College-Major Choice to College-then-Major Choice:

The Heterogeneous Impacts of Late Specification Reforms on College Student Composition

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Abstract

This paper provides one of the first natural experimental evidence on the consequences of a transition from college-major (early specialization) to college-then-major (late specialization) choice mechanism. Specifically, we study a recent reform in China that allows college applicants to apply to a meta-major consisting of different majors and to declare a specialization late in college instead of applying to a specific major. Using administrative data over 18 years on the universe of college applicants in a Chinese province, we examine the impacts of the staggered adoption of the reform across institutions on student composition changes. We find substantial heterogeneous effects across institutions and majors despite the aggregate null effects. This paper provides important policy implications regarding college admissions mechanism designs.

JEL classification:

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Keywords:

college major choice; meta-major reform; early and late specialization; student composition

1. Introduction

College major choice is one of the most important decisions students make and has long-lasting effects on their life. Various supply-side policies in higher education, such as admissions criteria, tuition policies, and targeted financial aid, have been used to alter the composition of college majors (Patnaik et al., 2020). One of the most important mechanism design policies in college admissions is for students to choose a college major sequentially (college-then-major choice) or jointly (college-major choice). In counties like the United States and Canada, students do not have to declare a specific major upon admission, and they can make the specification choice later at college. Differently, many other countries, like Chile, Japan, and Spain, require students to choose a college-major pair jointly when they submit their applications (Bordon & Fu, 2015; Kirkeboen et al., 2016; Krussig & Neilson, 2021; Machado & Szerman, 2021; Meyer et al., 2021). However, in recent years, there have been opposite reform trends in those two systems. For example, in many US colleges, incoming students are now asked to apply to one college, division, or meta-major directly, and their final major options will be limited to the selected college/meta-major.[1] In contrast, as we examine in this paper, Chinese colleges have been adopting meta-major reforms in their traditional centralized college-major choice system.

These two mechanisms – college-major choice and college-then-major choice - are different in various aspects, such as the major choice timing and process, knowledge and skill training, and peer types. For example, under the joint college-major choice mechanism, students can receive specialized training and gain the knowledge and skills directly related to their potential future careers once entering college. In contrast, under the sequential college-then-major choice, students receive general education during the first or two years to explore and

[1] See https://hechingerreport.org/some-colleges-ease-up-on-pushing-undergrads-into-picking-majors-right-away/, https://success.gsu.edu/initiatives/meta-majors/ for examples.

develop their specific major and occupational interests before making their final major choices. Also, they are more likely to be surrounded by peers with various interests and comparative advantages.

In this paper, we evaluate the policy consequences of a recent nationwide meta-major reform in China. The reform is one of China's most important university-level reforms in shifting from college-major choice to college-then major choice mechanism in the past two decades. The reform provides a unique opportunity to empirically study students' choices for different college major choice mechanisms. Colleges undertaking the reform cluster relevant majors to form a larger meta-major, for example, an engineering meta-major includes all engineering-related majors. Students could be admitted to a meta-major first at the entrance of college, and then declare their final major within the scope of the meta-major after one or two years of education under the general field of study. Therefore, the meta major can be interpreted as an intermediate form between college-major admissions and college-then-major admissions.

Recent literature found that the timing of specialization across different admission systems is an important determinant of students' college major choices and their subsequent careers and welfare. Malamud (2010, 2011) studied the labor market outcomes across various admission systems, i.e., joint or sequential college and major choice mechanisms. He found that although there is no significant difference in earnings, individuals are less likely to switch to an unrelated occupation under the sequential choice system (Malamud, 2010, 2011). The results imply that the benefit of the student-major match outweighs the loss of early specialized education (Malamud, 2011). Bordon & Fu (2015) studied the impacts of postponing the timing of college major choice by developing a sorting equilibrium model under the college-major-specific choice regime. The model allows for uncertainties over student-major fits and endogenous peer quality that affects individual outcomes. They found that switching from the joint choice to the counterfactual regime (sequential choice) leads to a 1% increase in average student welfare, with larger impacts on female, low-income, and/or low-ability students (Bordon & Fu, 2015). Similarly, Birdet & Leighton (2015) built and estimated a dynamic college choice model where the optional specialization timing reflects a tradeoff between discovering comparative advantage and acquiring occupational-specific skills. The share of worker not working in their field of comparative advantage rises substantially and the expected earnings fall in a system that imposes early specialization. However, there is still a lack of evidence about how would the postponement of specialization timing impact students' college major choice in one education system since current literature estimated the impact either by comparing different education systems in different countries or simulating a counterfactual education system.

Our paper contributes new empirical evidence to the ongoing international debate over the transitions between the jointly college-major and sequential college-then-major choice. While late specialization (i.e., college-then-major choice) provides opportunities for students to learn about their comparative advantages, interests, and fit (Fricke et al., 2018; Patterson et al., 2021; Meyer et al., 2022), many students may not make their optimal major choice or major switch decisions (Astorne-Figari & Speer, 2019). Recent literature also suggests the benefits of course-taking diversity in college on early-career employment and earnings might be small (Seah et al., 2020). Moreover, the debate between early or late major specialization assumes that students make fully informed and rational decisions. But information friction is a common problem among students from different contexts (Hastings et al., 2016; Ding et al., 2021). Therefore, evidence on students' behavioral responses to the college major admission reform under uncertainties has important implications for students confronted with similar information barriers worldwide.

In China, a substantial college admissions reform allowing a subset of universities to switch from the jointly college-major admissions to sequentially college-then-major admissions was recently implemented and potentially changing the composition of students across higher education institutions. The meta-major reforms in China provide a unique opportunity to empirically study students' preferences for different college major choice mechanisms. The investigation of Chinese meta-major reform is likely to be informative in contexts with different progress in college admissions mechanisms reforms.

For institutions, meta-major is an important practice of multidisciplinary education and cultivating interdisciplinary talents, which are essential for scientific and technological development and innovations. It also alleviates the polarization between popular and unpopular majors in student quality. For students, meta-major reduces the initial number of major options available for entering students and postpones the timing of the ultimate major choice. However, students face great uncertainties in their ultimate major choice and the risk of being assigned to a less preferred major since not only the policy of the final major declaration varies across institutions and even schools within institutions, but also the policies in some colleges are equivocal for entering students. Information friction, thus, is a major problem that students are faced in the meta-major reform and evidence on students' behavioral responses to the reform have important implications for students confronted with similar information barriers worldwide.

This paper provides one of the first quasi-experimental evidence on the impact of the transition from college-major choice to college-then-major choice mechanism on student composition and heterogeneity across institutions and majors by making use of the meta-major reform in China. We use the administrative data over 18 years on the universe of students' college-major admissions outcomes in China. The data include information on students' demographic characteristics, college preparedness, and college-major admission results for a complete provincial-level admission market. We investigate how the transition from college-major to college-then-major choice (i.e., the meta-major reforms in the Chinese context) affects student composition within college-majors. We use two dimensions of measures to depict the admitted student profile.

The first one is a common practice in higher education policy research to use, which is college or college-major level mean standardized test scores (e.g., in entrance exam or SAT/ACT) of the entering cohort to evaluate institutional policies as the scores indicate the attractiveness of the colleges or college-majors among students, or students' revealed preferences for institutional quality (see recent examples in Dillon & Smith, 2020 and Castro-Zarzur et al., 2022). We created five different score-based measures including the mean, median, minimum, maximum values, and range of the *Gaokao* scores of the students admitted to a college-major.[2] The second dimension of student composition is student demographic characteristics, including gender, ethnicity, hukou status, type of county of origin, and the *Gaokao*-retaking status.[3]

We find that, aggregately, there are no statistically significant changes in student composition (entrance exam scores and demographics) in college-majors after the

[2] These values measure different aspects of the ability of the admitted students. Both the mean and medium values measure the central tendency of the admission scores, which is the average level of ability of admitted students. The mean value is sensitive to outliers, while the median value is more robust against outliners. The minimum value is the lowest qualifying score. Only students with scores above this cutoff score have the chance to enter the program. The maximum score describes the highest ability level of the students the program could attract. The score range is the difference between the maximum and minimum scores, which measures the variability of admitted students' test scores. In the Hukou system, each citizen was classified as being rural or urban based on the demographic variable, the "location of origin".

[3] Gaokao repeaters are those who retake the college entrance examination because they fail or underperform in their first attempt, do not get admitted or are not satisfied with their admission results, and want to get higher scores and enter better colleges in the repeated year.

implementation of the meta-major reform. The result is robust to using alternative measurements, samples, models, and estimators (e.g., the heterogeneity-robust DID estimators). The heterogeneous impacts across institutional types and major categories supplement the main results. Meta-major reform disproportionately increases the student quality at non-elite universities and non-advantaged STEM majors. The reform also alters the student profile in terms of ethnicity and place of origin at the most prestigious institutions. We discuss these results from the supply-side in terms of the recruitment strategy of universities in the final discussion section.

The paper contributes to three strands of literature. First, there is a growing body of literature on the determinants of college major choices and a large body of previous literature has documented the supply-side factors of major choices including the number, type, and quota of majors (Altonji et al., 2016; Patnaik et al., 2020). Our paper extends the discussion on how the major policies at the university level would affect students' choice behaviors. Second, the results presented in this paper speak to recent studies on mechanism designs of college major choice. The paper contributes new empirical evidence on the ongoing reforms of college major policies, i.e., the transitions between college-major and college-then-major choices by making use of a natural experiment (Bordon & Fu, 2015). Third, the paper also contributes to the debate over the access equity of higher education and college major choices with uncertainties by investigating how the meta-major reform may disproportionately impact students from different backgrounds (Kanny et al., 2014). Moreover, the investigation of how the meta-major affects students' application behaviors also has important implications for promoting better admission practices and policies of universities worldwide that are alternating between college-major and college-then-major choices.

2. Background

China's centralized college admission system was established in 1978 and has expanded massively since 1999. It is the largest centralized student-college matching market in the world. Like many other countries, such as Chile, Japan, and Spain, students in China traditionally choose college and majors jointly. The centralized admission system allocates applicants to majors and colleges only considering their declared college-major preferences and their academic performance, i.e., solely the test scores in *Gaokao*. Students apply for different tiers of higher education institutions, including key universities, regular provincial and local four-year colleges, and tertiary vocational colleges, and choose majors within each college. The examination and admission are conducted separately by each provincial-level administrative division.

In the recent shift from college-major choice to college-then major choice, one of the most important university-level reforms is the implementation of the meta-major reform, which clusters relevant academic majors into a larger cohesive bucket (e.g., in clusters of science, engineering, medical, business, liberal arts, social science). The reform aims to consolidate the foundation of both general and major-specific knowledge, as well as provide a wide range of major and career opportunities under the general field of study. From the perspective of higher education institutions, the meta-major is a potential approach to attract talented students by providing multidisciplinary education and broader career prospects. By 2020, all the 42 "double first-class" universities and more than 50% of the Project-211 universities have implemented the meta-major reform.[4]

The reform in college majors simplifies student major choice by reducing the initial number of major options available for entering students and postponing the timing of the ultimate major choice. Similar to college-then-major choice, students have to declare a major in a specific discipline after enrolling in general courses related to the areas of study under the meta major, and the final major choice is based on individual preference and academic performance. The assignment mechanisms of meta majors are different across universities, students' final major choice in these programs may be determined by their *Gaokao* scores, academic performance in the first or two years after enrollment, the scores of tests specifically designed for assignment, etc. The published major assignment mechanisms could be complicated, equivocal, and vary across schools/colleges. Some students even have no access to specific information about the assignment mechanisms when they apply for colleges; therefore, they are faced with great uncertainty in their final major choices. One potential risk of meta majors is that students may be under greater academic pressure in the first few years of college and end up being assigned to a less preferred major.

Next, we use two hypothetical students to illustrate the reform, especially the uncertainty students are faced with in the reform. A high school graduate student is interested in mechanical engineering and makes her college application based on her major interest. Before the reform, she could apply directly to a mechanical engineering major in a couple of universities and will be admitted to a college-major option when she passes its admission threshold. After the reform, an

[4] The "double first-class" universities are the most elite institutions of Chinese tertiary education, representing the top 5% of overall universities and colleges in China. Project-211 is a broader group of key universities in the 21st Century, which includes 112 highly selective universities.

institution that she would like to choose has already conducted the meta major reform and bundles a lot of majors related to engineering, such as mechanical engineering, aeronautical engineering, energy and power engineering, and vehicle engineering, so she must choose the engineering meta major instead. It is uncertain whether she would enter the mechanical engineering major after one or two years of study because of various assignment mechanisms. For example, if the final major choice is determined by student GPA, she will miss her favorite major once the number of students with higher GPAs listing mechanical engineering as their first choice exceeds the quota for the major. And she will be admitted to her second or subsequent less preferred majors. In this case, the student would not prefer a meta major.

Another student wants to study finance at a top university. However, his *Gaokao* score may not meet the admission threshold of the college-major. Before the meta-major reform, it is impossible for him to be admitted his ideal major at the entrance, and the probability of switching to another major is also very low. Although many Chinese universities allow students to change majors in their first year of college, it is always exclusively open to top students and the major options are limited. Things become different after the reform. He can enter the social science meta-major that includes finance and other social meta-majors first, and then he has a certain possibility to enter his ideal major if he meets the assignment requirement of the finance major. Therefore, the meta-major reform provides additional risks for the first student but new opportunities for the second student under the centralized college-major admissions.

