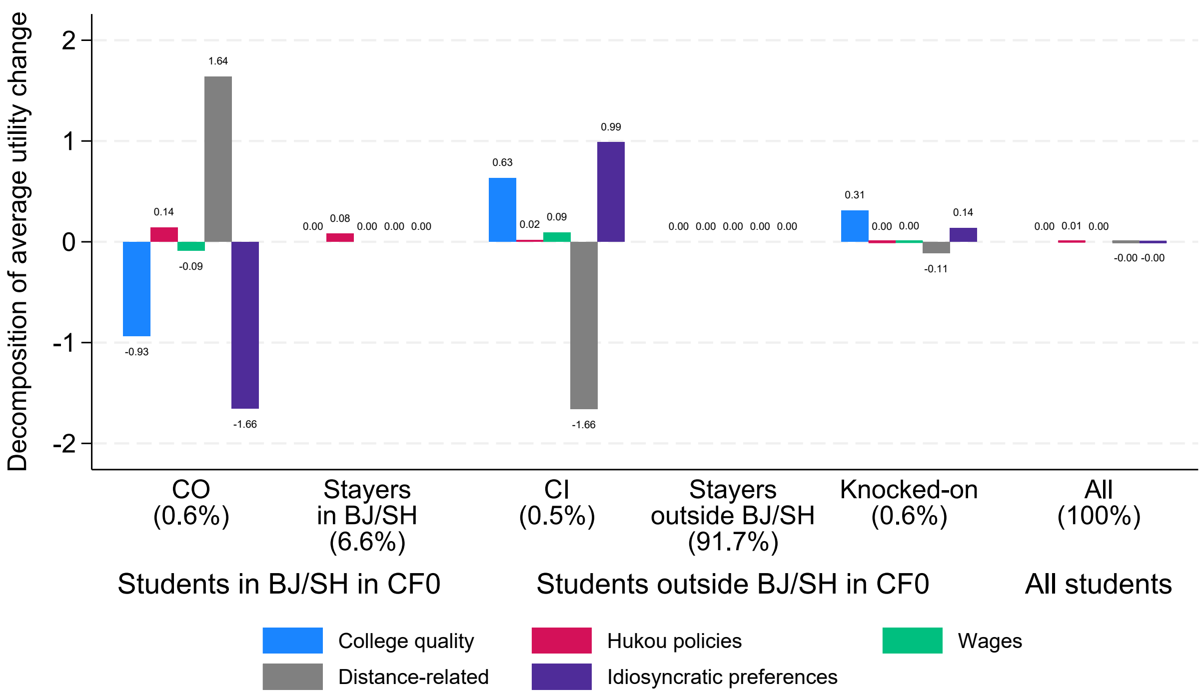
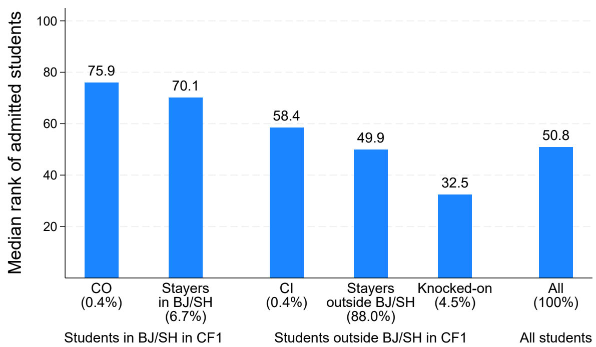
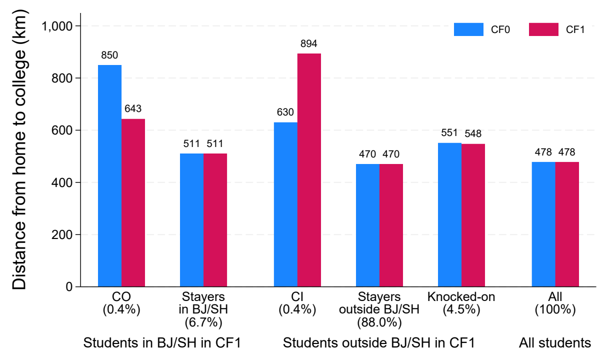


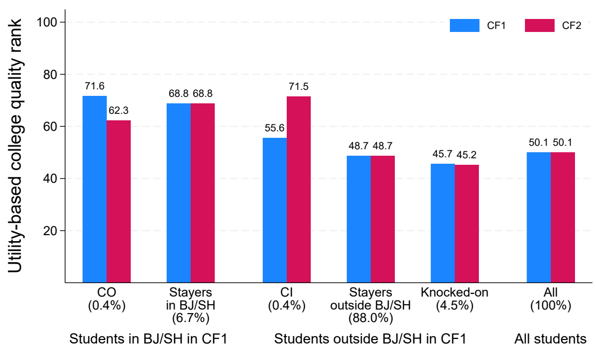
Figure A4: Decomposition of average utility change from CF0 to CF1



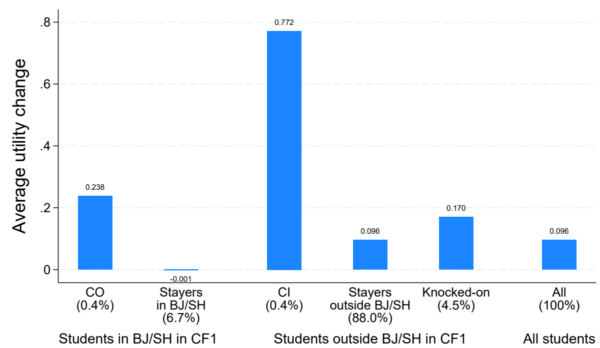
(a) Median ranks of admitted students (0–100)



(b) Distances from home to college



(c) Utility-based college quality ranks (0–100)



(d) Average utility change

Figure A5: Student Characteristics and Outcomes Under CF1 and CF2, by Group

Notes: Utility-based college quality ranks are derived from estimated utilities that incorporate input–output-based college quality and elite status (Project 985 and Project 211). The resulting ranks are normalized to range from 0 to 100, with higher values indicating higher quality.

