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Meritocracy and Its Discontent: Long-run Effects of Repeated School Admission Reforms[1]

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Abstract

We study the impacts of changing school admissions systems in higher education. To do so, we take advantage of the world's first known implementation of nationally centralized admissions and its subsequent reversals in early twentieth-century Japan. This centralization was designed to make admissions more meritocratic, but we find that meritocracy came at the cost of threatening equal regional access to higher education and career advancement. Specifically, in the short run, the meritocratic centralization led students to make more inter-regional and risk-taking applications. As high ability students were located disproportionately in urban areas, however, increased regional mobility caused urban applicants to supplant rural applicants from higher education. Moreover, these impacts were persistent: four decades later, compared to the decentralized system, the centralized system continued to increase the number of urban-born elites (e.g., top income earners) relative to rural-born ones.

Keywords: Elite Education, Centralized vs Decentralized Admissions, Matching Algorithms, Strategic Behavior, Regional Mobility, Universal Access, Persistent Effects
JEL Classification: I20, N30, N40, O20

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1 Introduction

College and school admission processes vary across time and places. For example, American college admissions use a decentralized system where each college makes its own admissions often based on opaque evaluation criteria. In contrast, China's public college admissions illustrate a regionally-integrated, single-application, and single-offer system using a transparent admission criterion. How do different admissions institutions affect students' behavior and future professional careers?

This paper studies the short- and long-run consequences of making school admissions meritocratic and centralized. We do so by combining a series of natural experiments in history, newly assembled historical data, and a game-theoretic model. Our theoretical and empirical investigations reveal the pros and cons of centralized meritocratic admissions, especially a tradeoff between meritocracy and equal regional access to selective higher education and career achievements.

Our empirical setting is the first known transition from decentralized to nationally-centralized school admissions. At the end of the 19th century, to modernize its higher education system, the Japanese government set up elite national schools (high schools or colleges) that served as an exclusive entry point to the most prestigious tertiary education (Yoshino, 2001a,b; Takeuchi, 2011). These schools later produced many of the most influential members of the society, including several Prime Ministers, Nobel Laureates, and founders of global companies like Toyota. Acceptance into these schools was merit-based, using annual entrance examinations. Initially, the government let each school run its own exam and admissions based on exam scores, similar to many of today's decentralized K-12 and college admissions. The schools typically held exams on the same day so that each applicant could apply for only one school. Similar restrictions on the number of applications exist today in the college admission systems of Italy, Japan, Nigeria, and the UK.

At the turn of the 20th century, the government introduced a centralized system in order to improve the quality of incoming students. In the new system, applicants were allowed to rank multiple schools in the order of their preference and take a single unified exam.[1] Given their preferences and exam scores, each applicant is assigned to a school (or none if unsuccessful) based on a computational algorithm. The algorithm was a mix of the so-called Immediate Acceptance (Boston) algorithm and Deferred Acceptance algorithm with a meritocracy principle imposed upfront. To the best of our knowledge, this instance is the first recorded, nation-wide use of any matching algorithm.[2] Furthermore, for reasons

[1]As shown later, the defining feature of the centralized system is not the use of a single unified exam, but to allow applicants to list multiple schools.

[2]The earliest known large-scale use of the Boston algorithm is the assignment of medical residents to

detailed below, the government later re-decentralized and re-centralized the system several times, producing multiple natural experiments for studying the consequences of the different systems.

We exploit these bidirectional institutional changes to identify the impacts of the meritocratic centralization. We first use a stylized theoretical model to predict the impacts of centralization on application behavior and admissions. Consistent with the stated goal of centralization, we confirm that the centralized system produces more meritocratic school seat allocations. Our model also predicts that centralization would cause applicants to apply to more selective schools and make more inter-regional applications, increasing regional mobility. These theoretical results guide our empirical analysis.

For constructing the dataset for our analysis, we newly digitalized several historical sources. From Government Gazettes and administrative documents by the Ministry of Education, we assemble data on applicants, their applications, and birth prefectures for 1898-1930. We combine this data with a complete administrative list of entrants by school, year, and birth prefecture, using the Higher School Student Registers published annually by each school. To our knowledge, these documents have not been used in economics research.

We first find that meritocratic centralization had large short-run effects on both application behavior and enrollment outcomes. First, consistent with the theoretical predictions, centralization caused stark strategic responses in application behavior. In particular, strategic incentives in the centralized system led both urban and rural applicants to more frequently rank the most selective school first.[3] Second, the centralized system caused a greater number of high-ability applicants from urban areas to be admitted to schools in rural areas, often after being rejected by their first choice schools. As a result, urban high-achievers crowded out rural applicants; the number of entrants to any national elite school coming from the urban area increases by about 10% during centralization.[4]

Historical documents suggest that this distributional consequence upset rural schools and communities. Partly as a result of such rural discontents, the government went back and forth between decentralized and centralized systems, finally settling for a decentralized scheme. This series of bidirectional reforms enables us to identify the causal effects of centralization more precisely than a usual, single policy change would.

hospitals in New York City in the 1920s (Roth, 1990). The oldest known national use of the Deferred Acceptance algorithm is the National Resident Matching Program (NRMP) in the 1950s (Roth, 1984). See Abdulkadiroğlu and Sönmez (2003) for the details of these algorithms in school admission contexts.

[3]We use the nomenclature of "urban" and "rural" schools, but note that "rural" schools were located in regional cities rather than in the countryside. See Section 2 for more details.

[4]It is also empirically true that the centralized system made a greater number of rural applicants apply to and enter urban schools. The centralized system thus increased regional mobility across the country. But their net effects are such that urban high-achievers crowded out rural applicants.

Most importantly, we find that centralization had lasting impacts on students' career outcomes. Since the centralized system is designed to be more meritocratic and high-achieving students are disproportionately located in urban areas, centralization is expected to let urban areas disproportionately gain school access relative to rural areas. Our short-run analysis confirms this expectation. This result motivates us to compare long-term career outcomes of urban- and rural-born individuals by each cohort's exposure to the centralized system. The career outcome data come from the two editions of the Japanese Personnel Inquiry Records (JPIR) published in 1934 and 1939, more than thirty years after the first episode of meritocratic centralization. The JPIR is an equivalent of Who's Who in Japan that provides a list of highly distinguished individuals (e.g., high-income earners, national medal recipients, high-ranking government officials) along with their personal information. We provide extensive investigations about the quality of this long-term outcome data.[5]

Our difference-in-differences estimates suggest persistent effects of centralization. Almost four decades later, relative to the decentralized system, the centralized system produced a greater number of top income earners, prestigious medal recipients, and other elite professionals who came from urban areas compared to rural areas. Quantitatively, the number of urban-born career elites increased by 10-20% for the cohorts exposed to the centralized admissions. We also obtain suggestive evidence that, in the long run, the centralized system increased the number of career elites residing in urban areas in their middle age relative to those residing in rural areas. The design of admission systems therefore affects the geographical origins and destinations of highly educated and skilled individuals, also known as "upper-tail human capital" (Mokyr, 2005), which is an important determinant of economic growth (Glaeser, 2011; Moretti, 2012; Autor, 2019).

In total, the impacts of centralization highlight an equity-meritocracy tension, both in the short- and long-run. On the one hand, the centralized system achieved the goal of rewarding applicants with higher academic performance. On the other hand, this meritocracy came at the cost of urban applicants dominating rural applicants. This distributional effect turned out to be persistent after decades.

Our analysis sheds light on the causal impacts of selective admission systems, contributing to the literature on their effects on application behavior, regional mobility, and applicants' academic achievement and welfare (Abdulkadiroğlu et al., 2006, 2009, 2017; Calsamiglia et al., 2010; Avery et al., 2014; Pallais, 2015; Machado and Szerman, 2017; Hafalir et al., 2018;

[5] We find that the data covers a large fraction of the national population of elites (e.g., 53% of the top 0.01% income earners) by comparing our data with national statistics. We also find no systematic variation in the sampling rates across prefectures, consistent with our assumption that sample selection bias is uncorrelated with the prefecture-cohort variation we use. Dell and Parsa (2019) also use the Japanese Personnel Inquiry Records in their analysis.

Carvalho et al., 2019; Grenet et al., 2019; Knight and Schiff, 2019).[6] While these prior studies focus on the short-run effects, we estimate the long-run effects by taking advantage of bidirectional, repeated policy changes in history. This use of bidirectional policy changes echoes other studies with similar identification strategies (Niederle and Roth, 2003; Redding and Sturm, 2008).[7] With its interest in long-run effects, this paper also relates to studies of the long-term effects of educational resources (Duflo, 2001; Currie and Moretti, 2003; Meghir and Palme, 2005; Oreopoulos, 2006; Pischke and Von Wachter, 2008). These studies focus on the effects of expanding resources (such as school constructions and compulsory education extensions), while we investigate the effects of changing resource allocation mechanisms given the fixed amount of resources. This zero-sum nature of school seats allocation induces an equity concern, sharing much in common with ongoing policy discussions on affirmative actions (Arcidiacono and Lovenheim, 2016) and meritocratic college admissions.[8] Finally, this paper belongs to the broad literature on the effects of expanding school choice and competition (Hoxby, 2007).

From a broader historical perspective, this paper relates to the literature that uses historical data to understand the emergence and evolution of resource allocation mechanisms (Greif, 1993; Kranton and Swamy, 2008; Börner and Hatfield, 2017; Donna and Espín-Sánchez, 2018) and to a limited literature that investigates the long-term effects of such mechanisms (Dell, 2010; Bleakley and Ferrie, 2014, 2016). Our analysis is also related to Bai and Jia (2016), who examine political consequences of the abolition of a meritocratic elite recruitment system (i.e., civil service exam) in early twentieth-century China. While they focus on the short-run effects on revolution participation, we study the long-run consequences of introducing a meritocratic school admissions system on career trajectories.

The next section provides historical and institutional backgrounds. Section 3 develops theoretical predictions, which we test in Section 5 using data described in Section 4. Section 5 examines the short-term impacts of school admissions reforms, while Section 6 analyzes their long-term impacts. Finally, Section 7 summarizes our findings, discusses their limitations, and outlines future directions.

[6] Other studies measure the effects of selective schools conditional on a particular admission system (Dale and Krueger, 2002; Altonji et al., 2012; Dobbie and Fryer, 2013; Hastings et al., 2013; Pop-Eleches and Urquiola, 2013; Deming et al., 2014; Lucas and Mbiti, 2014; Kirkeboen et al., 2016; Beuermann et al., 2018; Abdulkadiroglu et al., 2019; Zimmerman, 2019).

[7] In addition to these empirical studies, several papers theoretically compare admission mechanisms with different degrees of centralization and choice based on their effects on application behavior and welfare (Haeringer and Klijn, 2009; Pathak and Sönmez, 2013; Che and Koh, 2016; Chen and Kesten, 2017; Hafalir et al., 2018; Shorrer, 2019).

[8] See also Kamada and Kojima (2015) and Agarwal (2017) for discussions about regional inequality in other matching markets.

2 Background

2.1 College Admissions around the World

One major trend in modern college admissions systems is a growing degree of centralization with transparent admission criteria. Today, over 30 countries use regionally- or nationally-integrated, single-application, and single-offer college admissions. Figure 1 depicts countries that adopt some centralized college admissions in dark red and countries without any centralized college admissions in light yellow, showing that centralized college admissions are used in all continents except North America. These systems often have well-specified admission criteria, mixing meritocratic achievement elements (such as GPA and entrance exams), affirmative action and other priority considerations.

Before the turn of the 20th century, however, no country used such a centralized system (see Online Appendix Table 1).[9] Even today, many countries, including the U.S. and Canada, continue to use decentralized systems. Such decentralized schemes tend to come with less transparent criteria for ranking applicants, as illustrated by recent court cases against American universities. Similar observations apply to K-12 school admissions as well. How does the centralization of college and school admissions affect students' application behavior, enrollment outcomes, and future careers? Understanding the costs and benefits of meritocratic centralization is the goal of our paper.

2.2 Bidirectional Admissions Reforms in History

To evaluate the impacts of different school admissions systems, we take advantage of unique historical episodes in early twentieth-century Japan. After 250 years of the seclusion policy that ended with the arrival of the Black Ships in 1853, to catch up with Western knowledge, science, and technologies, education reforms became a central part of modernization efforts by the Japanese government. In 1894, the government set up a new system of national higher education consisting of one Imperial University and five national Higher Schools. By 1908, the system was expanded to four Imperial Universities (Tokyo, Kyoto, Tohoku, and Kyushu) and eight National Higher Schools (First in Tokyo, Second in Sendai, Third in Kyoto, Fourth in Kanazawa, Fifth in Kumamoto, Sixth in Okayama, Seventh in Kagoshima, and Eighth in Nagoya, named after the order of establishment) in key locations across Japan, as shown in Figure 2. Hereafter we refer to these eight National Higher Schools as Schools 1-8 for short.[10]

[9] The link is `https://www.scribd.com/document/437545135/Online-Appendix191018`

[10] Schools 1-5 were established in 1894 and Schools 6, 7, and 8 were established in 1900, 1901, and 1908, respectively. Schools 1-8 were initially called the University Preparatory Devision of National Higher School

Schools 1-8 served as an exclusive entry point to Imperial Universities (the most prestigious form of tertiary education). Virtually all graduates of Schools 1-8 were admitted to these universities without further selection well into the 1920s. Imperial University graduates were also partially or wholly exempted from the Higher Civil Service Examinations and other selective national qualification exams to become high-ranking administrators, diplomats, judges, and physicians (Amano, 2007). As a result, entering Schools 1-8 was considered equivalent to obtaining a passport into the elite class. In fact, Schools 1-8 are known to have produced highly distinguished and socially influential individuals, including several Prime Ministers, Nobel Laureates, world-leading mathematicians, renowned novelists, and the founders of global companies like Toyota. To apply to these schools, one must be male aged 17 or older and have completed a five-year middle school.[11] As Schools 1-8 admitted fewer than 2,300 students each year throughout 1900–1930, they constituted less than 0.5% of the cohort of males aged 17.

The admission to Schools 1-8 was merit-based and determined by annual entrance exams. Initially, the government took a laissez-faire approach and let each school administer its own exam and admissions. Schools 1-8 typically held their exams on the same day so that each applicant could only apply to one school. Following the convention in the literature (Che and Koh, 2016; Hafalir et al., 2018), we call this system "decentralized admissions," "decentralized applications," or Dapp for short. The single choice aspect of Dapp captures an essential feature of decentralization, which incentivizes each applicant to self-select into an appropriate school by comparing the selectivity of schools with his own standing.