3. Data and Method

This paper uses unique administrative data on college admission in the province of Ningxia (2001-2018) provided by the Ningxia Department of Education. The administrative data includes information on the demographic characteristics, high school experience, college application and admission results for all high school graduates in Ningxia province from 2001 to 2018 (N=917,430). Ningxia uses a typical centralized college-major application and admission system like other provinces in China.

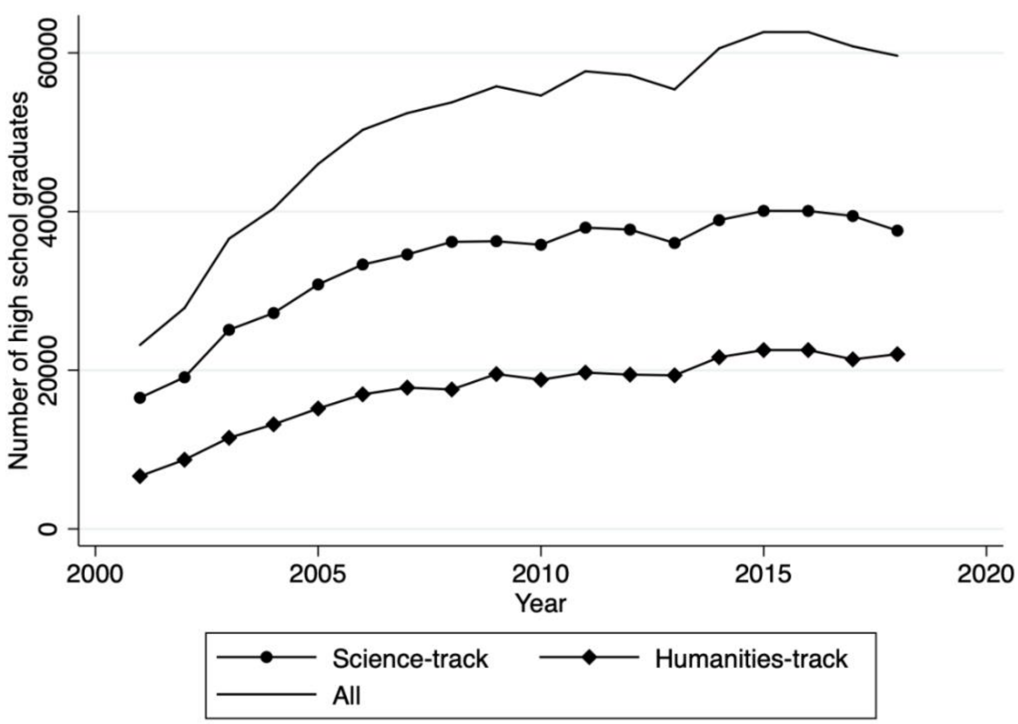

Figure 1 Number of High School Graduates (2001-2018)

shows the trend in the total number of high school graduates and the number of graduates in each track at high school (science or humanities). Because of the national college expansion policy since 1999, the student body increased over time with a rapid rise before 2009 and fluctuated upward after 2009. The trend is similar for students in different tracks, and science-track students are about twice as many as humanities-track students.

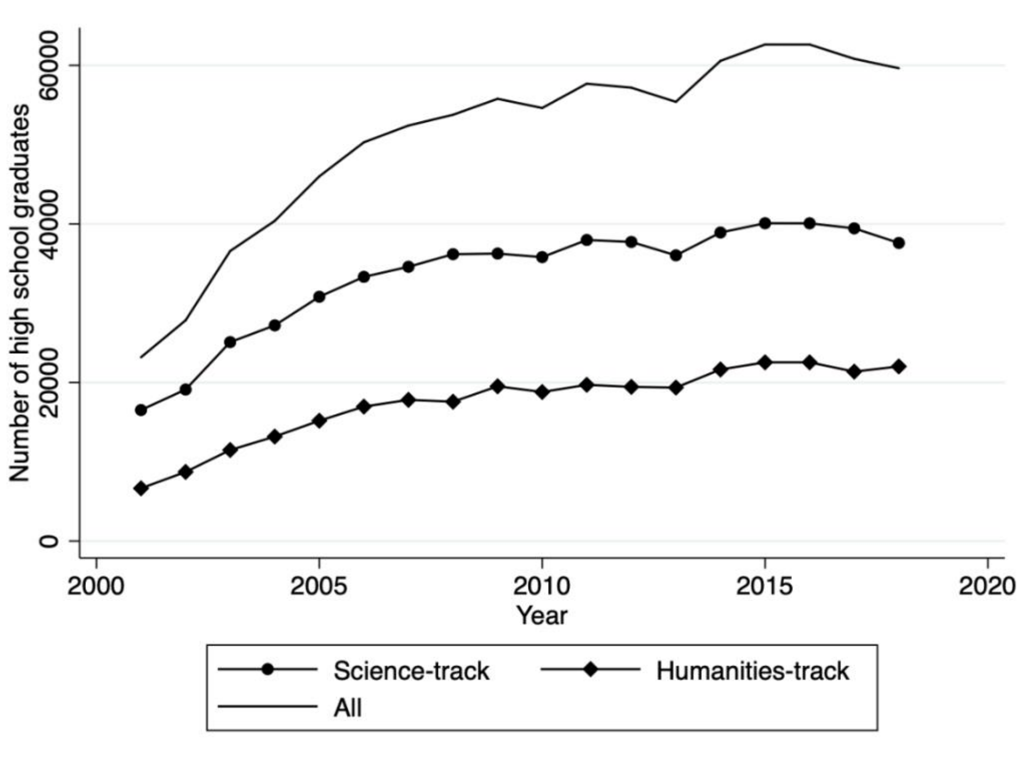

Figure 1 Number of High School Graduates (2001-2018)

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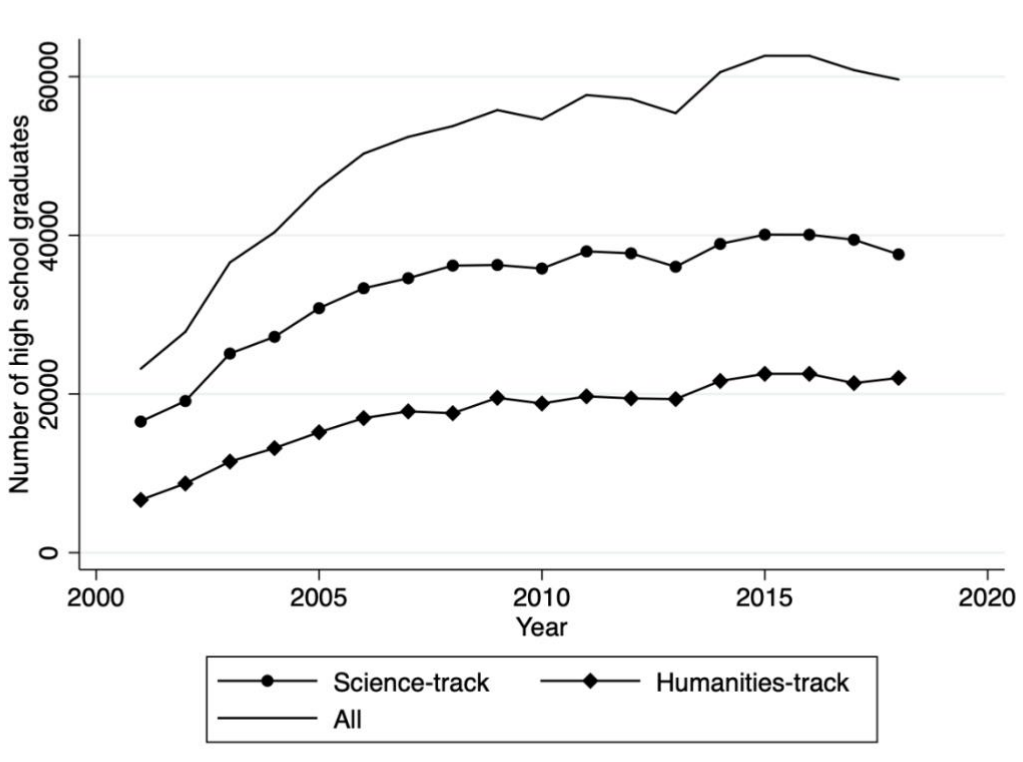

Figure 1 Number of High School Graduates (2001-2018)

shows the trend in the total number of high school graduates by track in Ningxia from 2001 to 2018.

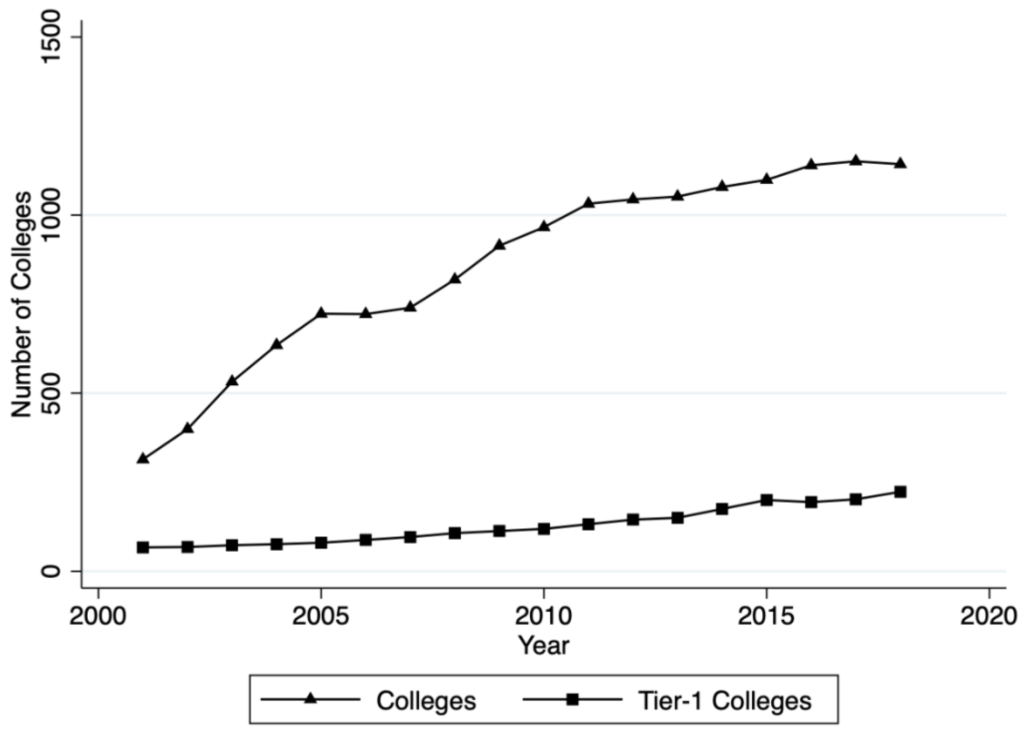

Figure 2 Number of Colleges (2001-2018)