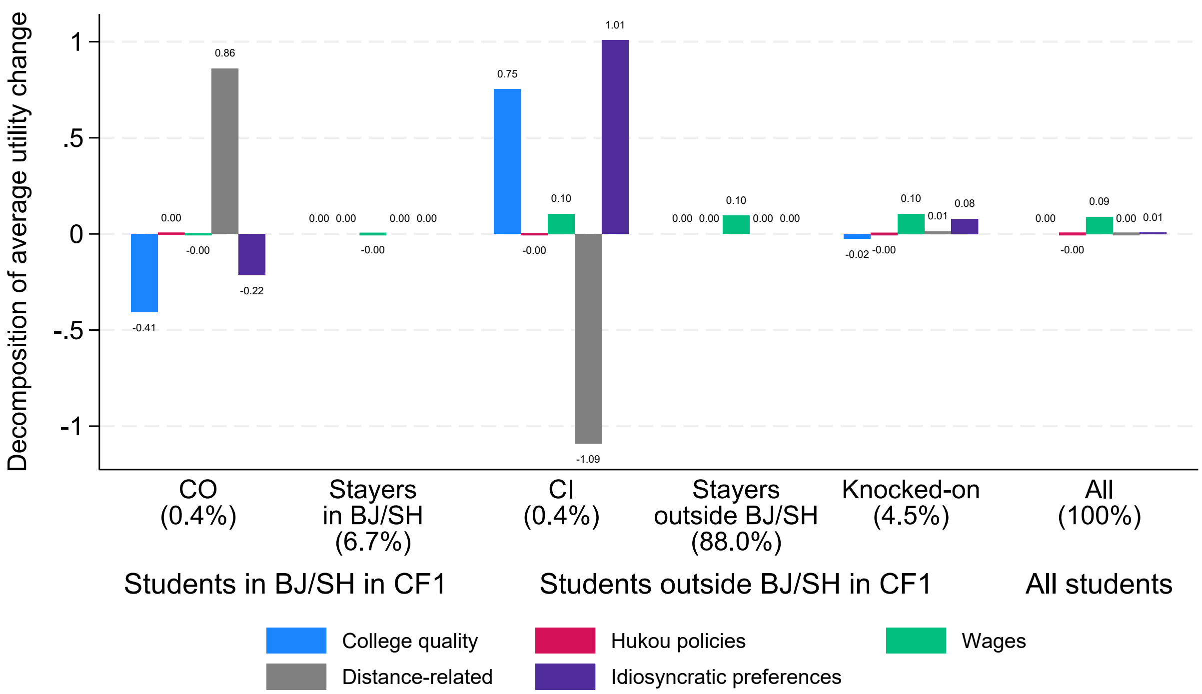


Figure A6: Decomposition of average utility change from CF1 to CF2

B A Model of the College Admissions Market

Setup

Consider a college admissions system within province p. Let $r_{ip} \in [0, 1]$ denote the percentile rank of student i from province p, where a higher r_{ip} indicates a higher NCEE score. Each student submits a preference list of up to k colleges based on expected utility: $\mathcal{C}_i = \{c_{i1}, c_{i2}, \ldots, c_{ik}\} \subseteq \mathcal{C}$. Let $\pi_{pc}(r)$ denote the share of students from province p at rank r who apply to college c. Each college c allocates a predetermined admission quota to students from province p, denoted by Q_{pc}. The college admits only those students who list it in their preference set and selects among them in descending order of ranks r_{ip} until the quota is filled. Because competition for admission is intense, the quota Q_{pc} is a binding constraint.

Student Demand for College Seats

Let $f_p(r)$ denote the density of student ranks in province p. Define $A_{pc}(r_o)$ as the cumulative number of applicants from province p with rank at least r_o who apply to college c:

$$A_{pc}(r_o) = \int_{r_o}^{1} \pi_{pc}(r) f_p(r)\, dr. \tag{B1}$$

This function captures the total number of students above rank r_o competing for admission to college c.

Market-Clearing Condition

Let $\underline{r}_{pc}$ denote the admission cutoff rank of college c for students from province p. The market-clearing condition equates the number of applicants above the cutoff with the available quota:

$$A_{pc}(\underline{r}_{pc}) = Q_{pc}. \tag{B2}$$

The equilibrium cutoff rank $\underline{r}_{pc}$ is determined by the interaction between student demand for college c and the quota allocated to province p. When a college is highly attractive and frequently listed by high-ranking students, the cumulative demand $A_{pc}(r)$ will be large at higher ranks. Consequently, the college can fill its quota with more competitive students, resulting in a higher cutoff rank $\underline{r}_{pc}$. Conversely, when demand—particularly among top-ranked students—is weaker, the college must admit lower-ranked students to fill its quota, leading to a lower cutoff.

Similarly, when a college increases the quota allocated to province p (i.e., Q_{pc} rises), it must admit additional students, including those with lower ranks, thereby lowering the equilibrium cutoff rank.

These mechanisms yield two predictions:

Model Prediction 1 *An increase in student demand for a college, especially among high-ranking students, raises the admission cutoff.*

Model Prediction 2 *An increase in the admission quota a college allocates to a province lowers the admission cutoff.*