Among the eight schools, School 1 in Tokyo was considered by far the most prestigious due to its location in the capital and geographical proximity to Tokyo Imperial University (today's University of Tokyo). The next most prestigious was School 3 in Kyoto. By contrast, located in a remote southwest region, Schools 5 and 7 were considered the least prestigious among all schools. Consequently, the schools differed substantially in their popularity and selectiveness (Takeuchi, 2011, Chapter 2). For example, the acceptance rate (i.e., the share of admitted applicants in all applicants) of School 1 (Tokyo) was always much lower than

(*kan-ei koutou gakkou daigaku yoka*) in 1894–1916 and were renamed National Higher School (*kan-ei koutou gakkou*) in 1917. Despite the growing demand for national higher education, due to fiscal constraints, the number of National Higher Schools remained constant until 1918. From 1918 to 1925, the number of National Higher Schools gradually increased from 8 to 25, but Schools 1-8 remained the most distinguished among all 25 schools. In addition to Schools 1-8, there was a quasi-national school, Yamaguchi Higher School, which was established in 1894, discontinued in 1904, and re-established in 1918. The number of higher education institutions increased after 1918, as the government permitted not only national but also local public and private higher schools and universities. In our empirical analyses, we control for the number of national higher schools as well as other higher education institutions.

[11] The eligibility was changed in 1919 to males aged 16 or older who have completed the fourth year of middle school.

that of School 5. In fact, a large number of high-achieving students applying to School 1 (Tokyo) were rejected and had to give up advancing to an Imperial University or retake the exam in the subsequent year, while less popular schools were admitting lower-achieving students. For the government whose goal was to select the best and brightest and send them to Imperial Universities, the decentralized system seemed inefficient. According to the Education Minister, failing to admit a high ability student was "*a loss for the country*" (Yoshino, 2001b, p.24).

To assess this problem, in 1901, the schools agreed to unify their entrance exams to a single exam, while maintaining decentralized admission decisions. Then, in 1902, the government launched a centralized admission system in which applicants were allowed to apply for multiple schools, rank them in order of their preferences, and take a unified exam at any school. Based on their exam scores and preferences, applicants were then assigned to a school (or no school if unsuccessful) by a well-specified computational algorithm announced ex ante. We call this system "centralized admissions," "centralized applications," or Capp for short. In proposing the centralized system, the Higher Education Committee stated that its purpose was to enroll students with "*superior academic ability*" in each school, placing a clear emphasis on meritocracy (Yoshino, 2001a, p.53).

The centralized system operated as follows. Each year, the Ministry of Education announced application procedures in April, three months before the exam, as a public notice in Government Gazette. With some simplification for expositional purpose, the assignment algorithm reads as follows (see Appendix Figure A.1 for a reprint of the original public notice in Japanese).[12]

> (1) Select the same number of applicants as the sum of all schools' capacities in the order of exam scores. In the case of a tie, decide by lottery.
>
> (2) For applicants selected in (1), in the order of exam scores, assign each applicant to the school of his first choice until the school capacity is filled. In the case of a tie, decide by lottery.
>
> (3) For those applicants who are selected in (1) and not assigned to any school in (2), in the order of exam scores, assign each applicant to a school of their second choice until the school capacity is filled. In the case of a tie, decide by lottery.
>
> (4) Repeat the same for the third and lower choices.

[12] To be precise, each school was divided into several departments, such as law and literature, engineering, science, and medicine, and the assignments were made separately at the department level. For simplification, we are assuming away departments in presenting the basic assignment algorithm.

Written more than a century ago in natural language, the rules were described with mathematical precision. Observe that the above method imposes meritocracy up front in which only top-scoring applicants were considered for admission regardless of their preferences (Step (1)). This step selects only applicants who would be admitted by any school under the Serial Dictatorship (Deferred Acceptance) algorithm, one of the most widely used algorithms in today's college and selective K-12 admissions. These applicants are then assigned to one of Schools 1-8 using the Immediate Acceptance (Boston) algorithm (Steps (2) to (4)). This algorithm is therefore a variant of the Immediate Acceptance algorithm with a meritocracy constraint, making it closer to the Serial Dictatorship (Deferred Acceptance) algorithm. To the best of our knowledge, this is the world's first recorded nation-wide use of a matching algorithm.[13]

This institutional innovation was short-lived, however. Due to political and administrative reasons, the government switched back to Dapp (with a unified exam) in 1908. The government then continued to oscillate between decentralization and centralization, reintroducing Capp in 1917, moving back to Dapp (with a unified exam) in 1919, reinstituting Capp (with major modifications of allowing applicants to list at most two schools) in 1926, and finally settling down to Dapp (with separate exams) in 1928. In a space of thirty years, therefore, there were three periods of centralized admissions: first in 1902–1907, next in 1917–1918, and finally in 1926–1927.

According to historical studies, these repeated policy changes were the results of intense bargaining between the Ministry of Education, who pushed for centralization to advance meritocracy, and the Council of School Principals, who preferred decentralization to protect school autonomy and regional interests (Yoshino, 2001a,b; Takeuchi, 2011; Amano, 2017). We exploit this series of bidirectional policy changes to identify the impacts of centralization on the selection of students and their career outcomes.[14]

3 Theory

To guide our empirical investigation, we develop a model to predict the impacts of centralization on application behavior and assignment. We first confirm that centralized admissions (Capp) was indeed designed to make the school seat allocation more meritocratic compared

[13] See Appendix A.1 for the actual admission outcomes in 1917 under the above centralized algorithm.

[14] These historical episodes are well known among historians of Japanese education, who provide detailed institutional accounts (e.g., Yoshino, 2001a,b; Takeuchi, 2011; Amano, 2017). The preceding studies, however, are mostly descriptive and qualitative. An important exception is Miyake (1998, 1999), who examines regional variations in access to higher schools and compares the number of higher school students per population across prefectures. Building on these studies, we combine a formal model and quasi-experimental research design to identify the causal effects of admission reforms.

to decentralized admissions (Dapp). Our model also has two predictions about application behavior. First, a greater number of applicants apply to the most popular school under Capp than under Dapp. Second, applicants make more inter-regional applications under Capp relative to Dapp, thus breaking the "local monopoly" of each school in its local area.

A school admission problem is $(S, I, q, (t_i)_{i\in I}, \succ)$ where $S = \{s_1, \dots, s_m\}$ is the set of schools while $I = \{i_1, \dots, i_n\}$ is the set of students. Motivated by our empirical setting, schools' common priority order over students is based on test scores $(t_i)_{i\in I} \in \mathbb{R}^n_+$ (the higher the better). Without loss of generality, sort students so that $t_{i_j} > t_{i_k}$ if $j < k$. We also assume that all students are acceptable for any school, which, in our institutional setting, is true conditional on the pool of eligible applicants. A capacity vector is $q = (q_{s_1}, \dots, q_{s_m})$ where q_s is the number of students school s can accommodate. The profile of student (strict) reported preferences is $\succ = (\succ_{i_1}, \dots, \succ_{i_n})$ defined over $S \cup \{o\}$ where o is the outside option. Let P_i denote the set of all possible preference relations for student i. $P = \times_{i\in I} P_i$ is the set of all preference profiles. Let $\succ$, $\succ'$ and so on denote students' reported preference profiles.

The outcome of a school admission problem is a matching $\nu : I \to S \cup I$ where $\nu(i)$ means the school that admits student i (or no assignment if $\nu(i) = i$) with the following properties.

- $\nu(i) \notin S \implies \nu(i) = i$ for every $i \in I$, and
- $\left|\nu^{-1}(s)\right| \leq q_s$ for every $s \in S$.

A mechanism is a systematic procedure that determines a matching for each reported preference profile. Formally, it is a function $\mu : P \to \mathcal{M}$ where $\mathcal{M}$ denotes the set of all matchings. Let $\mu_s(\succ)$ denote the set of students assigned to s in mechanism μ for reported preference profile $\succ$. Let μ^C be the Capp mechanism introduced in Section 2.

We compare mechanisms with a thought experiment where the same set of applicants with the same true preferences and test scores participate in different mechanisms. Applicants may change their preference reports, depending on which mechanism they participate in. The set of schools and their capacities are assumed to stay constant. Index each school seat by $j = 1, \dots, k \equiv \sum_{i\in S} q_i$. Let $t_{\mu(\succ)}(j)$ be the test score of the student assigned to seat j under mechanism μ for preference profile $\succ$. $t_{\mu(\succ)}(j) = 0$ if no student is assigned to seat j. Let $F_{\mu(\succ)}$ be the cumulative distribution of test scores among assigned students under any mechanism μ for preference profile $\succ$, defined as

$$F_{\mu(\succ)}(t) = \frac{\left|\{j \in \{1, \dots, k\} \mid t_{\mu(\succ)}(j) \leq t\}\right|}{k}$$

for all $t \in \mathbb{R}_+$.

As should be the case given the official goal of centralization, Capp is more meritocratic than any other mechanism, especially Dapp, in that Capp induces a first-order-stochastic-dominance improvement of the test score distribution among admittees.

Proposition 1. *For any school admission problem and any mechanism* μ*, we have* $F_{\mu^C(\succ)}(t) \leq F_{\mu(\succ')}(t)$ *for all* $t \in \mathbb{R}_+$ *and* $\succ, \succ' \in P$*.*

This fact implies that the worst test score among assigned students under Capp is weakly better than that under any other mechanism, including Dapp. Proposition 4 in Appendix A further shows that in terms of the test score distribution, Capp is as meritocratic as the possibly most meritocratic mechanism, i.e., the Serial Dictatorship or Deferred Acceptance mechanism.

To derive additional predictions about applicant behavior, we need to impose more structures on the model. We consider a model with two schools s_1 and s_2 with capacities q_1 and q_2, respectively, and any number of applicants. Each applicant takes an action under each mechanism. Under Capp, for example, each applicant submits a preference list $\succ_i$. Under Dapp, each applicant applies to a school. The mechanism then uses these actions to obtain a matching. This procedure induces a strategic form game, $\langle I, (A_i)_{i \in I}, \succ^o \rangle$. The set of players is the set of applicants I. The action space of each applicant is A_i. Under Capp, this is the set of all possible preference relations P_i over schools. Under Dapp, this is the set of schools $S = \{s_1, s_2\}$. The outcome is evaluated through the true preferences $\succ^o = (\succ^o_{i_1}, \dots, \succ^o_{i_n})$.

Take any mechanism as given. Let A_{-i} denote the set of possible strategy profiles for all applicants except applicant i. Let i denote remaining unassigned. We define a *stochastic dominance* relation, denoted $sd(\succ^o_i)$, on the set of actions A_i as follows: Upon enumerating $S \cup \{i\}$ from best to worst according to $\succ^o_i$, we define

$$a_i \, sd(\succ^o_i) \, a'_i \iff \sum_{l=1}^{t} p_{il}(a_i, a_{-i}) \geq \sum_{l=1}^{t} p_{il}(a'_i, a_{-i}) \text{ for all } t \text{ and } a_{-i} \in A_{-i}$$

where $p_{il}(a_i, a_{-i})$ is the probability that applicant i gets assigned to the l-th best option in $S \cup \{i\}$ according to $\succ^o_i$ if he plays action a_i, given action profile a_{-i} of other applicants. We say that strategy a_i is a *dominant strategy* if we have $a_i \, sd(\succ^o_i) \, a'_i$ for all $a'_i \in A_i$. This notation allows us to obtain the following result.

Proposition 2. *Suppose that every applicant (1) prefers* s_1 *over* s_2 *and (2) submits the true preference whenever it is a dominant strategy. Then the number of applicants who apply to the most popular school* s_1 *is weakly larger under centralized admissions than under decentralized admissions.*

Intuitively, Capp would cause applicants to give a shot at the most prestigious and selective school since Capp gives applicants a chance of acceptance by lower-choice schools after rejected by the first-choice school.

To obtain the final theoretical prediction, assume that each applicant lives in a school's local area. Let n_j be the number of students from school s_j's area. Assume the cardinal utility of applicant i from school s to be $U_{is} = U_s + V * 1\{i \text{ is from } s\text{'s area}\}$. Applicants cannot observe their test scores when submitting their preferences, which is the case in our empirical setting. Assume that each applicant believes that every applicant's test score is independent and identically distributed, i.e., $t \sim_{iid} F(t)$ for some distribution F. Define $p(n, q)$ as the probability of being one of the top q applicants among n applicants as per i.i.d test scores, i.e., $p(n, q) = \min\{\frac{q}{n}, 1\} * 1\{n > 0\}$.

As above, Dapp induces strategic form game $(I, (A_i)_{i \in I}, (U_i)_{i \in I})$. The set of players and the action space remain the same. The outcome is now evaluated accordingly to cardinal utility. Define $U_i(.)$ as the expected payoff of player i at the application stage, i.e., $U_i(a_i, a_{-i}) = p(\bar{n}_{a_i}, q_{a_i}) * U_{ia_i}$ if he plays action a_i, given action profile a_{-i} of other applicants, where $\bar{n}_a = \sum_{j \in I} 1\{a_j = a\}$. A strategy vector $a = (a_1, \ldots, a_n)$ is an *equilibrium* if for each applicant $i \in I$ and each strategy $a'_i \in A_i$, we have $U_i(a) \geq U_i(a'_i, a_{-i})$. An equilibrium $(a_1, \ldots, a_n)$ is called a *symmetric equilibrium* if $a_i = a_j$ for all i and j from the same area. We make the following assumptions for the rest of this section:

A1. Every applicant prefers s_1 over s_2.

A2. Applicants play a symmetric equilibrium, which is assumed to exist.

w_j denotes the number of applicants assigned to school s_j while w_{jk} denotes the number of applicants assigned to school s_j who come from school s_k's area. Define the *proportion of assigned applicants assigned to their local school* as

$$\frac{w_{11} + w_{22}}{w_1 + w_2}.$$

Proposition 3. *Under assumptions A1 and A2, for sufficiently large V, the proportion of assigned applicants assigned to their local school is higher under Dapp than under Capp.*

Capp therefore reduces the number of local entrants born in the school's prefecture. Our empirical investigation starts with testing whether these theoretical predictions hold in the data.

4 Data

To analyze short-run effects of centralization, we collect data on applications, enrollments, and other outcomes by digitalizing several administrative and non-administrative sources.

First, we collect data on the number of applicants and their first choice schools for 1898-1930 from multiple sources: Government Gazettes for 1902; letters exchanged between the Ministry of Education and the Tokyo Imperial University for 1903 and 1904; Yoshino (2001a) for 1907; the Investigation Records of Higher School Entrance Examinations by the Ministry of Education for 1917,1918 and 1927; and the Ministry of Education Yearbook for other years (except 1905, 1906, and 1926 for which there are no data). Because the Investigation Records of Higher School Entrance Examinations contain more detailed data for 1916 and 1917, we collect the number of applicants by their first-choice school, birth prefecture, and the prefecture of their middle school, for these two years. Birth prefecture is defined by the prefecture of legal domicile registered in Japan's official family registry system. We include applicants born in all 47 prefectures (excluding colonies) in Japan and exclude foreign-born applicants.