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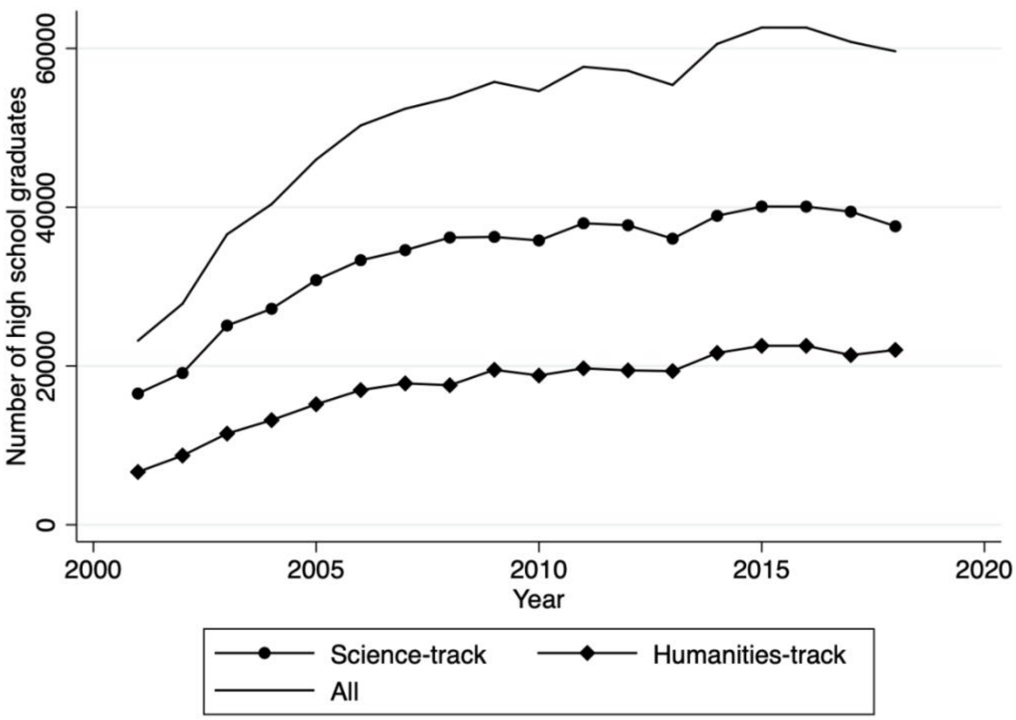
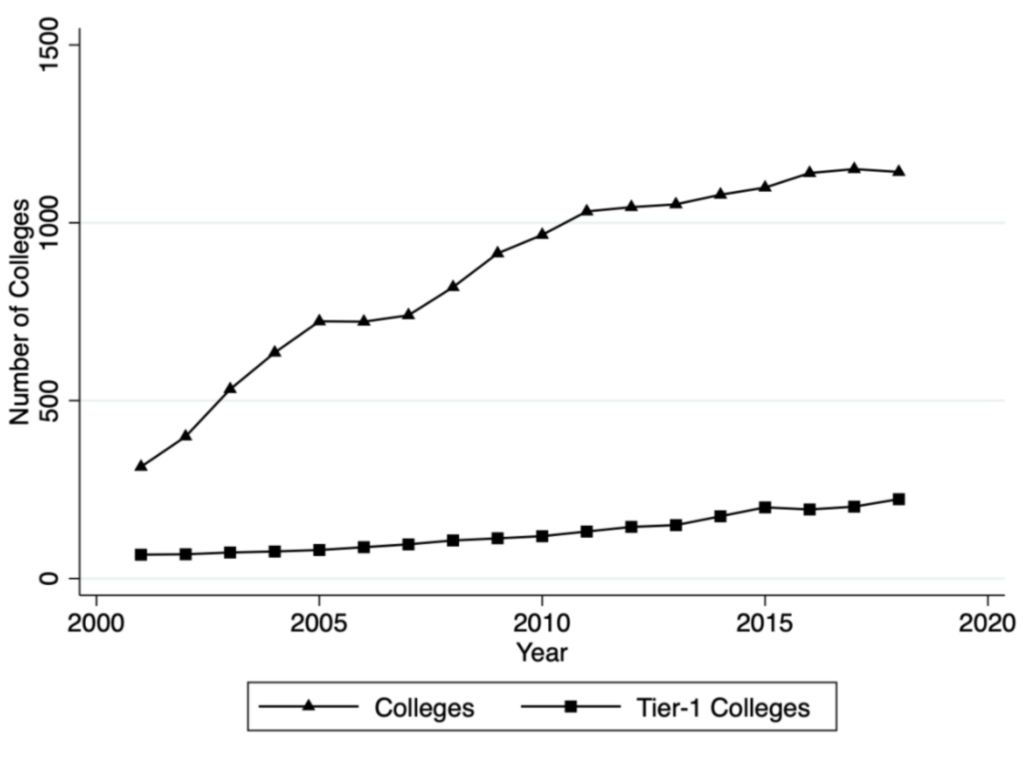


Figure 1 Number of High School Graduates (2001-2018)

shows the number of colleges recruiting high school graduates in Ningxia from 2001 to 2018.

illustrates the number of colleges recruiting students in Ningxia from 2001 to 2018. The total number of colleges increased 264% from 314 to above 1000 during these 18 years, and the number of tier-1 colleges also rose steadily since 2001 with more than 200 of them in 2018.[5]

[5] The tier-1 colleges here refer to colleges with admission scores above the first-tier cutoff, which is a larger subset of universities than what we usually define as "yiben," i.e., the first batch of universities with the highest admission scores.



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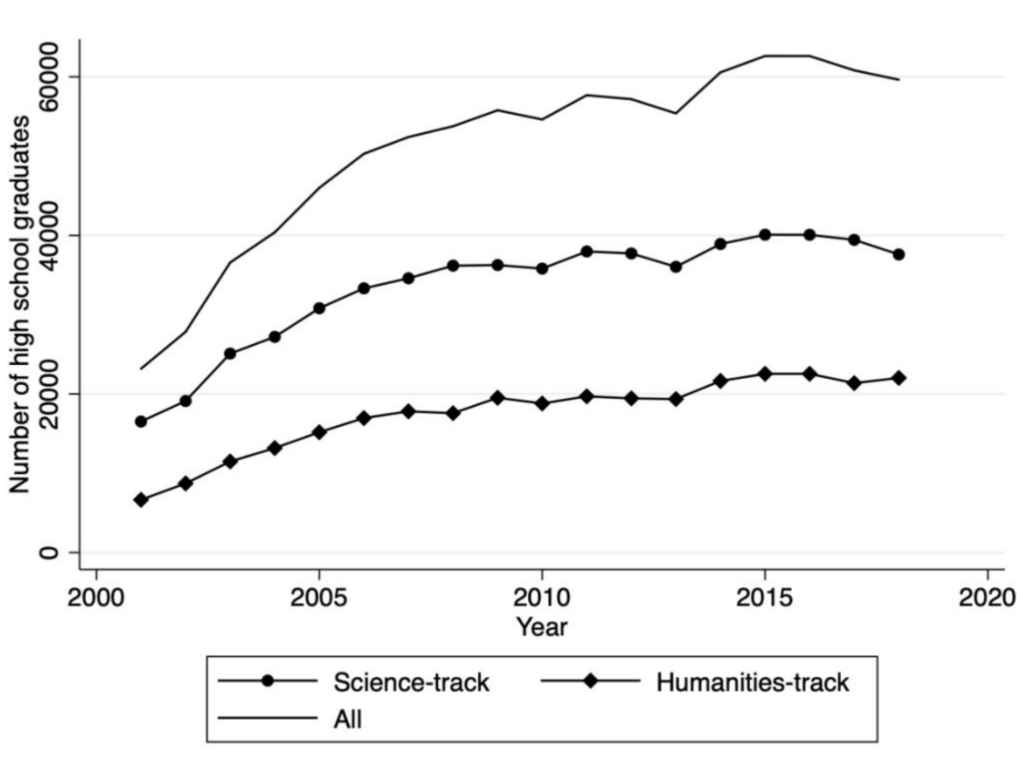

Figure 1 Number of High School Graduates (2001-2018)

shows the number of colleges recruiting high school graduates in Ningxia from 2001 to 2018.

We limit our analysis to a sample that consists of 120,576 students whose *Gaokao* score is above the first-tier cutoff score of their given track. First, most meta major reforms occurred at the first-tier elite colleges. As discussed below, we were able to construct a valid comparison group for the difference-in-differences estimation. Second, while more colleges started to recruit students from Ningxia and recruited more students over the years, admissions at the first-tier colleges remained stable.

It is worth mentioning that the data of the Ningxia is representative of the national population because the admissions mechanisms and the student application behavior in this province are highly similar to other areas in China (Chen et al., 2018). However, Ningxia is one of the most impoverished areas in China and a larger proportion of students are from poor counties. These students are more prone to be influenced by the information frictions problems. The admission reform is likely to be more acceptable in more advanced areas, and its impact may be more considerable. Even so, considering the prevalent problems of imperfect information and biased beliefs in students' college application, as well the information gap within advanced areas, the analysis on Ningxia could still shed light on the admission reform across China.

In terms of majors, on average, each university provided 25 majors prior to the reform. After the implementation of the meta-major reform, the number of majors in treated universities has reduced to 8. As for the degrees of consolidation of meta-majors, the number of majors within a meta-major ranges from 2 to 31 across these reformed universities. On average, the number of specific majors within a meta-major is 6-7, and about 80% of the meta-majors contain fewer than 10 specific majors. At these treated universities, the proportion of majors recruiting students in terms of meta-major and students enrolling in meta-major increased steadily since 2006 (see **Error! Reference source not found.**). There are more than 70% of the incoming students entered meta-majors at these institutions in 2017.

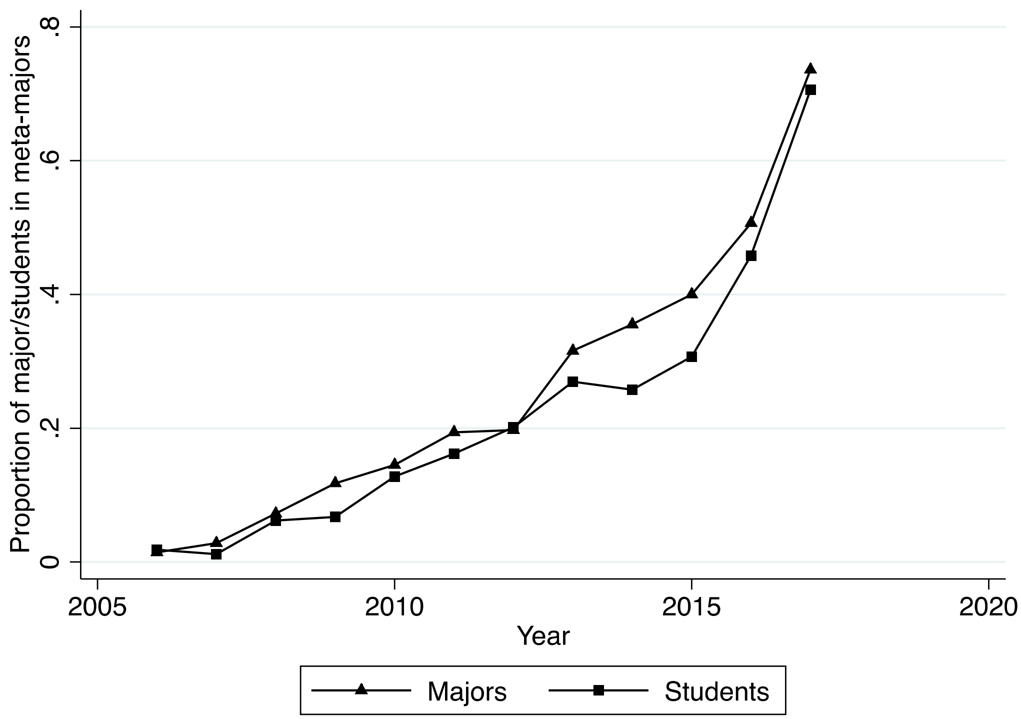

Figure 3 Proportion of majors/students in meta-majors at treated institutions

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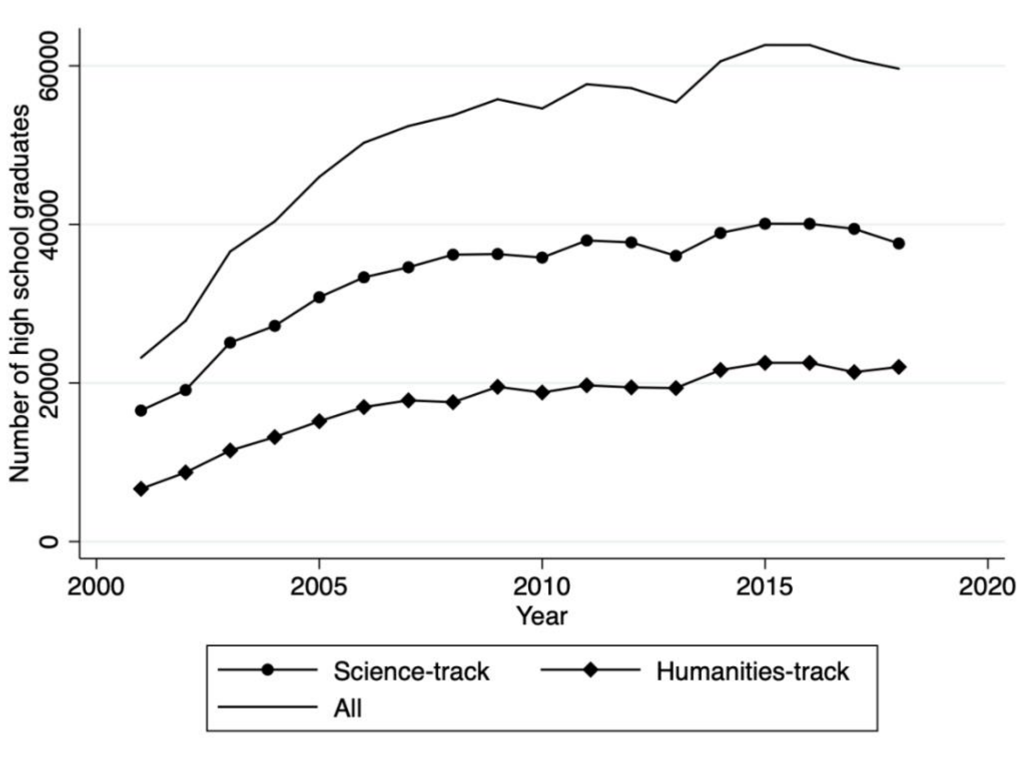

Figure 1 Number of High School Graduates (2001-2018)

shows the proportions of majors and students in meta-majors at treated institutions from 2006 to 2018.

Error! Reference source not found. presents the descriptive statistics of the main variables, aggregately and separately by five selected years. A noteworthy trend is that the share of female and ethnic minority students increased over time. The fraction of students with rural hukou or from poor counties increased during the early years but decreased slightly recently.[6] The share of *Gaokao* repeaters in recent years is about 18%. Around 80% of students with *Gaokao* scores higher than the first-tier cutoff are in the science track, which represents the pre-determined allocation of college-major admissions quotas by academic tracks.

[6] In the Hukou system, each citizen was classified as being rural or urban based on the demographic variable, the "location of origin".