Second, we newly collect data on the number of entrants (i.e., admitted applicants) by school, year, and birth prefecture from 1898 to 1930. We use the number of freshmen as a proxy for the number of entrants.[15] We collect the number of freshmen by birth prefecture, using the Higher School Student Registers published annually by each school. We include only freshman born in 47 prefectures in Japan, excluding foreign-born students and students born in colonies.

Third, we collect data on the number of middle school graduates by year, school type (public or private), and prefecture (defined by the location of middle school) from 1897 to 1930, using the Ministry of Education Yearbook. We use these data to control for the supply of potential applicants as well as the general education level. We also control for the numbers of national, public, and private higher schools by prefecture that were established in addition to Schools 1-8 starting in 1919, using the same source.

Finally, we compute a measure of the geographical mobility of applicants and entrants. Since the finest geographical unit of observation is a prefecture, we define the distance between an applicant's birth prefecture and the school of his first choice by a direct (straight-line) distance between the capital of the birth prefecture and the capital of the prefecture in which the school was located. Similarly, the distance between an entrant's middle school and one of Schools 1-8 he was admitted to is defined by a direct distance between the two

[15] Strictly speaking, the number of freshman may differ from the number of entrants due to dropouts and holdovers.

prefectural capitals determined by the prefectural locations of the middle school and the School 1-8. The distance data are from the Geospatial Information Authority of Japan. Descriptive statistics of main variables are summarized in Appendix Table A.2.

5 Short-run Impacts

5.1 Strategic Responses by Applicants

As an immediate effect, switching back and forth between the centralized admissions (Capp) and the decentralized admissions (Dapp) caused stark strategic responses in application behavior. Figure 3 shows that the three periods of Capp (in 1902-07, 1917-18, and 1926-27) are associated with a sharp increase in the share of applicants who select the most selective School 1 as their first choice, as predicted by Proposition 2. Such response was present and statistically significant in all geographic areas. The top panel of Table 1 reports the difference in the propensity of applicants to rank School 1 as their first choice between the two years, 1916 (under Dapp) and 1917 (under Capp), using the following regression:

$$Y_{it} = \alpha + \beta \times Centralized_t + \epsilon_{it},$$

where Y_{it} is the indicator variable that takes 1 if applicant i in year t selects School 1 as his first choice. $Centralized_t$ is the indicator variable that takes 1 if year t is under Capp. The first column of Table 1 shows that, at the national level, the share of applicants who rank School 1 first increased by 16 percentage points under Capp. This is about 64% increase compared to the mean of 25% under Dapp (reported as the estimate of the constant term α). Next, to observe regional variations, we group applicants into school regions based on which of Schools 1-8 was the closest to the applicant's middle school (see the map below Table 1) and run the same regression for each region. In all school regions, the share of applicants selecting School 1 rose substantially (by 11 to 19 percentage points) under Capp.

These strategic responses have heterogeneous effects on application distance (i.e., the distance between an applicant's first-choice school and middle school), as the bottom panel of Table 1 shows. At the national level, the application distance changes little between Dapp and Capp (see the first column). However, there were major changes at the regional level. The application distance decreased by 93 km (1 km is 0.62 miles) in the School 1 region under Capp as more applicants selected the nearest and most prestigious School 1, whereas it increased by more than 100 km in the School 5 and School 7 regions located in remote west.

Overall, the results in Table 1 show that the meritocratic centralization of school admissions induced a greater number of applicants around the nation to rank the most prestigious school in Tokyo first and encouraged applicants to make more long-distance applications. As a result, the competition to enter School 1 became even more intense under the centralized system. Appendix Figure A.2 depicts changes in the competitiveness of Schools 1-8, measured by the ratio of the number of applicants who select the school as their first choice (hereafter first-choice applicants) to the number of entrants to the school. During the periods of centralized admissions, the ratio spiked at School 1 (Tokyo), increased modestly at School 3 (Kyoto), and declined sharply at the rest of the schools. For instance, at the second introduction of Capp in 1917, School 1 attracted 12 times more first-choice applicants (4,428 in total) than its capacity (361 seats). This implies that only a small fraction of the first-choice applicants were admitted to School 1, leaving hundreds of high-scoring applicants rejected by School 1.

5.2 Regional Mobility in Enrollment

The centralized assignment rule allows high-scoring applicants from the urban area to be admitted to lower-choice schools, even after being rejected by their first choice.[16] As a result, the centralized system is associated with a sharp and discontinuous increase in enrollment distance, especially in the first two periods of Capp.[17] Figure 4 shows this by plotting the average enrollment distance (i.e., the distance between an entrant's birth prefecture and the school he entered).

This increase in regional mobility is also visible as a sharp reduction in the number of "local" entrants (defined by entrants who entered schools in their birth prefectures). We estimate the following regression for each school s separately:

$$\begin{aligned} Y_{pt} = & \beta_1 \times Centralized_t \times 1\{\text{school } s \text{ is located in prefecture } p\} \\ & + \beta_2 \times Centralized_t \times 1\{\text{school } s \text{ is 1-100 km away from prefecture } p\} \\ & + \beta_3 \times Centralized_t \times 1\{\text{school } s \text{ is 101-300 km away from prefecture } p\} \\ & + X_{pt} + \gamma_t + \gamma_p + \epsilon_{pt}, \end{aligned}$$

where Y_{pt} is the number of entrants born in prefecture p who entered school s in year t.

[16] Recall that under the meritocratic algorithm discussed in Section 2, even for a not-so-selective school, first-choice applicants will be rejected if their scores are below the threhold and second-choice applicants with sufficiently high scores will be admitted in their place.

[17] The centralized mechanism used in the third period of Capp in 1926-27 was qualitatively different from that in the first and second periods. Because the number of national higher schools increased from 8 in 1918 to 25 by 1926, the schools were divided into two groups and applicants were allowed to choose and rank at most two schools (one school per group) in 1926-27.

$Centralized_t$ is the indicator variable that takes 1 if the system was centralized in year t. 1{school s is 1-100 km away from prefecture p} is the indicator variable that takes 1 if school s is not located in, but within 100 km from prefecture p. X_{pt} controls for observable characteristics of prefecture p and year t, including the number of middle school graduates from prefecture p in year t and the number of higher schools other than School 1-8 in prefecture p in year t. γ_t and γ_p are year and prefecture fixed effects.

Capp reduces the number of local entrants born in the school's prefecture, as shown in Table 2. The coefficients of 1{school s is located in prefecture p} are significantly negative for all schools. Column 1 shows that the number of School 1 entrants born in Tokyo Prefecture declined by 28 under Capp from the average of 103 entrants under Dapp, or a 27% reduction. Most affected was School 7 (where the number of local entrants declined by 49%), while least affected was School 8 (with a decline of 17%). Schools 4-7 experienced reductions in the number of entrants born not only from the school's prefecture but also from surrounding prefectures. In other words, centralization weakened the local monopoly power of each school by creating a national market for higher education, consistent with Proposition 3. These results are robust to whether or not to control for prefecture characteristics (results available upon request).

5.3 Meritocracy vs Equal Regional Access

As established above, centralization reduced the number of applicants who were admitted to their local schools. Then who gained more school seats under the centralized system? Figure 5a plots the change in the number of entrants to Schools 1-8 from Dapp to Capp by birth prefecture (where blue colors indicate decreases and red colors indicate increases). The figure shows that most of the western and northern prefectures lost school seats, while Tokyo Prefecture (around School 1) and its surrounding area gained school seats under Capp.

Figure 5b depicts the time evolution of the share of entrants to Schools 1-8 who were born in the Tokyo area defined as prefectures located within 100 km from Tokyo (see Appendix Figure A.3). The share of Tokyo-area born entrants rose significantly during the years of centralization.

More formally, Table 3 compares the effects of Capp on Tokyo-area born entrants and locally-born entrants, by estimating the following equation for each school s:

$$
\begin{aligned}
Y_{pt} = {} & \beta_1 \times Centralized_t \times 1\{\text{prefecture } p \text{ is Tokyo}\} \\
& + \beta_2 \times Centralized_t \times 1\{\text{prefecture } p \text{ is 1-100 km away from Tokyo}\} \\
& + \beta_3 \times Centralized_t \times 1\{\text{prefecture } p \text{ is 101-300 km away from Tokyo}\} \\
& + \beta_4 \times Centralized_t \times 1\{\text{school } s \text{ is located in prefecture } p\} \\
& + \beta_5 \times Centralized_t \times 1\{\text{school } s \text{ is 1-100 km away from prefecture } p\} \\
& + \beta_6 \times Centralized_t \times 1\{\text{school } s \text{ is 101-300 km away from prefecture } p\} \\
& + X_{pt} + \gamma_t + \gamma_p + \epsilon_{pt},
\end{aligned}
$$

where Y_{pt} is the number of entrants born in prefecture p who entered school s in year t. Column 1 of Table 3 shows that the number of Tokyo-area-born students admitted to any of Schools 1-8 increased by 23 under Capp, indicating a 10% increase from the average of 226 under Dapp. The school-by-school estimates in columns 2-9 reveal that this effect comes mainly from Tokyo-area born students entering less selective rural schools (Schools 4-8).[18] In other words, the net effect of Capp is such that the increased inter-regional applications caused high-achieving students residing mainly in the Tokyo area to crowd out lower-achieving, rural-born students from their local schools.

5.4 Political Economy of School Admission Reforms

The short-term impacts of centralization highlight a meritocracy-equity tradeoff. On the one hand, the centralized admissions made the school seat allocation more meritocratic, enabling high-ability students to enter one of the elite national higher schools even if they failed at entering the most selective one. On the other hand, this meritocracy came at the expense of equal regional access to higher education, as high-achieving urban applicants dominated rural applicants.

This meritocracy-equity tradeoff was one of the main reasons why the government went back and forth between the centralized and decentralized systems. In this section, we briefly discuss why centralization was implemented three times (in 1902–07, 1917–18, and 1926–27) and why it was short-lived each time.

Historical evidence indicates that the repeated policy changes were the results of intense bargaining between the Ministry of Education (MOE), who pushed for centralization to advance meritocracy, and the Council of School Principals (CSP), who preferred decentral-

[18]The results remain almost the same whether we control for observable prefecture characteristics or not (a table available upon request).

ization to protect school autonomy and regional interests of rural schools and communities (Yoshino, 2001a,b; Takeuchi, 2011; Amano, 2007).

When centralizing the school admissions, the MOE repeatedly emphasized the importance of enrolling only the best and brightest to the national higher education system. The problem of the decentralized system was that the ability of admitted students varied widely across schools depending on the school's selectiveness.[19] With a striking clarity, the Minister of Education criticized the decentralized system as follows (*Education Times* No.1146, p.21, published in February 15, 1917):

> "*[Under the decentralized system] among applicants rejected by School 1 and School 3, which attract a large number of high ability applicants, there are many applicants whose academic performance is superior to that of applicants admitted to other rural schools. (...) Namely, hundreds of applicants with sufficiently high academic ability to enter rural schools are idly wasting another year [to retake the exam]. This is not only a pity for them, but also a loss for the country.*"

To maximize the quality of admitted students, the MOE proposed to centralize admissions, in which all applicants would take a single unified exam on the same date, all exam sheets would be sent to a central exam committee and graded by a single person per question to ensure fairness, and applicants would be admitted in the order of their exam scores.[20]

The Council of School Principals strongly opposed to the idea of centralization, however. First of all, the principals deemed it as an intrusion on their power and autonomy.[21] Second, the CSP argued that the centralized system was disadvantageous to rural schools in both the quality of entrants and the quality of match between schools and entrants. According to the CSP, under the centralized system, urban schools were able to enroll all the best students, because applicants in all areas tended to rank urban schools as their first choice. As a result, rural schools lost the most talented students in their local areas who used to enter rural schools under decentralized admissions.[22] Moreover, after reviewing the admission results of 1917 (the first year of the second centralization period), the CSP found that, in the prefectures where rural schools were located, the number of middle-school graduates

[19] *Education Times* (*Kyouiku Jihou*) No. 609, p.40, March 15, 1902; No.610, p.29, March 25, 1902; No.1141, pp.17-18, December 25, 1916; No.1146, pp.21, February 15, 1917; No.1151, pp.12-13, April 5, 1917.

[20] *Education Times* No. 609, p.40, March 15, 1902; No.610, p.29, March 25, 1902; No.1141, pp.17-18, December 25, 1916.

[21] *Education Times* No. 1143, p.21, January 15, 1917; Yoshino (2001b), p.30.

[22] "A Proposal Regarding a Revision of the Entrance Examination Rules" by the CSP submitted to the MOE in 1906, reprinted in *Compendium of Higher Schools, Volume 3: Education (Kyusei Koutou Gakkou Zensho: Kyouiku-hen)*, pp.605-607.

admitted not only to their local higher school, but also to any higher schools, declined considerably compared to the previous three years under decentralized admissions.[23]

The CSP further complained that under the centralized system, rural schools must admit a sizable number of reluctant and unmotivated students who came to the school as a fallback option ("A Proposal Regarding a Revision of the Higher School Entrance Examination Rules" by the CSP submitted to the MOE in 1906):

> "*Students who entered the school of their second choice or below can never dispel a thought that they had to enter that school because of their exam results. As a result, they are unmotivated to study and have no loyalty to their school. Especially, in those schools that enroll many students who chose the school as their fourth or fifth choice, these students often have adverse effects on the general quality of education.*"

This was upsetting to rural schools as well as rural communities, as they typically donated much resource when inviting a higher school to their prefectures (Takeuchi (2011), p.56 and pp.106-107).

Finally, the administrative cost of implementing the centralized system was always a serious concern. Both MOE officials and the school principals repeatedly pointed out the difficulty of grading thousands of exam sheets by a small number of people in a short period of time and assign these applicants to schools according to the algorithm. Certainly, time and labor costs of implementing the centralized admissions in the absence of modern computers and photocopying technologies was high.

Reflecting on these issues underlying the unusual series of centralization and its abolitions, a noted historian writes as follows (Takeuchi (2011), p.121):

> "*Urban applicants "overwhelm" rural applicants by applying for rural schools as fallback options. Urban applicants rob rural applicants of opportunities that were once open to them. This ruins the meaning of building national higher schools across the nation.*"

This equity-meritocracy tradeoff was one of the reasons why the government oscillated between decentralized and centralized systems, finally settling down to the decentralized system in 1928.

[23]Investigative Records of Higher School Entrance Examinations in 1917, p.40, published by the MOE; *Education Times* No. 1190, p.18, May 5, 1918.