Table 1 Descriptive Statistics

Variable	Total	2002	2006	2010	2014	2018
Female	0.488	0.396	0.435	0.496	0.501	0.529
	(0.500)	(0.489)	(0.496)	(0.500)	(0.500)	(0.500)
Han ethnic group	0.729	0.837	0.752	0.736	0.724	0.688
	(0.444)	(0.370)	(0.432)	(0.441)	(0.447)	(0.447)
Rural hukou	0.433	0.356	0.389	0.452	0.454	0.434
	(0.495)	(0.479)	(0.488)	(0.498)	(0.498)	(0.498)
Poor county	0.228	0.253	0.265	0.269	0.205	0.177
	(0.420)	(0.435)	(0.441)	(0.444)	(0.404)	(0.404)
Gaokao repeater	0.231	0.282	0.248	0.309	0.181	0.178
	(0.421)	(0.450)	(0.432)	(0.462)	(0.385)	(0.385)
Science-track	0.805	0.826	0.829	0.783	0.800	0.802
	(0.396)	(0.379)	(0.377)	(0.412)	(0.400)	(0.400)
Standardized *Gaokao* scores	1.477	1.677	1.697	1.554	1.381	1.261
	(0.478)	(0.491)	(0.395)	(0.433)	(0.433)	(0.433)
N	120,576	2,771	3,978	6,012	10,748	12,940

Note. The table reports the descriptive statistics of student characteristics. The coefficients are means and standard deviations are in parentheses.

To investigate the impact of adopting a meta-major reform on the composition of students enrolled in college majors, the following difference-in-differences model is estimated:

$$Y_{ijt} = \beta_0 + \beta_1 \cdot Meta_{ijt} + \lambda_i + \mu_t + \varepsilon_{ijt} \quad (1)$$

The outcome of interest (Y_{ijt}) is the average characteristics of students getting admitted to college-major i at college j in year t. All the outcome variables are aggregated at the college-major level (N=35,487). We are mainly interested in the following important characteristics of students, including the distribution of students' ability (described using the mean, median, minimum, maximum values, and range of the *Gaokao* scores), the proportion of female students, students with rural residence (hukou), students from nationally designated poor counties, and students who re-took the college entrance exam. $Meta_{ijt}$ refers to whether major i in college j adopted the meta-major reform in year t. β_1 is the effect of conducting the meta-major reform.

The college-major fixed effects (λ_i) are added to control for time-invariant characteristics of college-majors that might be correlated with student composition and the decision to adopt the meta-major reform. The year fixed effects (μ_t) is used to control for common shocks that affect all students each year. All standard errors are clustered at the college level. All regressions are weighted using the quota of each college-major, i.e., the number of admitted students, to improve estimation efficiency.[7]

Moreover, to capture the dynamic effects of the meta-major reform, the following event study design is conducted:

$$Y_{ijt} = \beta_0 + \sum_{m=-12}^{12} \beta_m \cdot M_{ijt}^{m} + \lambda_i + \mu_t + \varepsilon_{ijt} \quad (2)$$

The effect of meta major reform is mapped to a set of dummy variables (M_{ijt}^{m}) indicating the number of years since the reform. The year before adopting the reform as m=-1, the year adopting the reform as m=0, and all remaining years are indexed relatively. β_m are the dynamic effects of the meta-major reform relative to one year before the event (the reference year). The other variables were defined as described previously.

The identification of the above equations relies on the parallel trend assumption that college-majors adopting the meta-major reform would have similar trends to other majors that did not adopt the reform if the reform had not occurred. The assumption could be tested using the falsification test by assessing whether the coefficients (β_m) before the reform are statistically indistinguishable from zero. Although universities have the autonomy to decide whether to adopt the meta-major and what majors to be transformed, the adoption and the timing of the meta-major reform are exogenous conditional on the college-major and year fixed effects. In the next section, we will also discuss that our estimates are robust to accounting for the staggered

[7] Whether including weights or not does not change the results qualitatively.

adoption of the reforms (Callaway & Sant'Anna, 2020; Chaisemartin & D'Haultfoeuille, 2020; Roth et al., 2022).

4. Results

4.1 Main Results

Error! Reference source not found. shows the results of Equation (1), which estimates the impacts of meta-major reforms on admitted students' ability distribution and demographic characteristics over 12 years before or after the reform. Overall, the absolute scores increase with the range narrowing, but the distribution does not change significantly after the implementation of meta-majors (see Column 1-5). An exception is the increase in admission cutoff (minimum) score (2 points in the absolute *Gaokao* score), which is marginally significant (p-value = 0.094). There are also no substantial changes in students' gender, ethnicity, hukou status, and type of county. Based on the baseline model, the only significant change comes from the share of repeaters, which increases by 6.4 percentage points from the baseline mean of 23.7%.

Table 2 Effects of Meta-Major Reform on Student Composition

VARIABLES	(1) Mean score	(2) Median score	(3) Minimum score	(4) Maximum score	(5) Score range	(6) Female	(7) Han ethnic group	(8) Rural hukou	(9) Poor county	(10) *Gaokao* repeater
Meta-major	0.034	0.030	0.047+	0.038	-0.009	0.004	0.007	-0.032	0.018	0.064**
	(0.022)	(0.022)	(0.028)	(0.029)	(0.027)	(0.016)	(0.022)	(0.022)	(0.022)	(0.019)
Constant	1.450***	1.455***	1.227***	1.678***	0.451***	0.486***	0.733***	0.435***	0.234***	0.237***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487
College-major FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note. The table shows the estimated effects of meta-major reforms on admitted students' ability distribution and demographic characteristics over 12 years before or after the reform. All regressions control for college-major and year fixed effects. Standard errors in parentheses are clustered at the university level. ***, **, *, and + indicate statistical significance levels of 0.001, 0.01, 0.05, and 0.10, respectively.

Error! Reference source not found. presents the event study estimates from Equation (2). The *Gaokao* score distribution did not change substantially after the implementation of meta-majors. The pre-trends of the average, median, lowest, highest scores, and the score range are flat after controlling for a set of fixed effects including the college-major and year fixed effects, supporting the parallel-trend identification assumption. The mean and median scores increase in the first year of the implementation (by about 0.04 standard deviations and significant at the 5% level), but then remain stable or drop and do not change substantially in the long term. Overall, no significant differences before and after the reform are observed. Appendix **Error! Reference source not found.** reports the corresponding coefficient estimates in Columns (1) - (5).

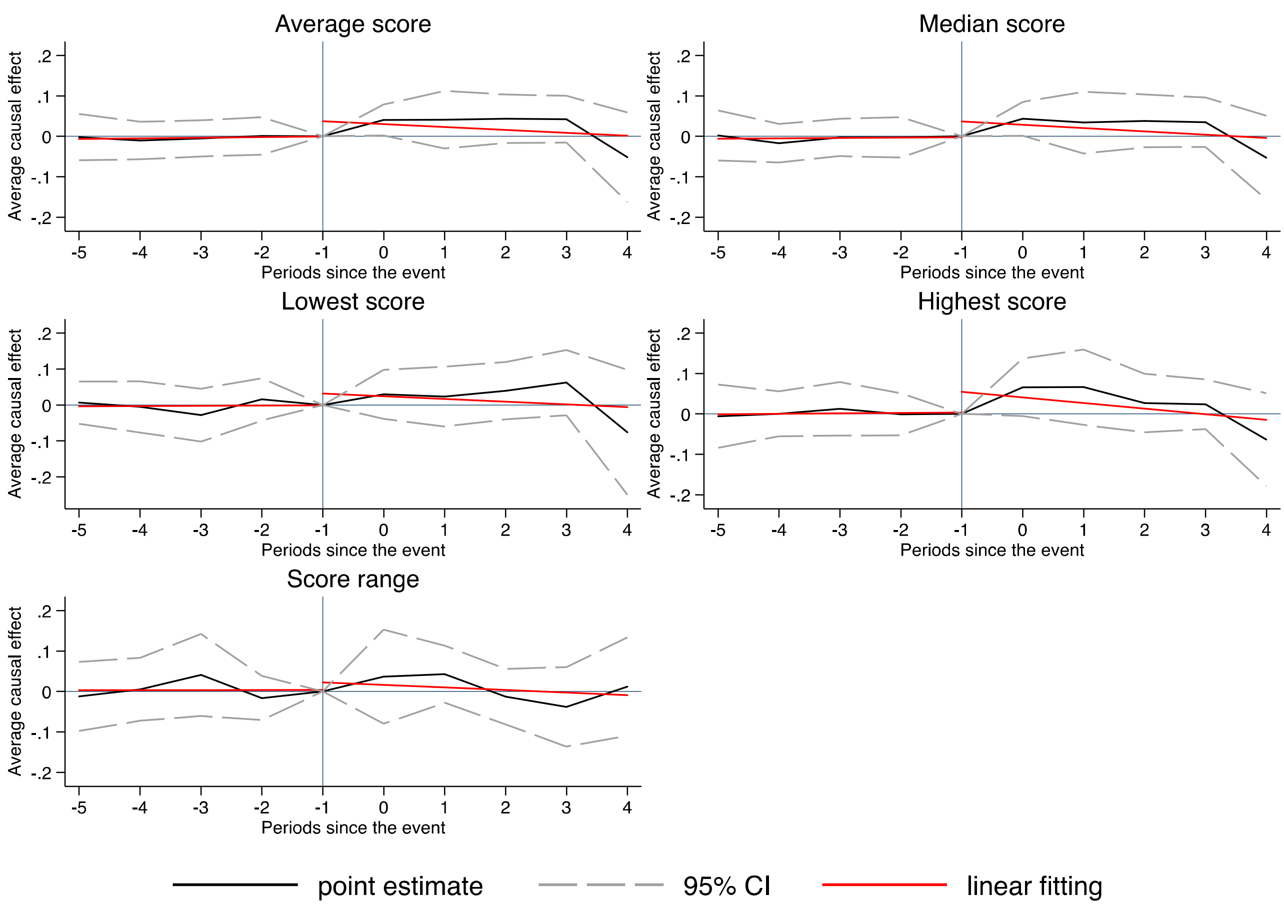

Figure 4 Event Study Results: Student Ability

Note. The figure shows the event study estimates of the impact of meta major reform on admission score distribution. The scores remain almost flat during the years before the reform and fluctuate after the reform, but no significant effect was found. The coefficient and standard error estimates are shown in Appendix Table A.1.

Additionally, student composition in terms of demographic characteristics also did not change substantially after the implementation of the meta-major. The proportion of female students, ethnic minority students, and students from poor counties stayed relatively similar after the reform, with a slight decrease in students from disadvantaged backgrounds (see **Error! Reference source not found.**). The number of repeaters increased steadily, which indicates that there is a linear time trend in the share of repeaters. There is also a slightly decreasing time trend in the share of rural students. We will address this concern using alternative models in the next section. Appendix **Error! Reference source not found.** reports the corresponding coefficient estimates based on the event study in Columns (6)–(10).

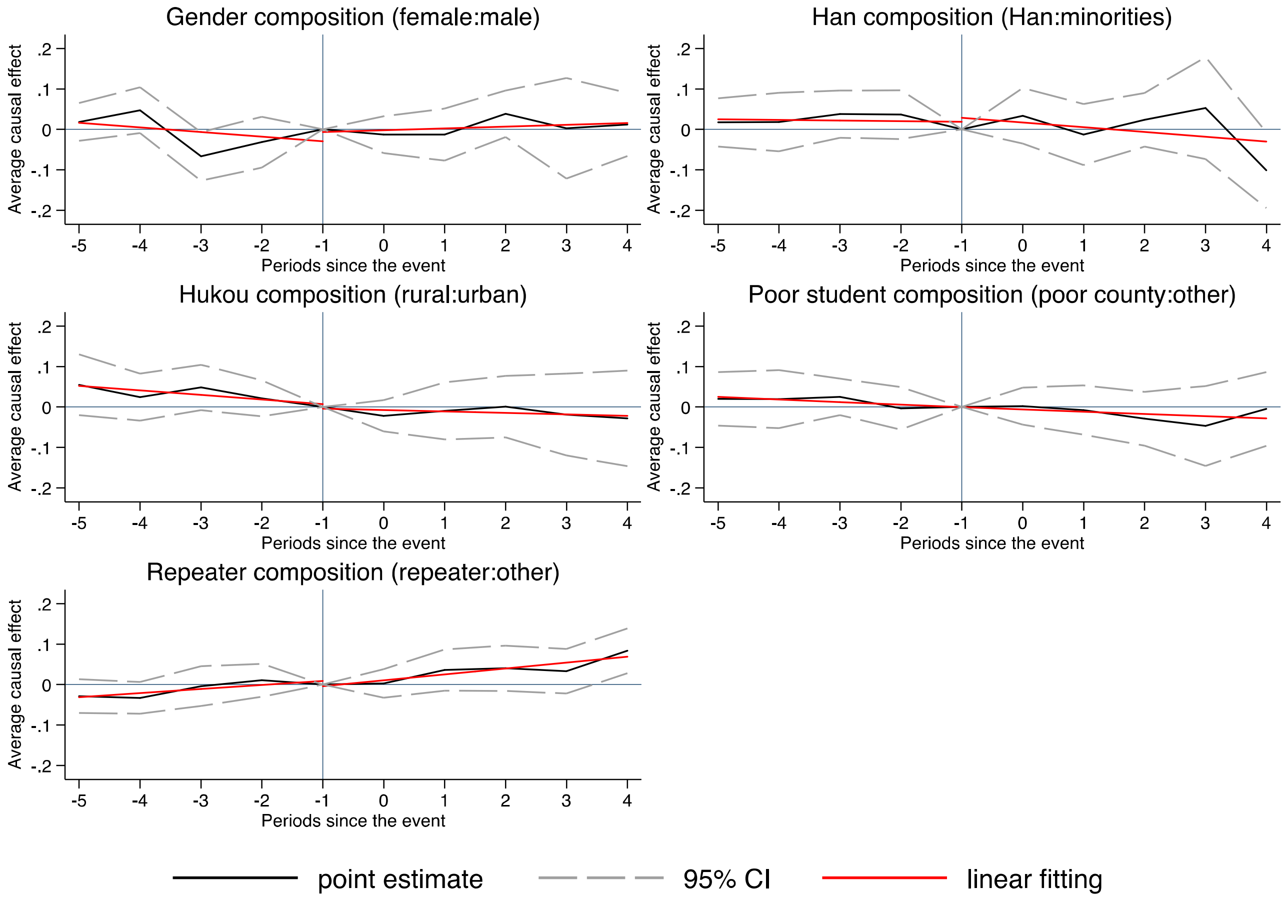

Figure 5 Event Study Results: Student Characteristics

Note. The figure shows the event study estimates of the impact of meta-major reform on student composition. The coefficient and standard error estimates are shown in Appendix Table A. 1.