5.5 Other Institutional Changes

Before moving on to long-term effects, we discuss potential threats to our analysis, especially whether changes in other institutional factors could explain away our short-run results. Our analysis takes the timing of the reforms as exogenous, which raises a few concerns. The first concern is that if there were simultaneous reforms in middle schools, it could affect application behavior. Second, if there were capacity changes at Schools 1-8 that were correlated with the admission reforms, it could influence application behavior and enrollment outcomes. The final concern is that if the capacity of School 1 increased relative to the capacity of other schools with the admission reforms, this could explain our findings on application behavior.

We investigate these concerns and confirm that time-series changes in the number of middle school graduates, the total number of entrants to Schools 1-8, and the share of entrants to School 1 in all entrants are not correlated with centralization periods (columns 1-3 in Appendix Table A.3). In columns 4 and 5, we also verify that the number of applicants as well as the level of competitiveness (measured by the number of entrants divided by the number of applicants) do not move systematically with introductions of Capp. In addition, if the probability of unsuccessful applicants retaking the exam in subsequent years changes with the admission reforms, this may also affect our results. As shown in column 6, however, we find that the average age of entrants does not change with the introductions of centralization.

A potential concern with the above robustness analysis is that the insignificant results in Appendix Table A.3 may be due to a small sample size (the number of observations is around 30). Yet, using the same empirical specification, we find that centralization is significantly correlated with our main outcome variables (the share of applicants to School 1, the enrollment distance, and the share of entrants who were born in the Tokyo area), as shown in columns 7-9 of Appendix Table A.3. Taken together, these results suggest that it is unlikely that our findings are driven by institutional changes other than the school admission reforms.

Finally, another concern is that the centralization reform introduced not only the meritocratic assignment algorithm, but also the unified entrance exam that applicants can take in any of the school locations. The estimated impacts of centralization may be confounded by the integration of entrance exams and more flexible exam location choices. To investigate this issue, we analyze how key outcomes change from 1900 to 1901, during which the government also introduced a single entrance exam that applicants are allowed to take anywhere while the assignment method remained unchanged (decentralized). Figures 3 and 4 show that the institutional change between 1900 and 1901 induced little changes in application and enrollment patterns. The estimated impacts of centralization are therefore likely due to the meritocratic assignment algorithm, not other confounders like the content and location of entrance exams.

6 Long-run Impacts

6.1 Long-run Outcome Data

To assess longer-term effects, we use the Japanese Personnel Inquiry Records (JPIR) published in 1939 as our main data source.[24] The JPIR is an equivalent of Who's Who in Japan, which compiles a highly selective list of distinguished individuals such as high-income earners, imperial medal recipients, top business managers, elite professionals, high-ranking politicians, bureaucrats, and military personnels.[25] In total, the 1939 JPIR lists 55,742 individuals or 0.15% of the adult Japanese population of that time. In selecting these individuals, the JPIR uses a variety of sources, including the directory of banks and companies, the government personnel directory, the directory of Japanese notables, and the directory of industrial associations board members.[26]

To capture the effects of the first period of the centralized admission system in 1902–1907, we use the cohorts born in 1880–1894, who turned 17 years old (the age eligible for application) in 1897–1911. The cohorts born in 1880–1894 were 45 to 59 years old in 1939.[27] The number of individuals listed in the JPIR in each of these cohorts is about 1,800. We use the following information from the JPIR data for each individual: full name, birth date, birth prefecture,[28] residing prefecture, final education[29], occupational titles and positions, the name of the employer (if applicable), the medal for merit and the court rank awarded (if any), and the amount of national income tax and corporate tax paid.

We define the following (mutually non-exclusive) groups of elites as subsets of JPIR-listed individuals: (1) top 0.01% and 0.05% income earners,[30] (2) medal recipients (individuals

[24]Digital images of the Japanese Personnel Inquiry Records (*Jinji Koushin-roku*) are publicly available at the National Diet Library Digital Collections.

[25]The JPIR also lists the imperial and peerage families, but they are excluded from our data as we focus on career elites in our analysis.

[26]The directory of banks and companies includes a list of all directors of banks and companies whose capital is 300,000 yen or above. The government personnel directory provides a complete list of politicians, military personnels, and civil servants in national and local governments, including Imperial University professors. The directory of Japanese notables includes high tax payers defined by individuals who paid more than 50 yen of income tax or more than 80 yen of business tax.

[27]The average life expectancy at age 20 for males born in 1880–1900 was about 40 years.

[28]The JPIR obtained information about birth date and prefecture from the official family registry system administered by local governments.

[29]Because final education is typically a university, we are unable to observe which higher school these individuals attended.

[30]The threshold income tax payments for the top 0.01% and 0.05% income earners are 9,967 yen and 2,385 yen, respectively. For example, 9,967 yen of income tax payment is equivalent to around 50,000 yen

who received either the medal of the Fifth Order of Merit or above, or the court rank of the Junior Fifth Rank or above, excluding military personnels),[31] (3) professionals (individuals whose occupation is either physician, engineer, lawyer, or scholar), (4) professors at Imperial Universities (individuals whose occupation is either professor or associate professor at one of the Imperial Universities), and (5) managers (individuals employed in a private sector with a positive amount of income or corporate tax payment). Descriptive statistics in Appendix Table A.2 show that these categories are highly selective groups of career elites. For instance, the average number of the top 0.05% income earners per cohort per prefecture is fewer than 5 and the total number for the whole country per cohort is just 230. These categories encompass social, economic, political, and cultural definitions of career elites, or "upper-tail human capital" of the society (Mokyr, 2005).

We use these data to count the number of elites in each group by birth prefecture and cohort. These counts allow us to conduct a difference-in-differences analysis that compares long-term career outcomes of urban- and rural-born individuals by each cohort's exposure to the centralized system.

Assessing the Coverage and Bias of the Data

Since the JPIR data is not exhaustive administrative data, we are concerned about potential sample selection bias. For top income earners and Imperial University professors, we can compute the exact sampling rates by comparing the number of individuals in the JPIR against complete counts reported in government statistics.[32] We find that the sampling rates are decent even by modern standards: 53% and 39% for the top 0.01% and top 0.05% income earners, respectively, and 70% for Imperial University professors. Consistent with the nature of the JPIR, which lists only distinguished individuals, the sampling rates increase with the income level (Appendix Figure A.4).

Sample selection bias becomes a problem for our difference-in-differences analysis only if the difference in sampling rates between urban and rural areas changes with cohorts' exposure

of taxable income. The mean household income in 1936 is estimated to be about 900 yen (Yazawa, 2004). The top 0.01% income group earned about 3% of national income in the 1930s, indicating a high degree of income concentration at the top of income distribution comparable to that of the U.S. during the same period (Moriguchi and Saez, 2006, 2008).

[31] In the Japanese honor system, the medals for merit and the court ranks were conferred on individuals in recognition of their exceptional public service or distinguished merit. The medals had 8 grades from the First Order of Merit (the highest honor) to the Eighth Order of Merit (the lowest honor), and the court ranks had 16 ranks from Senior First Rank (the highest) to Junior Eighth Rank (the lowest). The highest orders and ranks were awarded mostly to top-ranking military officers, bureaucrats, and politicians, but a small number of private individuals such as top corporate executives received the Fourth and Fifth Orders of Merit (Ogawa, 2009).

[32] The number of high income earners are reported in the Tax Bureau Yearbook, and the number of Imperial University professors are reported in the Ministry of Education Yearbook.

to the centralized admission system. To assess this possibility, we examine the prefecture-level JPIR sampling rates for top income earners. As Appendix Figure A.5 shows, the number of JPIR-listed individuals and the complete count from tax statistics are highly correlated, with similar sampling rates across prefectures. This result provides further support for the quality of the JPIR data. Even so, one potential concern is that Imperial University graduates might have a higher likelihood of being sampled by the JPIR even after controlling for the income level. However, we find no positive correlation between the sampling rates of top income earners in the JPIR data and the numbers of Imperial University graduates across prefectures (see Appendix Table A.4). This series of findings suggests that possible sample selection bias in the JPIR data is unlikely to drive our empirical results.

Finally, we collect and control for a set of time-varying prefecture characteristics. To control for demographical changes, we collect prefecture-level birth populations for the cohorts born in 1886–1894 from the population census and estimate birth populations for the cohorts born in 1880-1885 using age-specific population data available in 1876-1894. To control for local economic conditions, we take prefecture-level manufacturing GDP estimates in 1874, 1890, 1909, and 1925 from Tangjun et al. (2009) and interpolate them linearly for each prefecture. To control for changes in middle schools, we collect the number of middle school graduates in each prefecture in the year when the cohort became age 16.

6.2 Regional Disparity in Producing Career Elites

We estimate the long-run impacts of the centralized school admissions (Capp), by conducting a difference-in-differences analysis by birth cohorts and birth areas. The key idea behind our empirical strategy is that applicants born in the Tokyo area should experience a greater gain in entering Schools 1-8 under Capp relative to Dapp, since the centralized system is designed to be more meritocratic and high-achieving students are disproportionately located in urban areas. Figure 5 and Table 3 confirm this expectation. We exploit this differential gain in school access to compare the career outcomes of individuals born inside and outside the Tokyo area by the cohort's exposure to Capp. If admission to Schools 1-8 increases one's chance of becoming a career elite, we should observe a greater number of elites born inside the Tokyo area for the cohorts exposed to Capp.

We estimate a difference-in-differences specification as follows:

$$Y_{pt} = \beta \times Centralized_t \times Urban_p + \gamma_p + \gamma_t + \epsilon_{pt},$$

where Y_{pt} is the number of elites listed in the JPIR defined above in cohort t born in prefecture p. $Centralized_t$ is the binary variable that takes 1 if cohort t turned 17 during

Capp (1902–1907), $Urban_p$ is the indicator variable that takes 1 if prefecture p is in the Tokyo area. The prefecture fixed effects γ_p capture any systematic difference in career outcomes across prefectures that do not vary across cohorts. The cohort fixed effects γ_t control for common shocks that affect career outcomes in all prefectures as well as secular time trends. To allow for serial correlation of ϵ_{pt} within prefecture over time, we cluster the standard errors at the prefecture level.[33]

We define $Centralized_t$ as a binary indicator, as the simplest proxy for the intensity of exposure to Capp. In reality, however, a nontrivial number of unsuccessful applicants retook the exam at age 18 and beyond.[34] As a result, the cohorts who turned age 17 in 1899–1901 were partially and increasingly exposed to Capp (as they might have taken the exam in 1902), the cohorts who turned age 17 in 1902–1904 were fully exposed to Capp, and the cohorts who turned age 17 in 1905–1907 were partially and decreasingly exposed to Capp (as they might have taken the exam in 1908), and the intensity of exposure drops to zero for the cohorts who turned age 17 in 1908. For this reason, we provide a robustness check by dropping the cohorts who were also partially exposed to Dapp below.

We first check whether the number of Imperial University graduates born inside the Tokyo area increased for the cohorts exposed to Capp. Since all Schools 1-8 graduates were automatically admitted to an Imperial University during this period, the areas that produced more Schools 1-8 entrants should produce more Imperial University graduates. Figure 6 (a) compares the average number of Imperial University graduates who were born in prefectures inside and outside the Tokyo area by cohorts (represented by their birth year plus 17 on the horizontal axis). In these and subsequent plots, we color cohorts according to their intensity of exposure to Capp as described above. Figure 6 (b) confirms that the urban-rural difference in the number of Imperial University graduates rises as the intensity of exposure to Capp increases. The difference then falls after the end of Capp in 1908. Column 1 in Table 4 shows that the difference-in-difference estimate is positive and statistically significant.

Our main results are presented in Figure 6 (c)–(h) and Table 4 columns 2-7. Figure 6 (c)–(h) show difference-in-differences plots that compare the number of the top 0.05% income earners, professionals (physicians, engineers, lawyers, and scholars), and medal recipients (the Fifth Order of Merit or the Junior Fifth Rank and above) who were born inside and outside the Tokyo area by the cohort's exposure to Capp. Across all elite categories, the plots show

[33] Bertrand et al. (2004) evaluate approaches to deal with serial correlation within each cross-sectional unit in panel data. They suggest that clustering the standard errors on each cross-section unit performs well in settings with 50 or more cross-section units, as in our setting.

[34] According to the limited data available, out of all Schools 1-8 entrants in 1903, 63% graduated middle school in the same year, 29% graduated in the previous year, 6% graduated two years before, and 1% graduated three years before.

that the difference between the Tokyo area and the rest grows larger as the intensity of exposure to Capp increases, and then drops sharply after the end of Capp in 1908.

Table 4 columns 2-7 show that the long-run effects of the centralized admissions are economically and statistically significant. Panel A controls only for cohorts and prefecture fixed effects. Panel B additionally controls for time- and cohort-varying prefecture characteristics (i.e., cohort birth population, the number of primary schools, the number of middle school graduates, prefecture-level manufacturing GDP). The coefficients fall slightly in magnitude after adding control variables, but remain statistically significant. For the cohorts exposed to Capp, the number of career elites born inside the Tokyo area (compared to those born outside the Tokyo area) increases by 23% for the top 0.05% income earners, 36% for the top 0.01% income earners, 19% for managers, and 11% for professionals, 44% for Imperial University professors, and 35% for medal recipients (in Panel B).[35] Panels C and D show that the effects are symmetric with respect to the direction of the admission reforms, i.e., the change from Dapp to Capp and the change from Capp to Dapp produce quantitatively similar effects of the opposite sign. These results suggest that almost four decades after its implementation, the centralized admission system had lasting effects on the career trajectories of students.

The above results are robust to alternative specifications. First, the above analysis assumes that the cohorts who turned age 17 in 1902–1907 are fully exposed to Capp while the rest of the cohorts are fully exposed to Dapp. Even when we drop the cohorts who are heavily exposed to both Capp and Dapp (i.e., cohorts who became age 17 in 1901 and 1907) from the sample, we still find qualitatively the same results with higher statistical significance (see Appendix Table A.5).

Second, we test if the assumption of parallel pre-event trends holds. Appendix Table A.6 verifies that the differences in pre-event trends between the areas of comparison are small and statistically insignificant for all of our outcome variables.

Another potential threat to our identification strategy is that there may be some age-specific trends in the number of JPIR-listed elites that differ across regions and covary with the cohort-region variation we use. Specifically, the number of observations in the 1939 JPIR data peaks at around the cohort who were 51 years old in 1939 (corresponding to the cohort who turned age 17 in 1905) and gradually falls for younger and older cohorts, suggesting that there are certain ages at which individuals are more likely to be listed in the JPIR. Such age effects may generate different trends in the number of elites born in the Tokyo and other areas, due, for example, to differences in population size across these areas. To

[35] For professionals, as shown in Appendix Table A.8, even if we look at each occupation separately (i.e., scholars, physicians and lawyers, engineers), the results remain similar, but with lower precision due to smaller sample size. The last column of Appendix Table A.8 further shows that a similar result holds for high-ranking government officials.

address this concern, we use the earlier edition of the JPIR published in 1934, construct the prefecture-cohort level data for the same cohorts used in our main analysis (but observed 5 years earlier), and conduct similar regression analyses. The results in Appendix Table A.7 confirm that our key results remain qualitatively the same even if we use the 1934 JPIR data.