4.2 Robustness Checks

We conduct a series of robustness checks, including (1) allowing for different treatment intensity of the major combinations in meta-majors, (2) considering a different time frame when another admission mechanism reform was introduced, (3) adding college linear time trends to control for unobserved time-variant college characteristics, (4) carrying out an individual-level analysis, and (5) using new DID estimators allowing for staggered adoption and heterogeneous effects.

Treatment intensity. The meta-major adoption status or the year since adoption are used as the main independent variables in the main analysis, we further allow for different treatment intensity by replacing them with the "size" of meta-majors, i.e., the number of specific majors included in the package of the meta-major. The more majors included in one meta-major, the more options for students to choose from in their final major decision, and the higher intensity of the implementation. For example, a science meta-major at one university is a large package of many STEM-related majors, including mechanical engineering, energy and power engineering, nuclear science and nuclear engineering, electronic information and electrical engineering, marine science and marine engineering, materials science and engineering, biomedical engineering and chemical engineering; while a computer science meta-major only combines highly relevant majors including computer science and technology and software engineering. The effect of the meta-major reform may depend on how broad the meta-majors are constructed. Panel A in **Error! Reference source not found.** indicates that the results remain almost the same when allowing for different treatment intensity. Therefore, the reform impact is more likely to be driven by extensive margin rather than intensive margin.

Different time frame. We restrict the sample to the years no earlier than 2009 to avoid the confoundedness from another important admission mechanism reform (Chen & Kesten, 2017). Ningxia adopted the parallel admission mechanism reform in 2009, which allows students to choose parallel colleges within the choice bands.[8] Although the choices of majors within each

[8] The Chinese parallel admission mechanism is similar to the Deferred Acceptance (DA) mechanism, in which students can choose parallel schools within the choice bands and will be accepted to their most preferred school for which they qualify (Machado & Szerman, 2021).

college still follow a Boston mechanism, the major choices of students could be altered as their selection sets of colleges are changed because of the college admissions mechanism transition.[9] The main difference between these two admissions mechanisms is that the parallel admission mechanism allows students to reveal their true preferences and retain both risky and safe options in their application (Chen & Kesten, 2017). We limit the sample to the years after the conduction of a parallel mechanism and find that the effects of meta-major remain almost the same when restricting the sample to recent years (see Panels B in **Error! Reference source not found.**). **Error! Reference source not found.**The only difference is that the effect of meta-major in decreasing the share of students with rural hukou becomes marginally significant when using the subsamples of students. This indicates that the effect of meta-major reforms observed in the baseline analyses is not mainly driven by the adoption of parallel admission mechanism.

College linear time trend. We add college linear time trends ($\nu_j \cdot t$) to Equation (1) to control for unobserved college characteristics that evolve over time. In the baseline model, we only control for the time-invariant college-major characteristics and the overall time trend. Adding the college linear time trends could further control for the potential different trends in student composition across colleges over time. The results after adding college linear time trends exhibit some different results. The effects on admission scores become marginal significant but remain small in magnitude (0.03 standard deviations) in terms of the mean and median scores. The previously significant effect on the share of repeaters disappears after ruling out the linear time trend, while the positive effects on the share of females and the negative effect on students from poor counties become marginally significant. Appendix Figure B.1 presents the event study

[9] Under the Boston mechanism (BM) or Immediate Acceptance (IA) mechanism, students submit an ordered list of schools/majors. The mechanism attempts to assign as many students to their first choice as possible, and only after all such assignments have been completed will it consider assigning students to their second choices, etc. (Abdulkadiroglu et al., 2006).

estimates after adding the college-specific linear time trend. We can see the previously visible time trends in students' hukou and repeat status become much flatter. However, a linear trend in the share of students from poor counties appears. This means that there are different trends in the share of poor students across treated and nontreated institutions over time, the fraction of poor students getting admitted to meta-major is increasing by year at the institutional level.

Table 3 Robustness Checks

VARIABLES	(1) Mean score	(2) Median score	(3) Minimum score	(4) Maximum score	(5) Score range	(6) Female	(7) Han ethnic group	(8) Rural hukou	(9) Poor county	(10) *Gaokao* repeater
					A. Meta-Major Intensity					
Meta-major	0.002	0.001	0.003+	0.002	-0.001	-0.001	0.000	-0.002	0.002	0.005***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
					B. Subsample During 2009-2018					
Meta-major	0.023	0.022	0.023	0.035	0.013	0.014	0.019	-0.039+	-0.002	0.056**
	(0.019)	(0.020)	(0.025)	(0.038)	(0.048)	(0.017)	(0.024)	(0.023)	(0.023)	(0.020)
					C. Adding College Linear Time Trend					
Meta-major	0.032+	0.031+	0.040	0.036	-0.003	0.036+	-0.010	-0.014	-0.032+	0.001
	(0.017)	(0.016)	(0.025)	(0.038)	(0.041)	(0.021)	(0.024)	(0.020)	(0.017)	(0.014)
Observations	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487
College-major FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note. The table shows the results of robustness checks using alternative measurements, samples, and models. All regressions control for college-major and year fixed effects. Standard errors in parentheses are clustered at the university level. ***, **, *, and + indicate statistical significance levels of 0.001, 0.01, 0.05, and 0.10, respectively.

Individual level analysis. The identification strategy is the same as in the baseline analysis but with individual-level dependent variables, including individual students' standardized *Gaokao* score, gender, ethnicity, hukou status, type of county of origin, and the repeat status. **Error! Reference source not found.** shows that the results confirm the institutional-level analysis above. Similarly, there is a significant increase in the standardized scores of students (at the 5% level), mainly coming from the first year of the meta-major conduction. The estimates of other students' characteristics replicate those from the previous section.

Table 4 Effects of Meta-Major Reform on Student Composition (Individual-Level Analysis)

VARIABLES	(1) *Gaokao* score	(2) Female	(3) Han ethnic group	(4) Rural hukou	(5) Poor county	(6) *Gaokao* repeater
Meta-major	0.044*	0.003	0.006	-0.030	0.020	0.064***
	(0.022)	(0.016)	(0.022)	(0.022)	(0.022)	(0.019)
Constant	1.477***	0.488***	0.729***	0.433***	0.228***	0.230***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	120,576	120,576	120,576	120,576	120,576	120,576
College-major FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Note. The table reports the results using individual-level dependent variables. All regressions control for college-major and year fixed effects. Standard errors in parentheses are clustered at the university level. ***, **, *, and + indicate statistical significance levels of 0.001, 0.01, 0.05, and 0.10, respectively.

Staggered adoption and heterogeneous effects. Finally, following the recent burgeoning innovative methods of DID, we use the estimation procedures allowing for the dynamic and heterogeneous treatment effects driven by variations in the reform's timing (Callaway & Sant'Anna, 2020; Chaisemartin & D'Haultfoeuille, 2020; Roth et al., 2022). When staggered adoption and heterogeneous effects exist, the classical two-way fixed effects may give misleading estimates. The comparison between the newly treated units and the already treated units could be wrong, which is usually referred to as the "forbidden" comparison (Goodman-Bacon, 2021). The comparisons lead to negative weighting problems and may give opposite treatment effects (Roth et al., 2022). To address this problem, Callaway & Sant'Anna (2020) only uses the never-treated or not-yet treated as control, and Sun & Abraham (2021) use the last-to-be-treated units as the comparison. Under the setting of staggered treatment adoption, these new methods give estimations that are robust to heterogeneous treatment effects across units and over time. We replicate the analyses using these methods and the results are shown in Appendix B. The figures indicate that the main results are robust to different estimations. Overall, the student composition does not change significantly. The share of repeaters remains the same with an increase after 5 years of the reform. No linear time trends of student composition are visible based on these estimators.

4.3 Spillover Effects

The meta-major reform may affect the whole institution and other untreated majors within the institution through spillover effects. Students can choose 4 universities and 6 majors within each university in their application. Students usually list preferences in decreasing priority and choose their most preferred majors as the first choice. Not all students can be admitted to their first-order major. Students prefer meta-majors but with score below the required threshold will be admitted to other majors within an institution. Therefore, the student composition of the untreated majors in the treated institutions and the entire institution may also be altered by the meta-major reform.

We measure whether an institution moving to meta-majors draws different types of students to the whole institution by replacing the outcome variables with the student composition at the institutional level. The meta-major reform may affect the sorting across majors (meta-major or traditionally specific major) within the institution and bring different effects for other specific majors and the cluster of all majors or the whole institution.

We investigate the impact of the reform on both meta majors and specific majors within the same institution. We find a slight spillover effects across majors within an institution that the meta-major reform also impacts other specific majors within the institution that also provide meta-majors.

Error! Reference source not found. shows that the meta-major reform may affect other unreformed majors and the whole institution to a greater extent as the effects for maximum score, score range, the share of students from Han ethnic group, rural hukou, and poor county become larger and more significant (marginally).

Table 5 Spillover Effects

VARIABLES	(1) Mean score	(2) Median score	(3) Minimum score	(4) Maximum score	(5) Score range	(6) Female	(7) Han ethnic group	(8) Rural hukou	(9) Poor county	(10) *Gaokao* repeater
					A. Institutional level student composition					
Meta-major	0.022	0.026	0.002	0.041*	0.039+	-0.017	0.023+	-0.035*	0.040*	0.053***
	(0.018)	(0.019)	(0.023)	(0.020)	(0.023)	(0.013)	(0.013)	(0.016)	(0.016)	(0.014)
					B. Spillover effects					
Meta-major	0.037	0.034	0.044	0.046	0.002	-0.001	0.013	-0.039+	0.027	0.073***
	(0.023)	(0.024)	(0.030)	(0.030)	(0.029)	(0.016)	(0.022)	(0.022)	(0.023)	(0.021)
Specific major	0.016	0.022	-0.015	0.038+	0.053*	-0.024	0.027+	-0.034*	0.045*	0.045**
	(0.019)	(0.020)	(0.024)	(0.021)	(0.024)	(0.016)	(0.014)	(0.016)	(0.019)	(0.014)
Observations	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487
College-major FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note. All regressions control for college-major and year fixed effects. Standard errors in parentheses are clustered at the university level. ***, **, *, and + indicate statistical significance levels of 0.001, 0.01, 0.05, and 0.10, respectively.

4.4 Heterogeneous Effects Across Institutions and Majors

Students consider the characteristics of specific universities and majors in real decision-making, which may result in the impacts of the reform at different types of institutions or of different majors varying. In this section, we examine the heterogeneous impacts of the meta-major reforms by institution and major characteristics.

Heterogeneity by institutions. The universities in China are stratified by tiers, including Project-985, Project-211, provincial and local colleges and vocational colleges. We constructed a college ranking based on the most recent admission scores of each institution, to obtain the list of the top 10 universities in China.[10] The heterogeneity of the treatment effects is investigated by interacting the treatment with the indicator of top university.

The results presented in **Error! Reference source not found.** indicate that the aggregate effects are masked by the substantial heterogeneity in the type of institutions. The mean, median, and minimum scores increase significantly at non-elite universities, and the difference in the effect of meta-major across different institution types is significant in the minimum score. Additionally, the score ranges change in different directions at universities with different selectivity levels, and this difference is statistically significant. Next, the effects of meta-major on student characteristics are also analyzed. We find that the share of ethnic minority students, students from poor counties and repeater increase significantly at elite universities.

[10] The top 10 universities are: Peking University, Tsinghua University, University of Science and Technology of China, Fudan University, Shanghai Jiaotong University, Zhejiang University, Nanjing University, Renmin University of China, University of Chinese Academy of Sciences, and Xi'an Jiaotong University.