Finally, we conduct placebo tests to examine if the results are driven by other factors such as the sample selection of the JPIR or changes in cohort populations. Column 5 confirms that the urban-rural difference in the cohort's birth populations do not change significantly with the cohort's exposure to Capp. As an additional placebo test, we also look at unrelated career outcomes. Among the elites listed in the JPIR, we expect that landlords (defined as individuals whose occupational titles includes landlord, but excluding managers and professionals) are least likely to be affected by the introduction of Capp as receiving higher education was not a typical pathway to becoming a landlord. As shown in column 4 of Table 5, the estimated effect of Capp on the number of landlords is small and statistically insignificant. .

Understanding the Mechanism behind the Long-run Impacts

Next, we explore potential mechanisms through which centralization affect career outcomes. First, in columns 1 and 2 of Table 5, we test if centralization, which caused substantial inter-regional mobility in the short-run outcomes, increased the geographical mobility of elites in a long run. Somewhat surprisingly, the results indicate that it did not: The urban-rural difference in the fraction of elites whose residing prefectures differ from their birth prefectures did not significantly increase under Capp. We find similar results when we use the distance between an elite's birth prefecture and his residing prefecture as an alternative measure of long-run mobility. This result suggests that, even though a greater number of students born in the Tokyo area entered rural schools under Capp, most of them might have returned to the Tokyo area when pursuing their careers.

We also test whether centralization affected the urban-rural gap in the quality of Schools 1-8 entrants (in addition to its quantity). As a quality measure, we use the ratio of the number of Imperial University graduates listed in the JPIR to the total number of Schools 1-8 entrants when the cohort became age 17. We hypothesize that if the quality of entrants is higher, then a larger fraction of them would be selected into the JPIR in their adulthoods. The estimated coefficients in column 3 are negative and insignificant. Our main results in Table 4 are therefore likely driven by an increase in the quantity, but not the quality, of Schools 1-8 entrants from urban areas (relative to those from rural areas) under Capp.

Geographical Destinations of Career Elites

Having established that the centralized admission system affected the geographic *origins* of highly educated individuals, we now ask how it affected their geographic *destinations*. While the former is about regional inequality in educational opportunities, the latter is about regional inequality in the supply of highly skilled human capital, which potentially affects both regional and aggregate economic growth and inequality. If a greater number of students who were born in the Tokyo area and admitted to rural schools under Capp eventually returned to the Tokyo area for their subsequent careers, we should observe a greater number of elites living in the Tokyo area for the cohorts exposed to Capp. To test this hypothesis, we change the outcome variables by re-defining the prefecture (p) from birth prefecture to residing prefecture and estimate the equation with the same specification.

Table 6 shows positive effects of Capp on the urban-rural gap in the number of residing elites, although some of the coefficients come with large standard errors and are not statistically significant. For the cohorts exposed to Capp relative to Dapp, the number of elites living in the Tokyo area in their middle age (compared to those living outside the Tokyo area) increases by 16% for Imperial University graduates, 13% for professionals, and 23% for medal recipients (Panel B). These results suggest that the centralized system likely intensified the concentration of career elites in urban areas relative to rural areas in the long run.

7 Conclusion

The design of school admissions persistently impacts the geography of career elites. We reveal this fact by looking at the world's first recorded use of nationally centralized admissions and its subsequent abolitions in early twentieth-century Japan. While centralization was designed to make the school seat allocations more meritocratic, there turns out to be a tradeoff between meritocracy and equal regional access to higher education and career success. In line with a theoretical prediction, the meritocratic centralization led students to apply to more selective schools and make more inter-regional applications. As high ability students were located disproportionately in urban areas, however, centralization caused urban applicants to crowd out rural applicants from advancing to higher education. Most importantly, these impacts persisted in the long run: Several decades later, the meritocratic centralization increased the number of high income earners, medal recipients, and other elite professionals born in urban areas relative to those born in rural areas.

Though our study uses the admission reforms unique to Japan, the implications of our study might be relevant for other contexts. For instance, distributional consequences of centralized admissions may be a reason why many countries continue to use seemingly inefficient decentralized college admissions. Methodologically, the use of natural experiments in history may be also valuable for studying the long-run effects of market designs in other areas, such as housing, labor, and health markets.

It is the multiple bidirectional policy changes in history that allow us to measure the long-run effects. The disadvantage of using historical events, however, is the limited availability of data. The ideal way to alleviate the data concerns would be to use modern administrative data. For example, one may imagine linking administrative tax return data and school district data to measure the long-run effects of school choice reforms in the past few decades. Such an effort would be a fruitful complement to our historical study.

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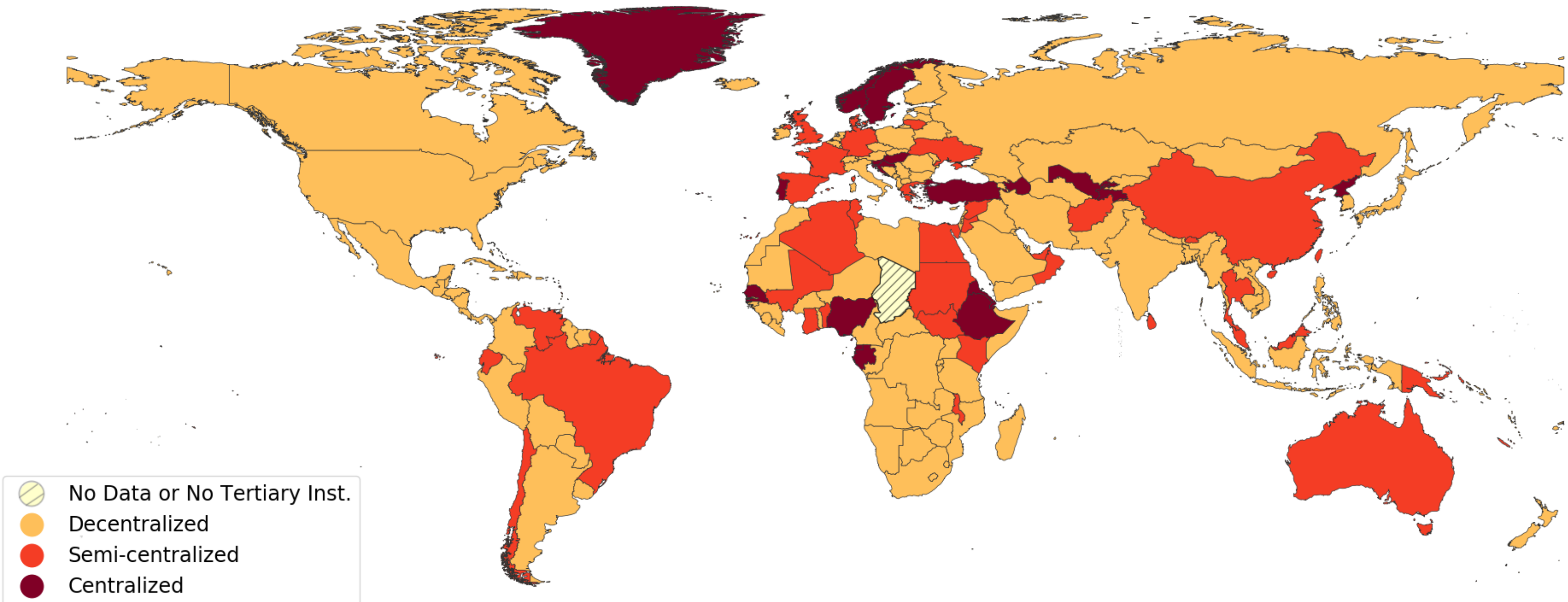
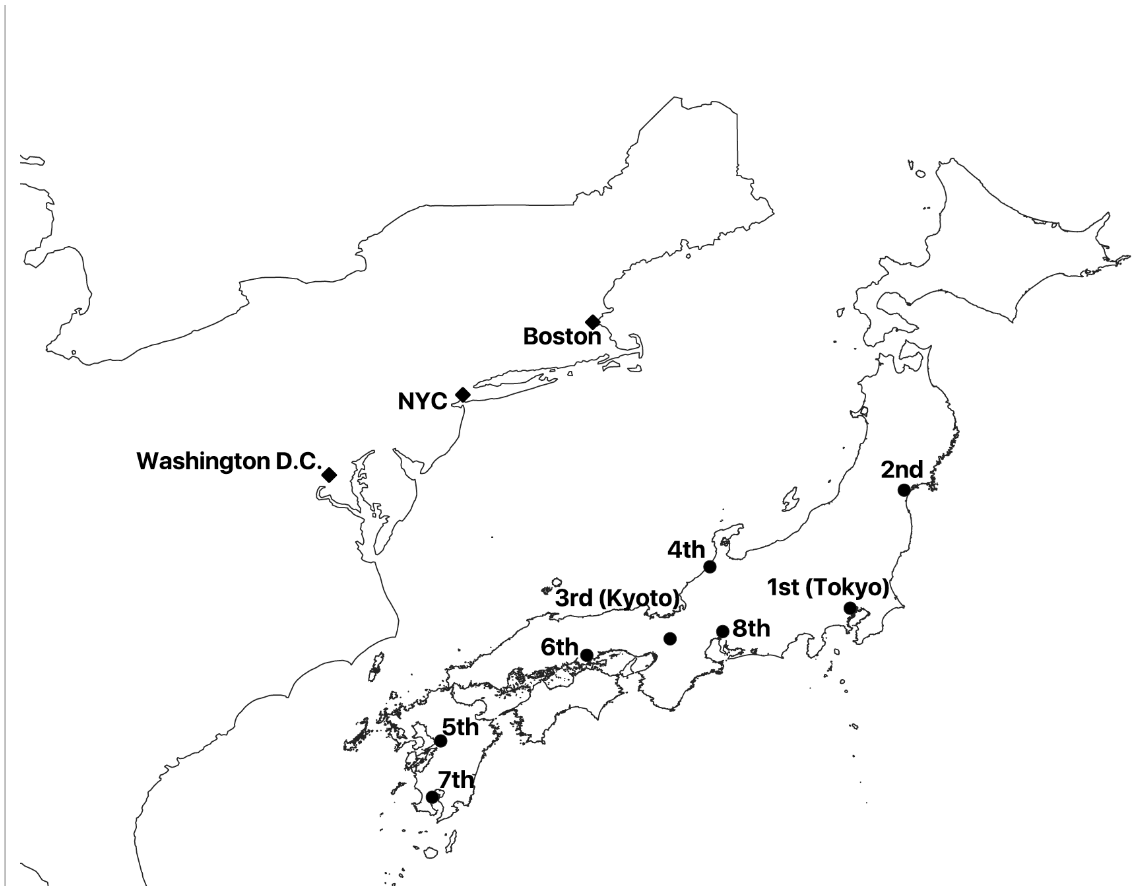
Figure 1: College Admissions around the World Today



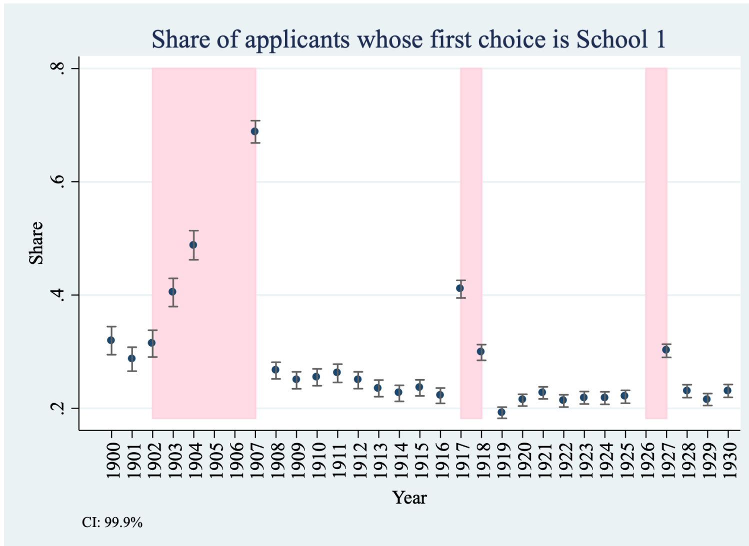
Notes: This figure summarizes each country and territory's college admission system today. Dark, red color (e.g. Norway): Regionally- or nationally-centralized college admissions, where a single-application, single-offer assignment algorithm (well-defined rule) is used to make admissions to both public and private universities. Medium, orange color (e.g. Brazil): Semi-centralized, defined as either (1) there is a centralized system, but not all universities (e.g. private universities) are included in the single-application, single-offer system or (2) students submit a single application and receive multiple offers. Light, orange color (e.g. U.S.A.): Decentralized college admissions, where each college defines its own admissions standards and rules. Yellow with diagonal lines (e.g. Chad): Not enough information available or if the country or territory does not have tertiary institutions. See Section 2 for discussions about this figure.

Figure 2: Map of Schools 1-8 in Japan (with the U.S. East Coast in Comparison)



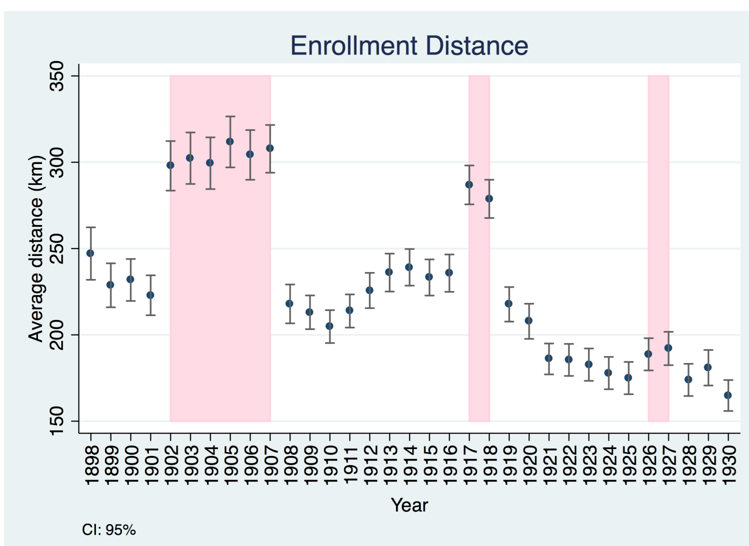
Notes: This figure shows the locations of Schools 1-8 and compares their geographical distribution to the US East Coast in the same scale unit. See Section 2 for discussions about this figure.

Figure 3: Centralization Caused Applicants to Apply More Aggressively: First Look



Notes: This figure shows the time evolution of the share of applicants who selected the most prestigious School 1 (Tokyo) as their first choice. Colored years (1902-07, 1917-18, and 1926-27) indicate the three periods of the centralized school admission system. No data are available for 1905, 1906, and 1926. Bars show the 99.9 percent confidence intervals. See Section 5.1 for discussions about this figure.

Figure 4: Centralization Increased Regional Mobility in Enrollment: First Look



Notes: This figure shows the time evolution of the average enrollment distance, i.e., the distance between an entrant's birth prefecture and the prefecture of the school he entered (measured by the direct distance between the two prefectural capitals). Colored years indicate the three periods of the centralized school admission system. Bars show the 95 percent confidence intervals. See Section 5.2 for discussions about this figure.

Table 1: Centralization Caused Applicants Across the Country to Apply More Aggressively

Dependent var	Select School 1 as First Choice								
Centralized	0.159***	0.192***	0.151***	0.146***	0.128	0.168***	0.180***	0.166***	0.114***
	(0.0106)	(0.00924)	(0.0329)	(0.0232)	(0.0646)	(0.0245)	(0.0336)	(0.0136)	(0.00786)
Constant	0.248***	0.494***	0.169***	0.0892***	0.178**	0.107***	0.184***	0.0813**	0.127*
	(0.0717)	(0.0437)	(0.0357)	(0.0162)	(0.0373)	(0.0185)	(0.0218)	(0.00991)	(0.0508)
Sample region	All	S1 Region	S2 Region	S3 Region	S4 Region	S5 Region	S6 Region	S7 Region	S8 Region
Observations	20,913	6,505	2,555	3,248	1,266	2,730	2,276	615	1,718
Dependent var	Application Distance								
Centralized	-2.534	-92.88***	10.95	2.080	-15.74	128.0***	46.52**	145.4**	-25.57
	(23.22)	(2.888)	(24.65)	(5.482)	(22.92)	(23.11)	(13.91)	(21.27)	(18.64)
Constant	226.2***	231.7***	289.7***	158.8***	166.7*	252.6***	294.1***	218.0*	154.2*
	(15.74)	(16.43)	(79.51)	(28.11)	(56.94)	(42.52)	(51.54)	(70.94)	(48.89)
Sample region	All	S1 Region	S2 Region	S3 Region	S4 Region	S5 Region	S6 Region	S7 Region	S8 Region
Observations	20,913	6,505	2,555	3,248	1,266	2,730	2,276	615	1,718

Notes: In the first panel, we estimate the effects of centralization on the propensity of an applicant to select the most prestigious school (School 1) as his first choice, using the applicant-level data in 1916 (under the decentralized system) and 1917 (under the centralized system). The prefecture-level application data are available only for these two years. We group applicants into "school regions" based on which school (among Schools 1-8) is nearest to the applicant's middle school in 1916, where "nearest" is defined by the distance between the prefectural capitals. The following map shows the locations of the eight school regions. The second panel measures the effects on the application distance between an applicant's first-choice school and middle school. Standard errors are clustered at the prefecture level. ***, **, and * mean significance at the 1%, 5%, and 10% levels, respectively. See Section 5.1 for discussions about this table.

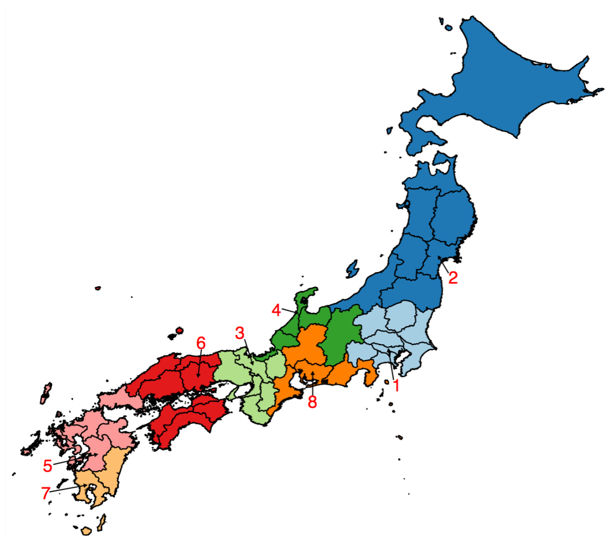


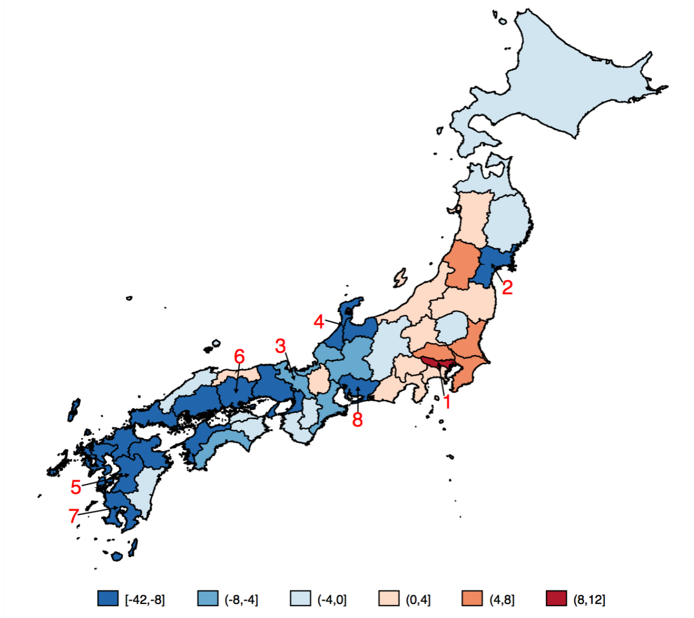
Table 2: Centralization Broke Local Monopoly and Increased Regional Mobility across the Country

Dependent variable = No. of entrants to:	(1) Sch. 1	(2) Sch. 2	(3) Sch. 3	(4) Sch. 4	(5) Sch. 5	(6) Sch. 6	(7) Sch. 7	(8) Sch. 8
Centralized x Born in school's prefecture	-27.80	-17.61	-15.63	-23.08	-28.43	-23.02	-45.86	-13.42
	(0.89)***	(0.14)***	(0.62)***	(0.24)***	(0.19)***	(0.56)***	(0.36)***	(0.86)***
	[7.82]***	[7.70]**	[8.39]*	[7.89]***	[7.68]***	[12.27]*	[12.98]***	[15.03]
Centralized x Born near school's prefecture (1-100 km)	0.30	-3.19	-3.99	-9.32	-11.99	-2.87	-2.00	1.05
	(0.66)	(2.44)	(2.06)*	(3.13)***	(3.21)***	(1.33)**	(0.27)***	(0.98)
	[0.53]	[1.38]**	[1.03]***	[2.64]***	[3.18]***	[1.02]***	[2.57]	[2.65]
Centralized x Born near school's prefecture (100-300 km)	1.06	-0.10	-0.16	-0.21	-3.30	-1.95	-3.03	1.24
	(0.55)*	(0.65)	(0.55)	(0.55)	(0.91)***	(0.84)**	(0.78)***	(1.06)
	[0.61]*	[0.49]	[0.37]	[0.40]	[0.83]***	[0.61]***	[1.26]**	[0.69]*
Observations	1,410	1,410	1,363	1,410	1,363	1,363	1,269	1,034
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean dep var	7.94	5.54	6.21	5.68	6.31	5.20	5.08	5.73
Mean dep var (school's pref dur. Dapp)	103.3	62.00	56.37	59.90	73.40	76.05	93.44	77.00
Mean dep var (within 1-100 km dur. Dapp)	9.150	21.20	17.68	26.88	34.90	8.439	8.333	15.50

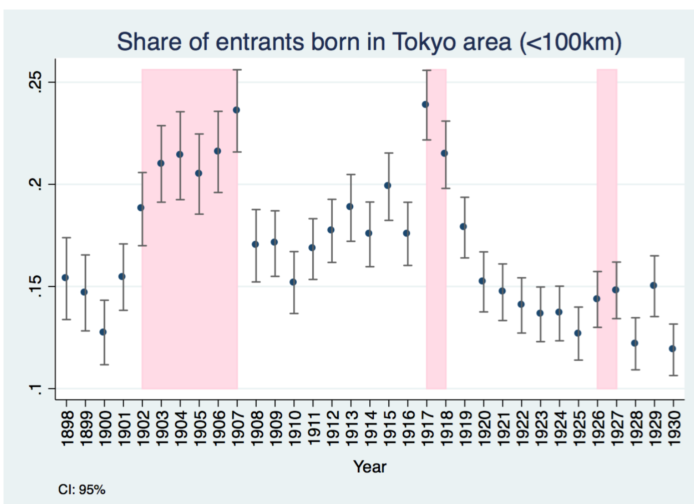
Notes: Using the prefecture-year level data in 1900-1930, we define the dependent variable as the number of entrants who were born in the prefecture and entered the school indicated in the column in each year. "Born in school's prefecture" takes 1 if the school indicated in the column is located in the entrant's birth prefecture. "Born near school's prefecture (1-100 km)" takes 1 if the school indicated in the column is not located in, but within 100 km from the entrant's birth prefecture (measured by the distance between the two prefectural capitals). "Born near school's prefecture (100-300 km)" takes 1 if the school indicated in the column is between 100 km and 300 km from the entrant's birth prefecture. We control for year fixed effects, prefecture fixed effects, the lagged number of public and private middle school graduates in the prefecture, and the number of higher schools other than Schools 1-8 in the prefecture. "Mean dep var" shows the mean of the dependent variable during decentralization for all prefecture-year observations. "Mean dep var (school's pref dur. Dapp)" shows the mean number of entrants to the school during decentralization, restricted to those born in the prefecture where the school is located. "Mean dep var (within 1-100 km dur. Dapp)" shows the mean number of entrants to the school during decentralization, restricted to those born in the prefectures within 100 km (excluding the prefecture where the school is located). For Schools 7 and 8, we drop the years in which they held an early exam (School 7 in 1908-1910 and School 8 in 1908). Standard errors reported in parentheses are clustered at the prefecture level. Standard errors reported in square brackets are clustered at the year level. ***, **, and * mean significance at the 1%, 5%, and 10% levels, respectively. See Section 5.2 for discussions about this figure.

Figure 5: Which Regions Win from Centralization? First Look

(a) Where Did Entrants Increase during Centralization?



(b) Centralization Increased Tokyo Area-born Entrants to Schools 1-8



Notes: Panel (a) estimates and plots the prefecture-specific coefficient β_p in $\#entrants_{pt} = \beta_p Centralized_t + \alpha_p X_{pt} + e_{pt}$, using the 1900-1930 data for each prefecture p, where $\#entrants_{pt}$ is the number of entrants in year t who were born in prefecture p and X_{pt} is the number of schools other than Schools 1-8 in prefecture p in year t. Panel (b) uses the entrant-level data from 1898 to 1930 to show the time evolution of the fraction of entrants to Schools 1-8 who were born in the Tokyo area defined as a set of prefectures that are within 100 km from Tokyo (see Appendix Figure A.3 for a map). Bars show the 95 percent confidence intervals. See Section 5.3 for discussions about this figure.

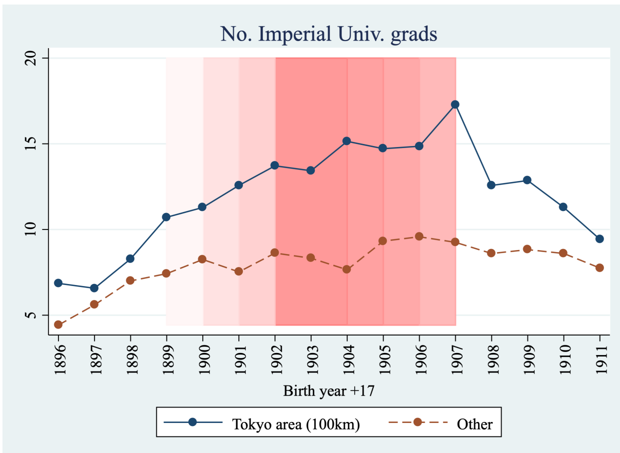
Table 3: Which Regions Win from Centralization?

Dependent variable = No. of entrants to:	(1) All schools	(2) Sch. 1	(3) Sch. 2	(4) Sch. 3	(5) Sch. 4	(6) Sch. 5	(7) Sch. 6	(8) Sch. 7	(9) Sch. 8
Centralized x Born in Tokyo prefecture	9.11		0.34	2.54	7.06	3.41	10.21	6.87	19.87
	(2.68)***		(0.31)	(1.74)	(0.53)***	(0.31)***	(1.69)***	(0.49)***	(1.34)***
	[20.37]		[3.19]	[3.34]	[2.32]***	[1.89]*	[2.09]***	[2.96]**	[3.42]***
Centralized x Born near Tokyo prefecture (1-100 km)	13.14		0.52	0.96	2.05	0.12	0.87	0.46	0.37
	(2.17)***		(0.60)	(0.36)**	(0.45)***	(0.34)	(0.43)**	(0.46)	(0.66)
	[3.79]***		[0.51]	[0.26]***	[0.65]***	[0.38]	[0.30]***	[0.46]	[0.34]
Centralized x Born near Tokyo prefecture (100-300 km)	3.91		0.91	1.67	-0.02	0.60	1.36	1.15	0.13
	(3.75)		(0.46)*	(0.78)**	(0.89)	(0.34)*	(0.59)**	(0.48)**	(0.52)
	[2.16]*		[0.37]**	[0.44]***	[0.89]	[0.38]	[0.35]***	[0.36]***	[0.70]
Centralized x Born in school's prefecture		-27.80	-17.41	-15.14	-22.81	-28.16	-22.08	-47.82	-13.42
		(0.89)***	(0.17)***	(0.58)***	(0.90)***	(0.21)***	(0.36)***	(0.40)***	(1.13)***
		[7.82]***	[7.66]**	[8.38]*	[8.43]**	[7.60]***	[12.18]*	[13.02]***	[14.57]
Centralized x Born near school's prefecture (1-100 km)		0.30	-3.91	-3.76	-9.07	-11.70	-1.91	-1.69	1.03
		(0.66)	(2.48)	(1.96)*	(3.15)***	(3.21)***	(1.30)	(0.27)***	(1.01)
		[0.53]	[1.44]**	[1.02]***	[2.81]***	[3.17]***	[0.88]**	[2.52]	[2.47]
Centralized x Born near school's prefecture (100-300 km)		1.06	-0.34	-0.37	-0.69	-3.02	-1.17	-2.50	0.26
		(0.55)*	(0.75)	(0.51)	(0.43)	(0.92)***	(0.68)*	(0.82)***	(0.37)
		[0.61]*	[0.51]	[0.35]	[0.49]	[0.76]***	[0.52]**	[1.18]**	[0.63]
Observations	1,410	1,410	1,410	1,363	1,410	1,363	1,363	1,222	1,034
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pref FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean dep var	45.26	7.94	5.54	6.21	5.68	6.31	5.20	5.02	5.73
Mean dep var (Tokyo pref dur. Dapp)	199.9	103.3	27.15	11.00	14.40	6.100	9.474	12.00	20.39
Mean dep var (within 1-100 km from Tokyo pref. dur. Dapp)	26.38	9.150	6.733	1.246	2.867	0.767	1.254	1.618	3.250