Table 6 Heterogeneity in the Effects of Meta-Major Reform on Student Composition by Institution Type (Top 10 Universities)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Mean score		Median score		Minimum score		Maximum score		Score range	
VARIABLES	Top10=1	Top10=0	Top10=1	Top10=0	Top10=1	Top10=0	Top10=1	Top10=0	Top10=1	Top10=0
Meta-major	0.050*	0.009	0.040+	0.013	0.087***	-0.012	0.052	0.017	-0.034	0.030
	(0.020)	(0.037)	(0.022)	(0.040)	(0.024)	(0.039)	(0.036)	(0.039)	(0.034)	(0.024)
Meta-major # Top10	-0.041	0.041	-0.027	0.027	-0.099*	0.099*	-0.035	0.035	0.064+	-0.064+
	(0.041)	(0.041)	(0.045)	(0.045)	(0.044)	(0.044)	(0.049)	(0.049)	(0.034)	(0.034)
Observations	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487
College-major FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Table 7 Heterogeneity in the Effects of Meta-Major Reform on Student Composition by Institution Type (Top 10 Universities)

(cont'd)

	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
	Female		Han ethnic group		Rural hukou		Poor county		*Gaokao* repeater	
VARIABLES	Top10=1	Top10=0	Top10=1	Top10=0	Top10=1	Top10=0	Top10=1	Top10=0	Top10=1	Top10=0
Meta-major	0.010	-0.006	0.045+	-0.049***	-0.056+	0.005	-0.019	0.073**	0.021	0.127***
	(0.021)	(0.019)	(0.026)	(0.013)	(0.029)	(0.020)	(0.021)	(0.025)	(0.022)	(0.017)
Meta-major # Top10	-0.016	0.016	-0.094***	0.094***	0.062+	-0.062+	0.092**	-0.092**	0.106***	-0.106***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.034)	(0.034)	(0.032)	(0.032)	(0.027)	(0.027)
Observations	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487
College-major FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note. This table reports the results of the two-way fixed effects model after adding the interaction term between the indicators of meta-major and institutional selectivity, i.e., whether the institution is a top-10 university. For each outcome, the first column (e.g., Column 1) shows the results when the indicator of top 10 university equals 1 (top 10=0 as the reference group), while the second (e.g., Column 2) shows the results when the indicator of top 10 equals 0 (top 10=1 as the reference group). Therefore, the coefficient of meta-major in the first column represents the effect of meta-major for non-top 10 universities, while the coefficient of meta-major in the second column represents the effect for top 10 universities. And the coefficient of the interaction terms represents the difference in the effects across university selectivity. All regressions control for college-major and year fixed effects. Standard errors in parentheses are clustered at the university level. ***, **, *, and + indicate statistical significance levels of 0.001, 0.01, 0.05, and 0.10, respectively.

Heterogeneity by majors. In terms of major, we define the popular or advantaged STEM majors are fields of study attached with high wage premiums in the Chinese context, including majors related to computer engineering, computer science, information technology, software engineering, and artificial intelligence. The heterogeneity of the treatment effects is investigated by interacting the treatment with the indicator of advantaged STEM major. The admission scores only rise significantly in non-advantaged majors, while the effects on students' gender, ethnicity, and background are similar across different major types (see **Error! Reference source not found.**).

Table 8 Heterogeneity in the Effects of Meta-Major Reform on Student Composition by Majors (Advantaged STEM Majors)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Mean score		Median score		Minimum score		Maximum score		Score range	
VARIABLES	AS=1	AS=0	AS=1	AS=0	AS=1	AS=0	AS=1	AS=0	AS=1	AS=0
Meta-major	0.042*	-0.026	0.037+	-0.025	0.054+	-0.004	0.051+	-0.056	-0.003	-0.053+
	(0.020)	(0.036)	(0.021)	(0.040)	(0.029)	(0.034)	(0.029)	(0.039)	(0.030)	(0.028)
Meta-major # Advantaged STEM	-0.068*	0.068*	-0.062+	0.062+	-0.057	0.057	-0.107**	0.107**	-0.050	0.050
	(0.030)	(0.030)	(0.034)	(0.034)	(0.035)	(0.035)	(0.035)	(0.035)	(0.040)	(0.040)
Observations	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487
College-major FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Table 9 Heterogeneity in the Effects of Meta-Major Reform on Student Composition by Majors (Advantaged STEM Majors)

(cont'd)

	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
	Female		Han ethnic group		Rural hukou		Poor county		*Gaokao* repeater	
VARIABLES	AS=1	AS=0	AS=1	AS=0	AS=1	AS=0	AS=1	AS=0	AS=1	AS=0
Meta-major	-0.004	0.063	0.010	-0.014	-0.039	0.020	0.022	-0.009	0.064**	0.064*
	(0.017)	(0.041)	(0.023)	(0.038)	(0.024)	(0.028)	(0.023)	(0.034)	(0.020)	(0.025)
Meta-major # Advantaged STEM	0.067	-0.067	-0.024	0.024	0.058	-0.058	-0.030	0.030	0.000	-0.000
	(0.043)	(0.043)	(0.039)	(0.039)	(0.037)	(0.037)	(0.034)	(0.034)	(0.025)	(0.025)
Observations	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487
College-major FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note. This table reports the results of the two-way fixed effects model after adding the interaction term between the indicators of meta-major and the popularity of majors, i.e., whether the major is an advantaged STEM major. For each outcome, the first column (e.g., Column 1) shows the results when the indicator of advantaged STEM major equals 1 (advantaged STEM major =0 as the reference group), while the second (e.g., Column 2) shows the results when the indicator of advantaged STEM major equals 0 (advantaged STEM major =1 as the reference group). Therefore, the coefficient of meta-major in the first column represents the effect of meta-major for non-advantaged STEM majors, while the coefficient of meta-major in the second column represents the effect for advantaged STEM majors. And the coefficient of the interaction terms represents the difference in the effects across majors. All regressions control for college-major and year fixed effects. Standard errors in parentheses are clustered at the university level. ***, **, *, and + indicate statistical significance levels of 0.001, 0.01, 0.05, and 0.10, respectively.

Heterogeneity by reform modes: A case study. Universities have the freedom to design their meta-majors, including decisions on the form of the collaboration across departments and the combination of majors. Thus, there are different major combinations modes across institutions. To investigate how the student composition in a specific meta-major evolves over time, we construct a synthetic control major category for each meta-major by the pool of all the other control majors (traditional specific college-major) (Abadie et al. 2010). The method assigns weights to the control majors such that the squared difference in terms of the outcome predictors between the treatment and its synthetic control in the pre-treatment period is minimized, then the effect of meta major reform is estimated by comparing the outcomes between the treatment and its synthetic control in the post-treatment period. The variables used as predictors in the construction of synthetic controls include the average and median admission scores and the admission quota.

Error! Reference source not found. shows the trends of average admission score of the meta majors and their synthetic control of four example meta-majors. Although the figure is illustrative, it does not tell us whether there is a statistically significant change in the admission scores in meta majors compared to synthetic control majors in the post-reform period (Ersoy, 2020). There is a clear increase in the mean score in some majors, for example, economics and management at Northeastern University and transportation engineering at Tongji University, compared to their synthetic control. Some majors do not show much change after the reform, for example, economics and management at Beijing Jiaotong University and engineering at Shanghai Jiao Tong University. By comparing these two groups of meta-majors, we find that the former majors basically only contain a set of majors that are highly relevant with a clear focus on the field of study, while the latter are usually large collections of many weakly correlated majors and lack a clear focus. While the transportation engineering at Tongji University only includes transportation engineering and logistics engineering, engineering at Shanghai Jiao Tong University covers almost all engineering majors, including mechanical engineering, electronic information science and technology, electrical information engineering, materials science and engineering, energy, and power engineering, etc. Therefore, the impacts of the meta-major reform are relevant to how the majors are constructed.

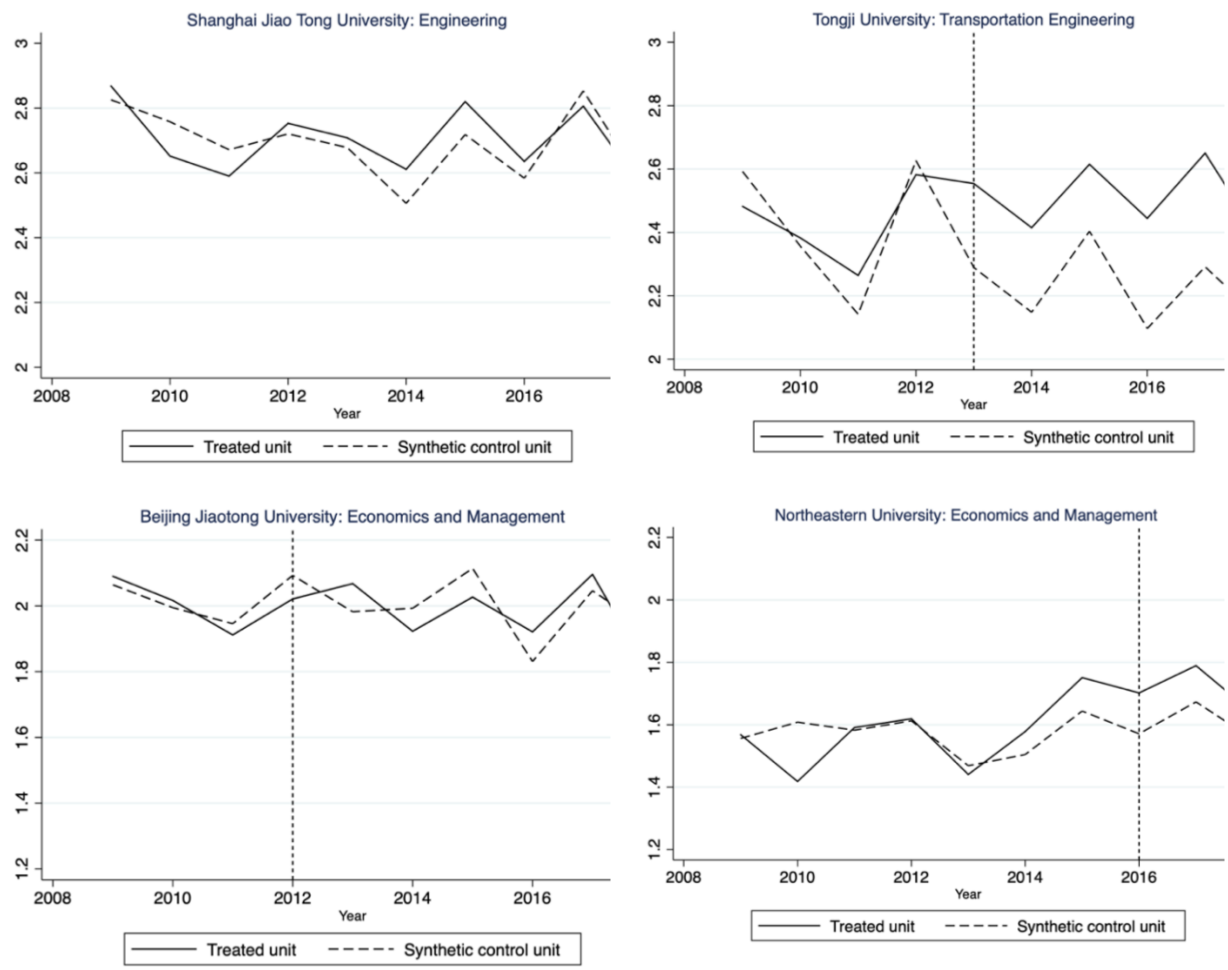

Figure 6 Trends in Average Admission Score (Synthetic Control)

Note. The figures show the mean scores of the four meta-majors and their synthetic controls. The vertical dashed lines denote the year of the reform.

5. Conclusion

In the past years, both centralized and decentralized college admissions systems have made many attempts in the transition between different major choice mechanisms. The institutional level policy leads to tradeoffs between different mechanisms in terms of students' college experience and career paths, including student-major match, completion and graduation, major switch, as well as major-job relevancy, as well as income levels and growth. (Antoine et al., 2010; Birdet & Leighton, 2015; Spight, 2018; Hill, 2019). Despite the wide debate about which mechanism benefits students, there is little evidence on how students respond to different designs in terms of their college applications and admissions. The empirical evidence on the consequences of admissions mechanisms reform on students would provide critical insights for understanding the pros and cons of each mechanism and key implications in college admission practice and policy all over the world. The paper contributes to the debate over the major choice mechanism designs by providing one of the first empirical evidence on how a university-level major reform, i.e., the transition from jointly college-major choice to sequentially college-then-major choice, could impact choice behaviors from the perspective of students and the characteristics of admitted students from the institutional side in a centralized higher education system.

Overall, the meta-major reform does not impact students' ability distribution and demographic characteristics within college-majors. The admission scores rise in the first year of the implementation of meta-major but do not change substantially in the long term. The instant effect implies that the new major setting attracted high-achieving students when the policy just came out. However, the effects faded out over time. One potential explanation is that students gradually learn more about regulations, training mode, and the real quality of a meta-major and begin to realize the potential risks attached to it. Additionally, although meta-major simplifies students' initial choice and allows learning before their final major declaration, it also adds to the uncertainty of students' major choices as the related information is usually unavailable or imperfect. Finally, the consequences vary across students, for example, students with different preferences and prior knowledge probably respond to the meta-major differently.

However, the aggregate null effects are masked by the substantial heterogeneity across institutions and majors. Meta-major reform disproportionately increases the student quality at non-elite universities, especially in terms of the minimum admission scores. Similarly, the admission scores in non-advantaged majors also rise after the adoption of meta-major. These findings imply that clustering traditional specific majors into a larger meta-major is potentially an effective way of attracting more talented students to non-elite colleges, and the student quality in non-advantaged majors also gets improved when these majors are combined with other popular majors and recruit students under a broad meta-major category. The findings suggest that for the policymakers, i.e., the universities, the meta-major shows the potential of increasing student quality, especially for those that are not ranked at the very top of the higher education hierarchy. The meta-major increases the "competency" of institutions in attracting talented students since it integrates the advantages of previously separated disciplines and departments and creates "super" majors. The policy could be eye-catching for candidates and possibly inspire them to choose the college-major even though the college is not at the very top. Another important implication of the combination of various majors is that the major classification within meta-major may be effective in improving the candidate pool, especially for majors that are usually attached with relatively low prospects by students. To get access to some popular majors, students must first enter the meta-major. The admission scores of other majors under the same meta-major could be improved even if they are not the target of most students.