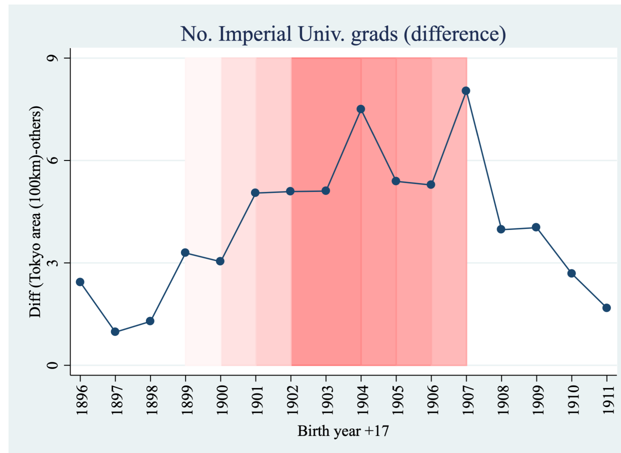
Notes: This table uses the prefecture-year level data in 1900-1930. In column (1), the dependent variable is the number of students from birth prefecture p who entered one of Schools 1-8 in year t. In columns (2)–(10), the dependent variable is the number of students from birth prefecture p who entered the school indicated in the column in year t. For Schools 7 and 8, we drop the years in which they held an early exam (School 7 in 1908-1910 and School 8 in 1908). We control for prefecture fixed effects, year fixed effects, the lagged number of public and private middle school graduates in the prefecture and the number of higher schools other than Schools 1-8 in the prefecture. "Born in Tokyo prefecture" takes 1 if in the entrant's birth prefecture is Tokyo prefecture. "Born near Tokyo prefecture (1-100 km)" takes 1 if the entrant's birth prefecture is different from Tokyo prefecture, but within 100 km from it. "Born near Tokyo prefecture (100-300 km)" takes 1 if the entrant's birth prefecture is between 100 km and 300 km from Tokyo prefecture. Refer to the notes for Table 2 for the definitions of "Born in school's prefecture," "Born near school's prefecture (1-100 km)", and "Born near school's prefecture (100-300 km)." "Mean dep var" shows the mean of the dependent variable during decentralization for all prefecture-year observations. "Mean dep var (Tokyo pref dur. Dapp)" shows the mean number of entrants to the school during decentralization, restricted to those born in Tokyo prefecture. "Mean dep var (within 1-100 km from Tokyo pref. dur. Dapp)" shows the mean number of entrants to the school during decentralization, restricted to those born in the prefectures within 100 km from Tokyo prefecture (excluding Tokyo prefecture). Standard errors reported in parentheses are clustered at the prefecture level. Standard errors reported in square brackets are clustered at the year level. ***, **, and * mean significance at the 1%, 5%, and 10% levels, respectively. See Section 5.3 for discussions about this figure.

Figure 6: Long-run Impacts of Centralization on the Origins of Career Elites

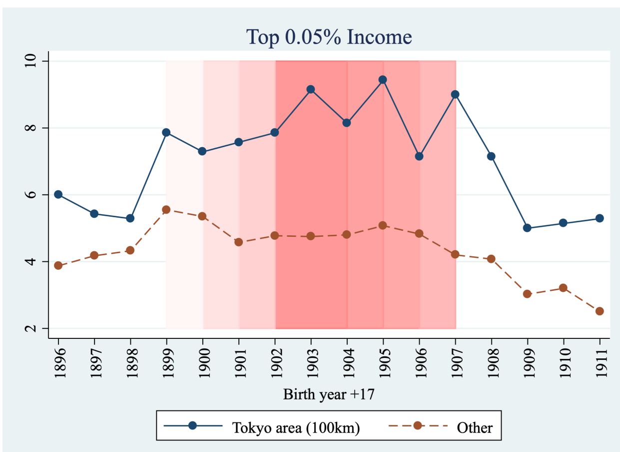
(a)



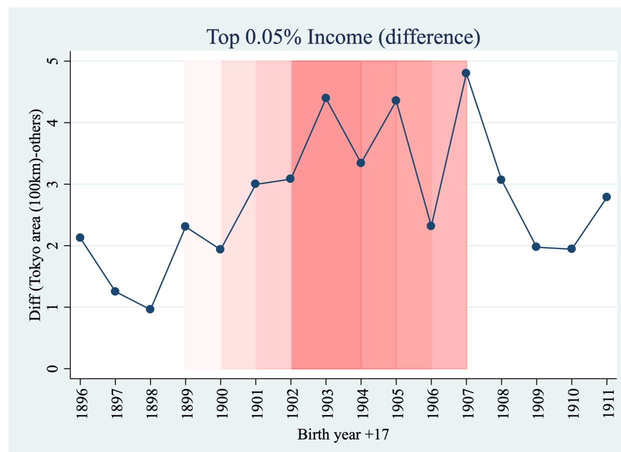
(b)



(c)



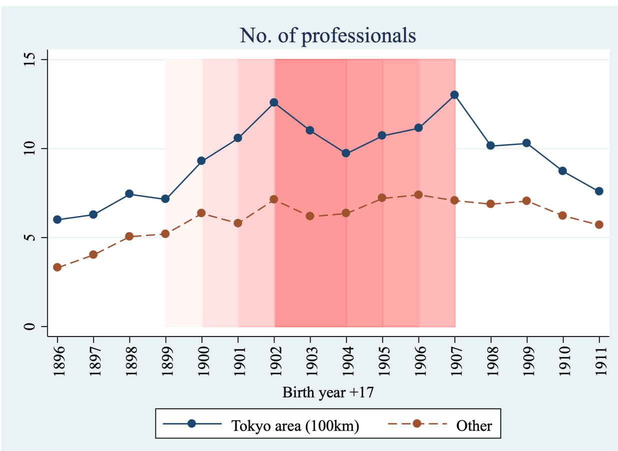
(d)



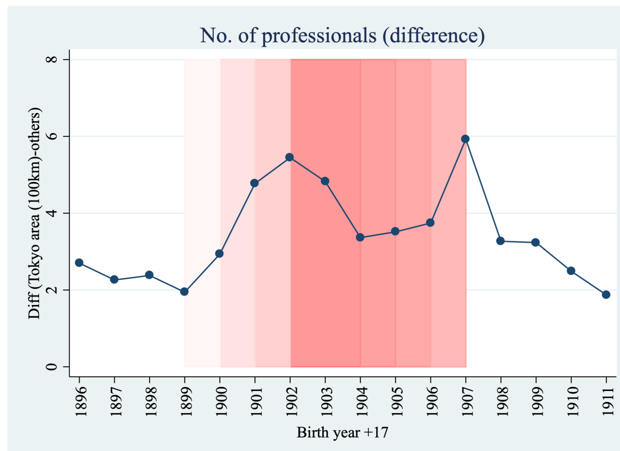
Notes: This figure shows difference-in-differences plots that compare the average number of elites born in prefectures inside and outside the Tokyo area by cohorts. The plots are based on the prefecture-cohort level data from the JPIR in 1939, counting the number of elites born in the prefecture by birth cohorts between 1879-1894. In (a) and (b), "Imperial Univ. grads" are defined as individuals in the JPIR who graduated from an Imperial University. In (c) and (d), "Top 0.05% income earners" are defined as individuals in the JPIR with more than 2385 yen of income tax payment, which corresponds to the top 0.05% of the national income distribution of that time (Moriguchi and Saez, 2008). In (e) and (f), "Professionals" is defined as individuals in the JPIR whose occupation is either lawyer, physician, engineer, or scholar. In (g) and (h), "Medal recipients" is defined as individuals in the JPIR who received the medal of the Fifth Order of Merit or above, or the court rank of the Junior Fifth Rank or above, excluding military personnels. The vertical axis shows the number of individuals in each of the above categories of elites who were born in the indicated area in the indicated birth cohort. The cohorts are colored according to their intensity of exposure to the first period of centralized admissions (Capp) in 1902–1907, where the darker color indicates the higher intensity of exposure. The intensity gradually increases from the cohort who turned age 17 in 1899 as some unsuccessful applicants might have retaken the exam in 1902 under Capp. The intensity reaches the highest level for the cohorts who turned age 17 during 1902–1904 and declines from the cohort who turned age 17 in 1904 as some might have retaken the exam in 1908 under Dapp. The intensity drops to zero for the cohort who turned age 17 in 1908 as they had no opportunity to take the exam under Capp. See Section 6 for discussions about this figure.

Figure 6: Long-run Impacts of Centralization on the Origins of Career Elites (Continued)

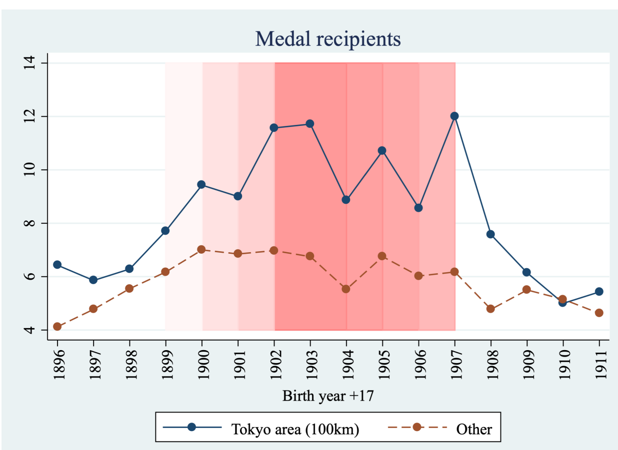
(e)



(f)



(g)



(h)

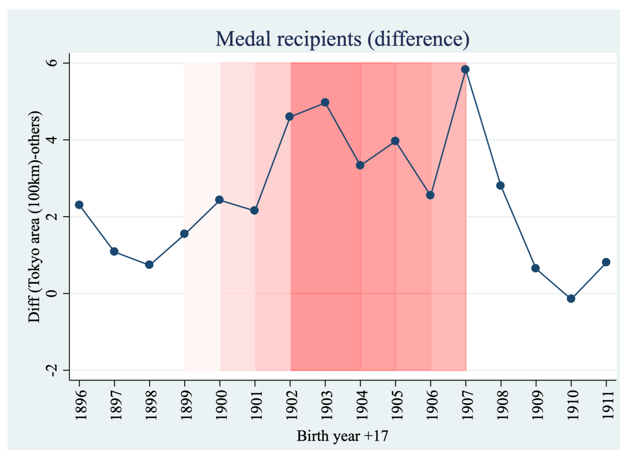


Table 4: Long-run Impacts of Centralization: Difference-in-Differences Estimates

VARIABLES	(1) Imperial Univ. grads	(2) Top 0.01% income earners	(3) Top 0.05% income earners	(4) Managers	(5) Professionals	(6) Imperial Univ. professors	(7) Medal recipients
			A. Baseline Specification				
Age 17 during Centralization	3.18**	0.62**	1.58*	3.38*	1.67**	0.44**	2.87***
× Tokyo area (<100 km)	(1.39)	(0.24)	(0.80)	(1.92)	(0.79)	(0.18)	(1.06)
			B. Adding Control Variables				
Age 17 during Centralization	2.05***	0.55**	1.43**	2.64**	0.97*	0.44**	2.40***
× Tokyo area (<100 km)	(0.55)	(0.23)	(0.65)	(1.30)	(0.54)	(0.20)	(0.72)
			C. Bidirectional Specification				
Age≤17 in 1902	3.34	0.81**	1.83***	4.26	1.61	0.36*	2.63**
× Tokyo area (<100 km)	(2.22)	(0.37)	(0.61)	(2.64)	(1.34)	(0.20)	(1.03)
Age≤17 in 1908	-2.97***	-0.38**	-1.28	-2.28**	-1.75**	-0.54**	-3.18***
× Tokyo area (<100 km)	(0.70)	(0.17)	(1.10)	(1.10)	(0.69)	(0.21)	(1.17)
			D. Adding Control Variables to Bidirectional Specification				
Age≤17 in 1902	1.65*	0.73*	1.66***	3.24*	0.52	0.34	1.89***
× Tokyo area (<100 km)	(0.91)	(0.39)	(0.55)	(1.84)	(0.60)	(0.21)	(0.55)
Age≤17 in 1908	-2.50***	-0.34**	-1.17	-1.98**	-1.48*	-0.54**	-2.96***
× Tokyo area (<100 km)	(0.75)	(0.15)	(0.96)	(0.85)	(0.83)	(0.22)	(0.98)
Observations	705	705	705	705	705	705	705
Birth cohort FE	YES	YES	YES	YES	YES	YES	YES
Birth prefecture FE	YES	YES	YES	YES	YES	YES	YES
Mean dep var	8.77	1.24	4.76	9.92	6.76	0.81	6.28
Mean dep var (Tokyo area during Dapp)	10.62	1.512	6.22	13.59	8.60	1	6.94

Notes: This table shows difference-in-differences estimates of the long-run effects of the centralized admission system on the geographical origins of career elites. The estimates are based on the prefecture-cohort level data from the JPIR in 1939, counting the number of elites born in the prefecture by birth cohorts between 1880-1894. All outcome variables below are measured at the level of birth prefecture and birth cohort. In (2) and (3), "Top 0.01% income earners" (or "Top 0.05% income earners") is defined as the number of individuals in the JPIR with above 2,385 yen (or above 9,967 yen) of income tax payment, which corresponds to the top 0.01% (or top 0.05%) of the national income distribution of that time (Moriguchi and Saez, 2008). In (4), "Managers" is defined as the number of individuals in the JPIR who are employed in a private sector and pays any positive amount of income or corporate tax. In (6), "Imperial Univ. professors" is defined as the number of individuals in the JPIR who are professors or associate professors at one of the Imperial Universities. Other outcomes are defined in the same way as in Figure 6. "Age 17 during Centralization" is the indicator variable that takes 1 if the cohort became age 17 (main application age) during Capp in 1902-1907. "Age≤17 in 1902" (or "Age≤17 in 1908") is the indicator variable that takes 1 if the cohort turned 17 years old in 1902 (or 1908) or later. "Mean dep var" shows the mean of the dependent variable for all prefecture-cohort observations. "Mean dep var (Tokyo area during Dapp)" shows the mean of the dependent variable in the Tokyo area during decentralization. In panels B and D, we control for time- and cohort-varying prefecture characteristics, i.e., the number of primary schools in the prefecture in the year when the cohort turned eligible age, the number of middle school graduates in the prefecture in the year when the cohort turned age 17, log of manufacturing GDP of the prefecture when the cohort turned age 20, and birth population of the cohort in the prefecture. Standard errors are clustered at the prefecture level. See Section 6 for discussions about this table.