Additionally, the meta-major reform could disproportionately benefit some traditional under-representative students in higher education, such as ethnic minority students and students from poor counties, by increasing their enrollment at elite universities. Many key universities adopt the policy of preferential admission for students from ethnic minorities and poor counties. And meta-majors are usually open to those students in order to provide them with a wide range of major opportunities, such as the special college enrollment plan for rural students in the science meta-major at Fudan University and engineering meta-major at Xi'an Jiaotong University. The policy may have the largest effects on disadvantaged students since they are usually the group of students who are faced with the problems of incomplete information and behavioral barrier. And the chance to explore their interests and gain more knowledge of majors could be extremely beneficial for them to make better college major choices. As the distribution of education resources is still unbalanced across different regions in China, the policy helps the promotion of education equity and inclusive practices. Our paper provides one of the first empirical evidence on such potential policy consequences of the college-major choice mechanism reforms. Future work can examine similar reforms in other countries, admissions systems, and higher education institutions.

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Appendix A. Event Study Results

Table A.1 Effects of Meta-Major Reform on Student Composition (Event study)

VARIABLES	(1) Mean score	(2) Median score	(3) Minimum score	(4) Maximum score	(5) Score range	(6) Female	(7) Han ethnic group	(8) Rural hukou	(9) Poor county	(10) *Gaokao* repeater
5 years prior to the reform	-0.002	0.002	0.006	-0.006	-0.012	0.018	0.017	0.055	0.020	-0.028
	(0.029)	(0.032)	(0.030)	(0.040)	(0.044)	(0.024)	(0.030)	(0.038)	(0.034)	(0.021)
4 years prior to the reform	-0.010	-0.017	-0.005	0.000	0.006	0.047	0.018	0.024	0.020	-0.033
	(0.024)	(0.024)	(0.036)	(0.028)	(0.040)	(0.029)	(0.037)	(0.030)	(0.037)	(0.020)
3 years prior to the reform	-0.005	-0.003	-0.028	0.012	0.041	-0.067*	0.038	0.048+	0.025	-0.004
	(0.023)	(0.024)	(0.038)	(0.034)	(0.052)	(0.031)	(0.030)	(0.029)	(0.023)	(0.025)
2 years prior to the reform	0.001	-0.003	0.015	-0.001	-0.016	-0.032	0.036	0.021	-0.003	0.011
	(0.024)	(0.026)	(0.030)	(0.027)	(0.028)	(0.032)	(0.031)	(0.023)	(0.027)	(0.021)
0 years post the reform	0.040*	0.043*	0.029	0.066+	0.037	-0.013	0.033	-0.022	0.002	0.003
	(0.019)	(0.021)	(0.035)	(0.036)	(0.059)	(0.023)	(0.035)	(0.020)	(0.023)	(0.018)
1 year post the reform	0.041	0.034	0.023	0.066	0.043	-0.013	-0.013	-0.010	-0.008	0.036
	(0.036)	(0.039)	(0.042)	(0.048)	(0.036)	(0.033)	(0.038)	(0.036)	(0.031)	(0.026)
2 years post the reform	0.043	0.038	0.040	0.027	-0.013	0.039	0.024	0.001	-0.029	0.040
	(0.031)	(0.033)	(0.041)	(0.037)	(0.035)	(0.029)	(0.034)	(0.039)	(0.034)	(0.029)
3 years post the reform	0.043	0.035	0.062	0.024	-0.038	0.003	0.053	-0.019	-0.047	0.033
	(0.029)	(0.031)	(0.046)	(0.031)	(0.050)	(0.063)	(0.064)	(0.052)	(0.050)	(0.028)
4 years post the reform	-0.052	-0.053	-0.076	-0.064	0.012	0.012	-0.101*	-0.028	-0.005	0.084**
	(0.056)	(0.053)	(0.089)	(0.059)	(0.062)	(0.040)	(0.048)	(0.060)	(0.047)	(0.028)

Constant	1.450***	1.455***	1.228***	1.678***	0.450***	0.487***	0.733***	0.434***	0.235***	0.238***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
Observations	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487	35,487
College-major FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note. The table reports the estimated effects of meta-major reforms on admitted students' ability distribution and demographic characteristics before or after the reform. All regressions control for college-major and year fixed effects. Standard errors in parentheses are clustered at the university level. The reference year is one year prior to the reform. ***, **, *, and + indicate statistical significance levels of 0.001, 0.01, 0.05 and 0.10, respectively.

Appendix B. Robustness Checks

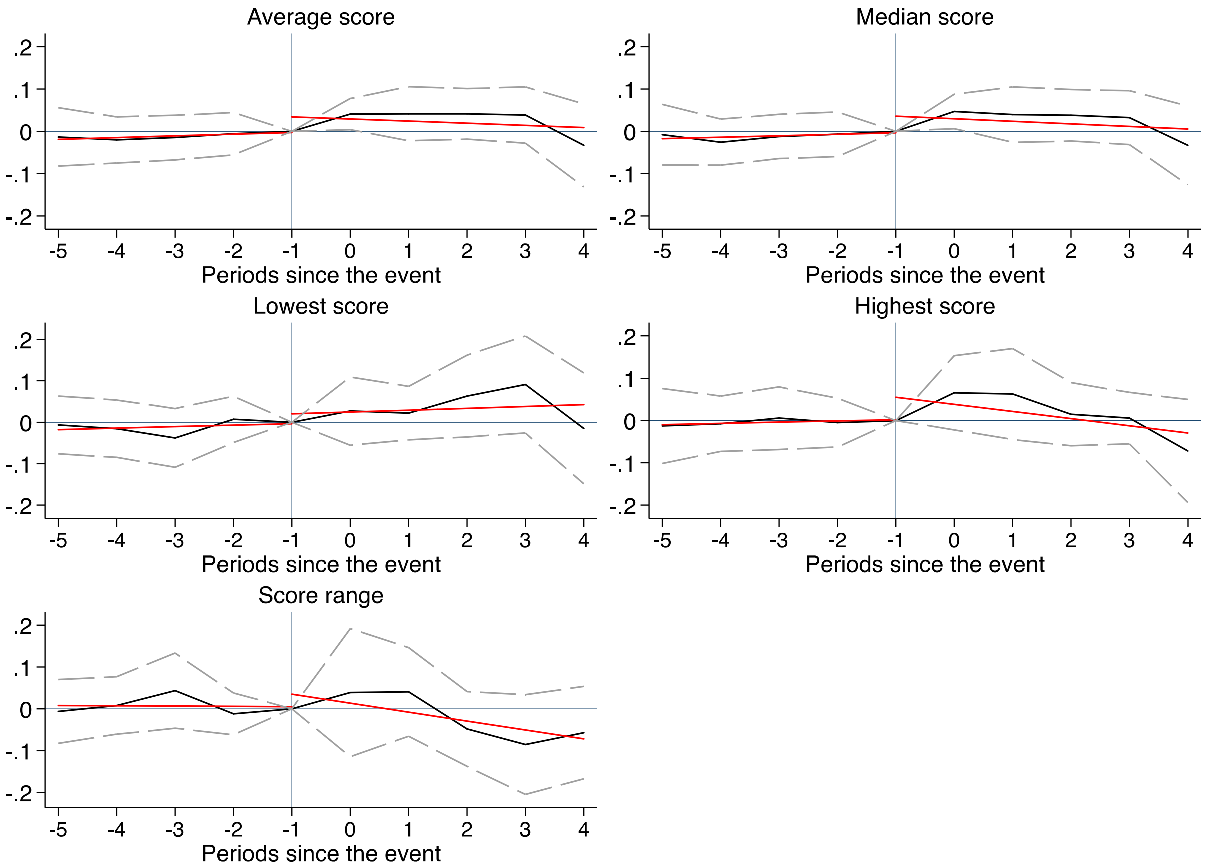

Figure B. 1 Event Study Results After Adding the College Linear Time Trends (Scores)

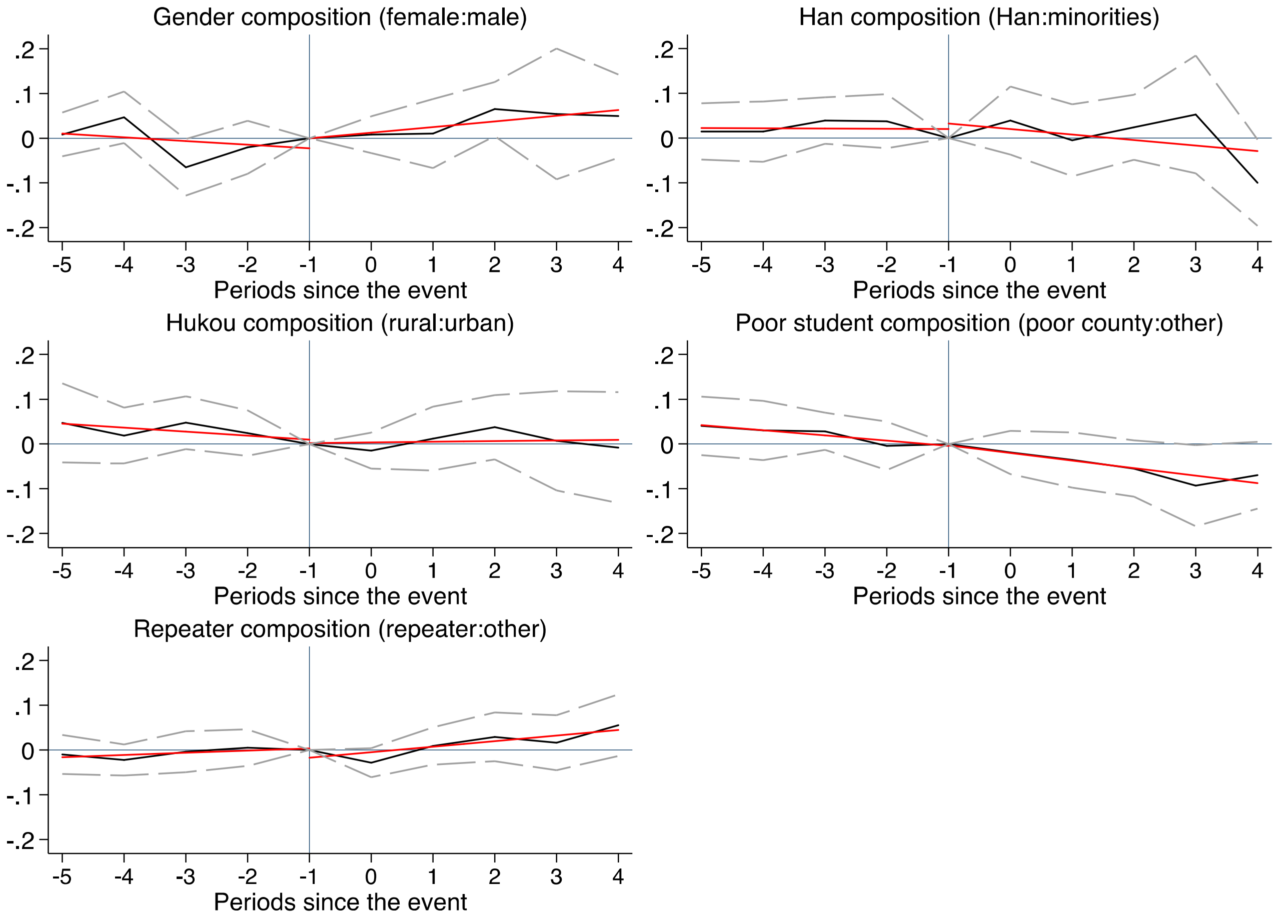

Figure B. 2 Event Study Results After Adding the College Linear Time Trends (Demographics)

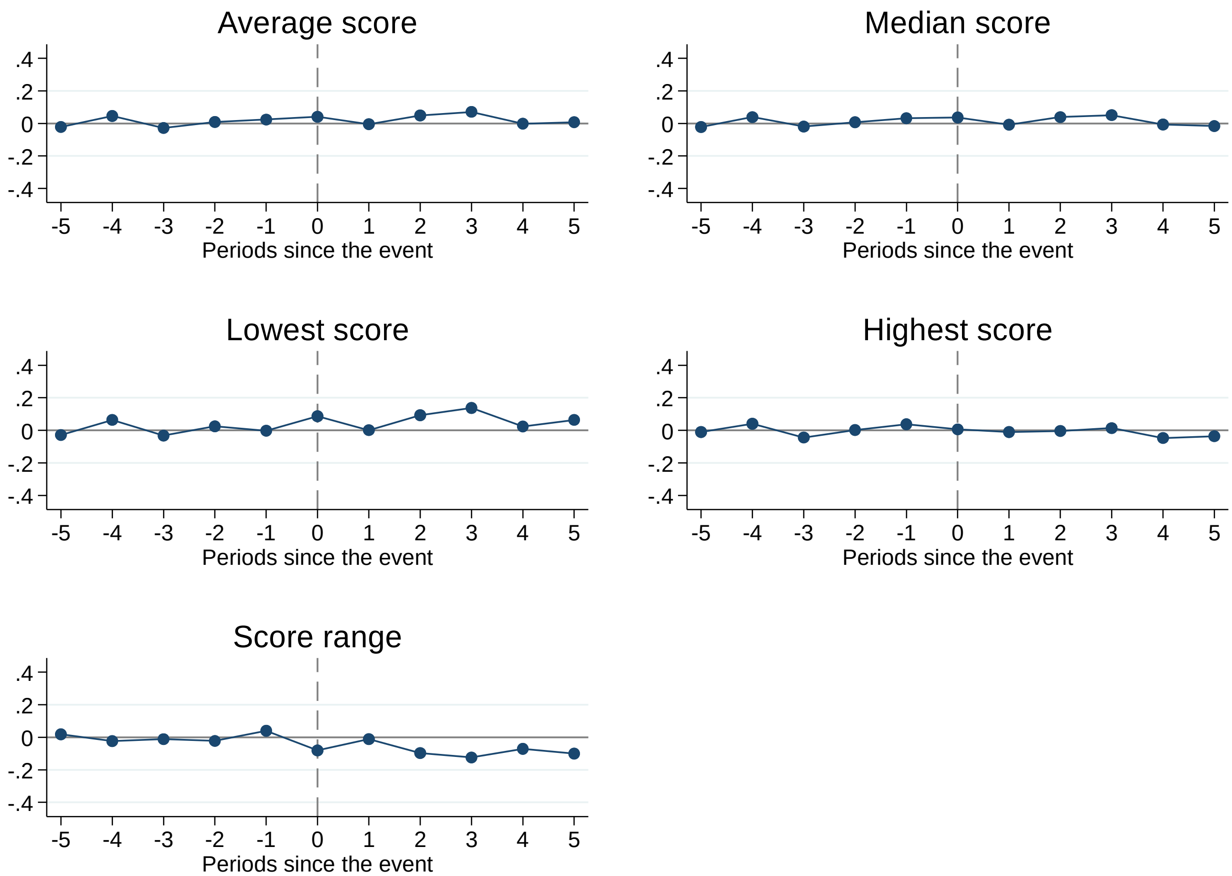

Figure B. 3 Event Study Results Based on Chaisemartin & D'Haultfoeuille (2020)'s Estimator (Scores)

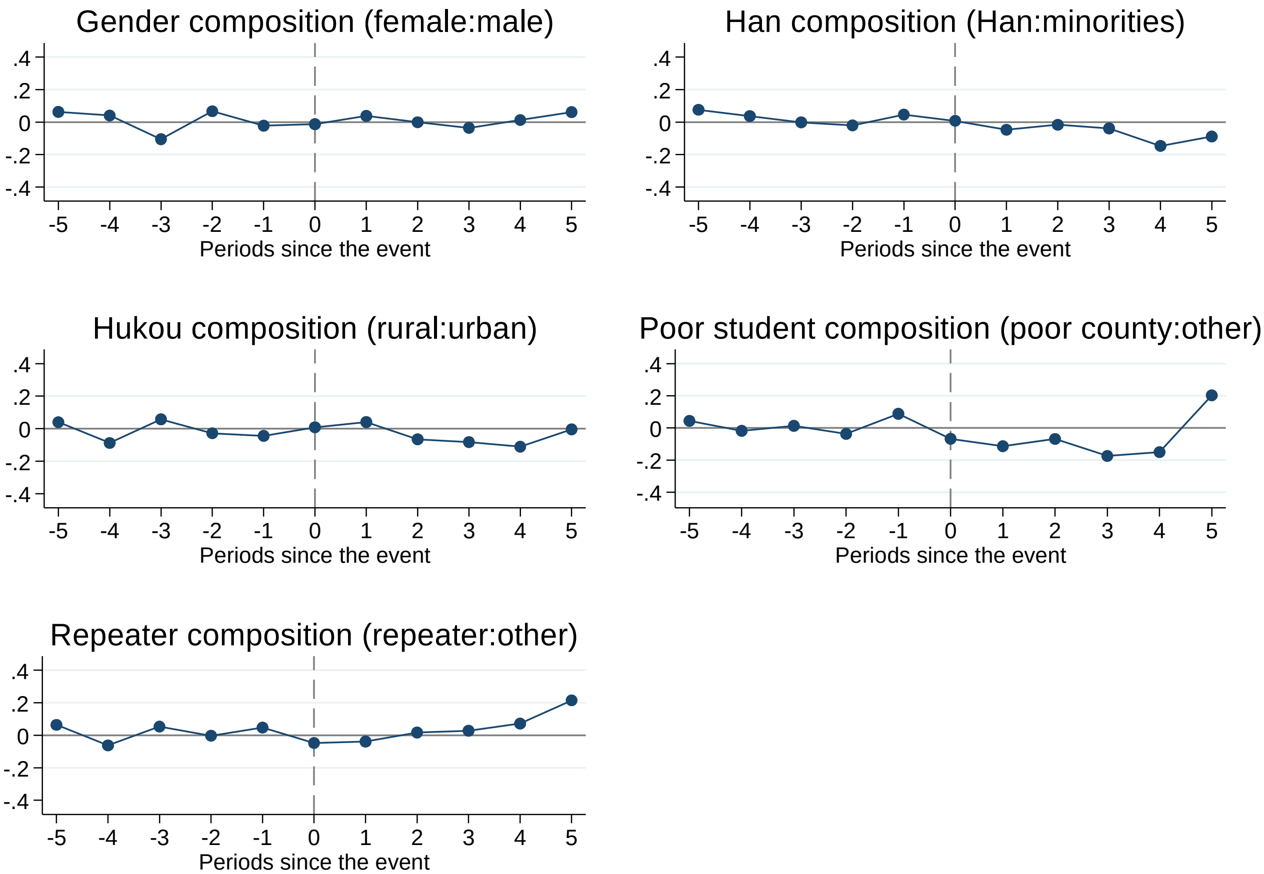

Figure B. 4 Event Study Results Based on Chaisemartin & D'Haultfoeuille (2020)'s Estimator (Demographics)

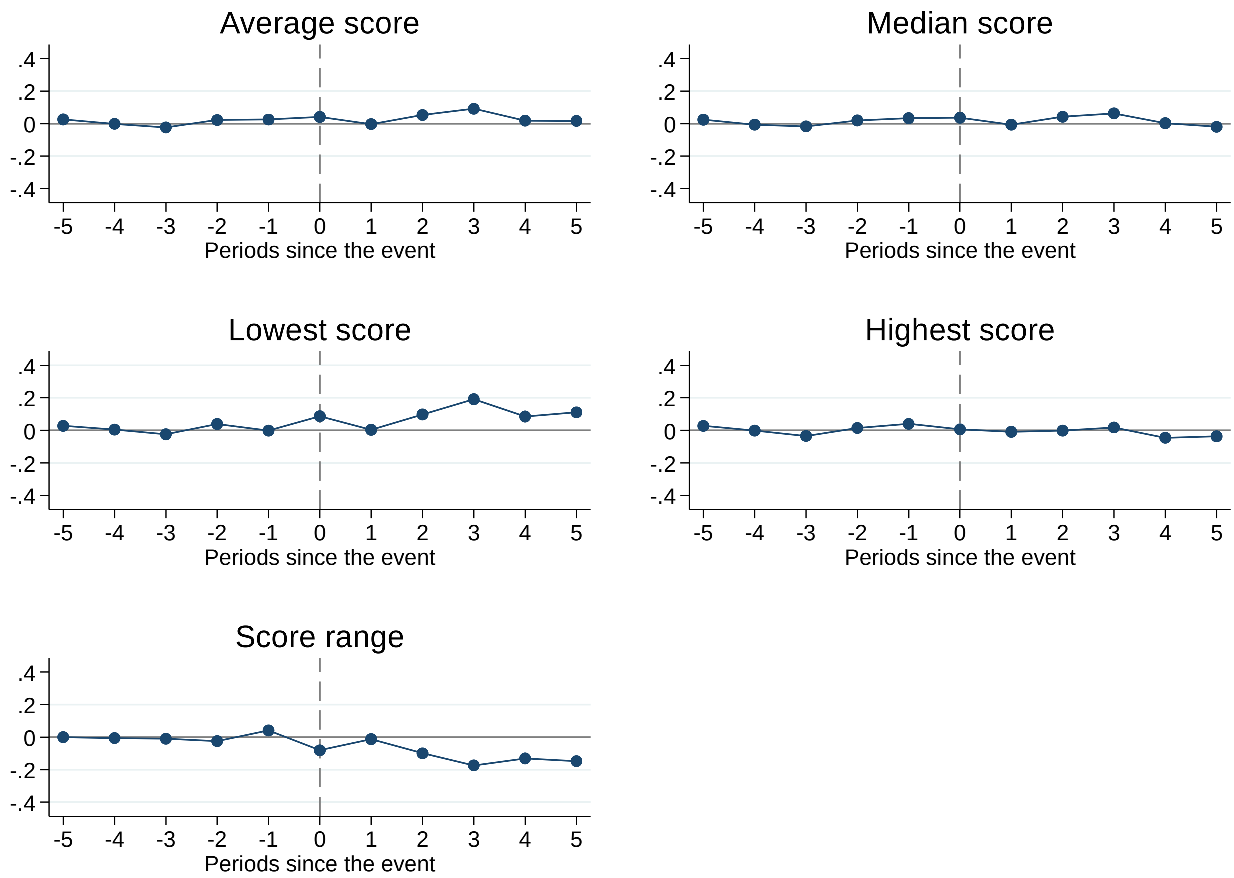

Figure B. 5 Event Study Results Based on Callaway & Sant'Anna (2020)'s Estimator (Scores)

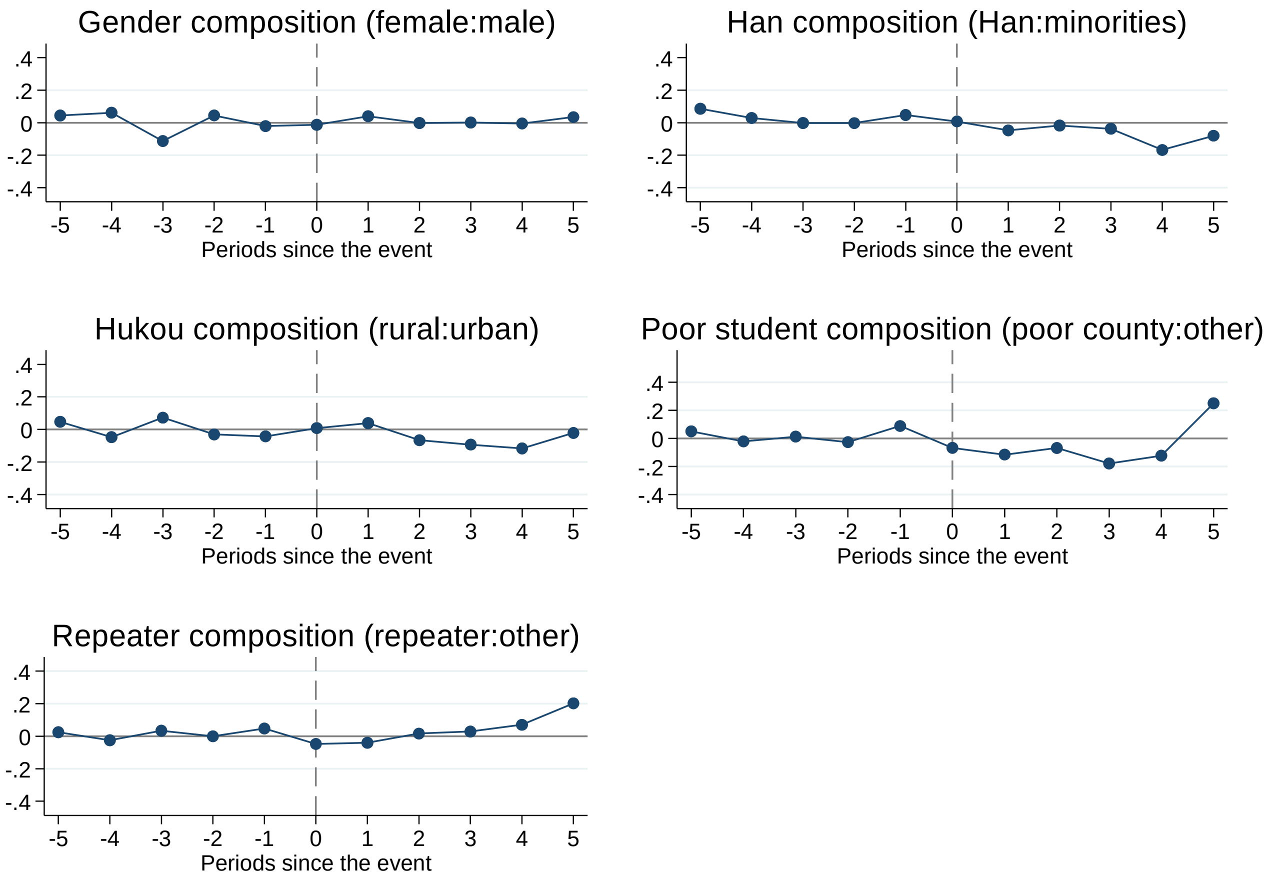

Figure B. 6 Event Study Results Based on Callaway & Sant'Anna (2020)'s Estimator (Demographics)