Table 5: Long–run Impacts of Centralization: Pathways and Placebo Tests

VARIABLES	(1) Pathway: Fraction moved in the long-run	(2) Pathway: Distance moved in the long-run	(3) Pathway: Imperial Univ. grads. divided by school entrants	(4) Placebo: Landlords	(5) Placebo: Population
			A. Baseline Specification		
Age 17 during Centralization	-0.013	-4.810	-0.02	0.165	0.624
× Tokyo area (<100 km)	(0.016)	(6.622)	(0.02)	(0.289)	(0.435)
			B. Adding Control Variables		
Age 17 during centralization	-0.015	-7.576	-0.013	0.219	
× Tokyo area (<100 km)	(0.018)	(9.409)	(0.020)	(0.333)	
Observations	705	705	705	705	657
Birth cohort FE	YES	YES	YES	YES	YES
Birth prefecture FE	YES	YES	YES	YES	YES
Mean dep var	0.233	89.73	0.26	1.179	11.55
Mean dep var (Tokyo area during Dapp)	0.241	24.07	0.22	3.286	12.69

Notes: This table shows difference-in-differences estimates to explore pathways of the long-run effects and to provide placebo tests. The estimates are based on the prefecture-cohort level data from the JPIR in 1939, counting the number of elites born in the prefecture by birth cohorts between 1880-1894. All outcome variables below are measured at the level of birth prefecture and birth cohort. In (1), "Fraction moved" is defined as the fraction of individuals in the JPIR whose prefecture of residence is different from his birth prefecture. In (2), "Distance moved" is defined as the average distance between the birth prefecture and the prefecture of residence of individuals in the JPIR. In (3), "Imperial University graduates divided by School Entrants" is defined by the number of Imperial University graduates in the JPIR divided by the total number of entrants to Schools 1-8 in the year when the cohort became age 17. This variable is a measure of the quality of Schools 1-8 entrants. In (4), "Landlords" is defined as the number of individuals in the JPIR whose occupational titles include landlord, but excluding managers and professionals. In (5), "Population" is the cohort's birth population in a given prefecture. "Age 17 during Centralization" is the indicator variable that takes 1 if the cohort became age 17 during Capp in 1902-1907. "Mean dep var" shows the mean of the dependent variable for all prefecture-cohort observations. "Mean dep var (Tokyo area during Dapp)" shows the mean of the dependent variable in the Tokyo area during decentralization. In panel B, we control for time- and cohort-varying prefecture characteristics, i.e., the number of primary schools in the prefecture in the year when the cohort turned eligible age, the number of middle school graduates in the prefecture in the year when the cohort turned age 17, log of manufacturing GDP of the prefecture when the cohort turned age 20, and birth population of the cohort in the prefecture. Standard errors are clustered at the prefecture level. ***, **, and * mean significance at the 1%, 5%, and 10% levels, respectively. See Section 6 for discussions about this figure.

Table 6: Long-run Impacts of Centralization on the Destinations of Career Elites

VARIABLES	(1) Imperial Univ. grads	(2) Top 0.01% income earners	(3) Top 0.05% income earners	(4) Managers	(5) Professionals	(6) Imperial Univ. professors	(7) Medal recipients
				A. Baseline Specification			
Age 17 during centralization	4.20*	0.46	1.84	6.79	2.55*	0.73	3.13*
× Tokyo area (<100 km)	(2.18)	(0.31)	(1.70)	(4.93)	(1.37)	(0.44)	(1.60)
				B. Adding Control Variables			
Age 17 during centralization	2.38***	0.62	1.67	4.70	1.41**	0.56**	2.26***
× Tokyo area (<100 km)	(0.73)	(0.45)	(1.41)	(2.84)	(0.57)	(0.24)	(0.80)
Observations	705	705	705	705	705	705	705
Birth cohort FE	YES	YES	YES	YES	YES	YES	YES
Residing prefecture FE	YES	YES	YES	YES	YES	YES	YES
Mean dep var	8.30	1.22	4.65	12.75	6.43	0.77	5.94
Mean dep var (Tokyo area during Dapp)	14.73	2.46	8.95	25.60	10.70	1.29	9.79

Notes: This table shows difference-in-differences estimates of the long-run effects of the centralized admission system on the geographical destinations of career elites. The estimates are based on the prefecture-cohort level data of from the JPIR in 1939, counting the number of elites who resided in the prefecture in 1939 by birth cohorts between 1880-1894. All outcome variables are measured at the level of residing prefecture and birth cohort. Refer to the notes for Table 4 for the definitions of outcome variables in columns (1)–(7). "Age 17 during Centralization" is the indicator variable that takes 1 if the cohort turned age 17 (main application age) during Capp in 1902-1907. "Mean dep var" shows the mean of the dependent variable for all prefecture-cohort observations. "Mean dep var (Tokyo area during Dapp)" shows the mean of the dependent variable in the Tokyo area during decentralization. In panel B, we control for time- and cohort-varying prefecture characteristics, i.e., the number of primary schools in the prefecture in the year when the cohort turned eligible age, the number of middle school graduates in the prefecture in the year when the cohort turned age 17, log of manufacturing GDP of the prefecture when the cohort turned age 20, and birth population of the cohort in the prefecture. Standard errors are clustered at the prefecture level. See Section 6 for discussions about this table.

A Appendix

A.1 Verifying the Centralized Assignment Algorithm

To see whether actual school assignments are consistent with the above algorithm, Appendix Table A.1 presents the number of admitted applicants (to the Department of Law and Literature in each school) and their exam scores by their school preference order. Observe that, in the prestigious Schools 1 (Tokyo) and 3 (Kyoto), all seats were filled with applicants who ranked these schools first. Both the maximum and minimum exam scores of School 1 entrants were the highest among all schools, indicating that School 1 was the most selective, followed by School 3, School 4, and School 2, in that order. By contrast, Schools 5 and 7 admitted a sizable number of students who ranked the school third or lower, because they did not have a sufficient number of high-scoring applicants who placed these schools at the top of their preferences. Students who were admitted to the school of their third choice or below are not necessarily low ability students. For example, the highest-score entrant to School 7 (with the score of 450) was the applicant admitted to his third choice after failing to enter Schools 1 and 3 by a narrow margin.

A.2 Additional Theoretical Results

Let μ^I be the mechanism that selects a matching based on the following Student-Proposing Deferred Acceptance or Serial Dictatorship algorithm.

- Step 1. Each student i proposes to her most-preferred school. Each school s holds top q_s students and rejects the rest. If less than q_s students proposed, then it holds all the students that proposed to s.

- Step k. Any student who was rejected at step $k-1$ makes a new proposal to his most-preferred school that has not yet rejected him. If no acceptable choices remain, she makes no proposal. Each school holds its most-preferred q_s students to date and rejects the rest. If less than q_s students proposed, then it holds all the students who proposed to s.

- The algorithm terminates when there are no more rejections. Each student is assigned to the school that holds her in the last step.

Motivated by the fact that Schools 1-8 are prestigious public schools with no significant competitors, we assume that every student prefers Schools 1-8 over the outside option.

Assumption 1. $s \succ_i o$ for all $i \in I$ and $s \in S$.

Under this assumption, μ^I and Capp are partially equivalent in the following sense.

Proposition 4. *For any school choice problem with Assumption 1,* $\cup_{s\in S}\mu_s^C(\succ) = \cup_{s\in S}\mu_s^I(\succ')$ *for all* $\succ, \succ' \in P$.

This result says that the same students are assigned to schools under Capp and DA, which is the most meritocratic mechanism we can design. This result holds regardless of applicant behavior.

A.3 Proofs

Proof of Proposition 1. As mentioned in step 1 of Capp, school seats are assigned to applicants $i_1, \ldots, i_k$ under μ^C, i.e., $\cup_{s\in S}\mu_s^C(\succ) = \{i_1, \ldots, i_k\}$ and $\cup_{j\in\{1,\ldots,k\}}\{t_{\mu^C(\succ)}(j)\} = \{t_{i_1}, \ldots, t_{i_k}\}$. Let $\cup_{s\in S}\mu_s(\succ') = \{i_{j_1}, \ldots, i_{j_l}\}$ with $l \leq k$, $j_1 < \ldots < j_l$ and $\{j_1, \ldots, j_l\} \subseteq \{1, \ldots, n\}$. This gives $\cup_{j\in\{1,\ldots,k\}}\{t_{\mu(\succ')}(j)\} = \{t_{i_{j_1}}, \ldots, t_{i_{j_l}}, \cup_{i=1}^{k-l}\{0\}\}$. Since $t_{i_1} \geq t_{i_{j_1}}$,..., $t_{i_l} \geq t_{i_{j_l}}$, we have that $\left|\{j \in \{1, \ldots, k\} \mid t_{\mu^C(\succ)}(j) \leq t\}\right| \leq \left|\{j \in \{1, \ldots, k\} \mid t_{\mu(\succ')}(j) \leq t\}\right|$ so that

$$F_{\mu^C(\succ)}(t) = \frac{\left|\{j \in \{1, \ldots, k\} \mid t_{\mu^C(\succ)}(j) \leq t\}\right|}{k} \leq \frac{\left|\{j \in \{1, \ldots, k\} \mid t_{\mu(\succ')}(j) \leq t\}\right|}{k} = F_{\mu(\succ')}(t).$$

Therefore, we have that $F_{\mu^C(\succ)}(t) \leq F_{\mu(\succ')}(t)$ for all $t \in \mathbb{R}_+$ and $\succ, \succ' \in P$. $\square$

Proof of Proposition 2. The proposition follows from a lemma below.

Lemma 1. *(a) Under Capp, submitting the true preference is a dominant strategy.*

(b) Under Dapp, there is no dominant strategy.

Proof of Lemma 1. Suppose, without loss of generality, for applicant i $s_1 \succ_i^o s_2 \succ_i^o i$ where i denotes remaining unassigned.

Part (a). Under Capp, applicant i has four strategies available: reporting s_1 as first choice and s_2 as second, denoted a_i $(=\succ_i^o)$; reporting s_2 as first choice and s_2 as second choice, denoted a_i'; and reporting a single school as top choice, either s_1 or s_2. Fix any $a_{-i} \in A_{-i}$. We have to show that reporting a_i is a dominant strategy for applicant i.

Notice that reporting a single school as top choice is not a dominant strategy since it is dominated by reporting that school as first choice and the other school as second because

$$\sum_{k=1}^{2} p_{ik}(a_i, a_{-i}) > \sum_{k=1}^{2} p_{ik}(s_1, a_{-i}) \quad \text{and} \quad \sum_{k=1}^{2} p_{ik}(a_i', a_{-i}) > \sum_{k=1}^{2} p_{ik}(s_2, a_{-i})$$

Now we show that a_i dominates a'_i. First, only top k students are assigned a school, that implies if a student is unassigned under $\mu^C(a_i, a_{-i})$, he would be unassigned under $\mu^C(a'_i, a_{-i})$ as well i.e. $p_{i3}(a_i, a_{-i}) = p_{i3}(a'_i, a_{-i})$. Therefore,

$$\sum_{k=1}^{2} p_{ik}(a_i, a_{-i}) = \sum_{k=1}^{2} p_{ik}(a'_i, a_{-i})$$

.

Second, if the student gets s_2 by reporting s_1 as first choice, it is clear that he cannot get s_1 by reporting s_2 as first choice because in that case he would be assigned s_2 in the second step of Capp. Therefore,

$$p_{i1}(a_i, a_{-i}) \geq p_{i1}(a'_i, a_{-i})$$

.

Therefore we have that a_i is a dominant strategy.

Part (b). Under Dapp, applicant i has two strategies available: applying to s_1, denoted a_i, and applying to s_2, denoted a'_i. Fix any any $a_{-i} \in A_{-i}$. Notice that $p_{i2}(a_i, a_{-i}) = p_{i1}(a'_i, a_{-i}) = 0$.

a_i is not a dominant strategy since in the case a_{-i} is such that all students apply to s_1, (note that applicant i is one of the top q_1 students with a positive probability) we have that,

$$\sum_{k=1}^{2} p_{ik}(a_i, a_{-i}) = p_{i1}(a_i, a_{-i}) < 1 = p_{i2}(a'_i, a_{-i}) = \sum_{k=1}^{2} p_{ik}(a'_i, a_{-i})$$

.

a'_i is not a dominant strategy either since in the case a_{-i} is such that all students apply to s_2, $p_{i1}(a_i, a_{-i}) = 1$ and therefore, $a_i \, sd(\succ_i^o) \, a'_i$. □

Proof of Proposition 3.

Lemma 2. *Under assumption A1, for sufficiently large V, all applicants apply to their local schools in any symmetric equilibrium under Dapp.*

Proof of Lemma 2. First, we show that for sufficiently large V, none of the following symmetric equilibrium survive: (i) all applicants apply to s_1, (ii) all applicants apply to s_2, and (iii) applicants from s_1's area apply to s_2 while those from s_2's area apply to s_1.

Case (i). Applicants from school 2's area apply to s_1 if $p(n_1 + n_2, q_1) * U_1 \geq U_2 + V$. For $V > (p(n_1 + n_2, q_1) * U_1) - U_2$, therefore, all applicants applying to s_1 cannot be a symmetric equilibrium.

Case (ii). All applicants applying to s_2 cannot be an equilibrium since this requires $U_{i1} < p(n_1 + n_2, q_2) * U_{i2}$, but we assume that $U_{i1} \geq U_{i2}$.
Case (iii). Suppose applicants from s_1's area apply to s_2 while those from s_2's area apply to s_1. It must be that the case that, for applicants from s_1's area: $p(n_1, q_2) * U_2 \geq p(n_2 + 1, q_1) * (U_1 + V)$. While for applicants from s_2's area: $p(n_2, q_1) * U_1 \geq p(n_1 + 1, q_2) * (U_2 + V)$. For sufficiently large V, this cannot be a symmetric equilibrium.

Now we show that, for large enough V, all students applying to their local schools is indeed a symmetric equilibrium. For applicants from school 1's area to apply to s_1, it must be the case that $p(n_1, q_1) * (U_1 + V) \geq p(n_2 + 1, q_2) * U_2$. For applicants from school 2's area to apply to s_2, $p(n_2, q_2) * (U_2 + V) \geq p(n_1 + 1, q_1) * U_1$ must hold. Since the left hand sides of both the inequalities are increasing in V, the equilibrium conditions hold for sufficiently large V. □

From Lemma 2, under assumptions A1 and A2, we know that under Dapp applicants apply to their locals schools. Therefore, the expected proportion of assigned applicants assigned to their local school under Dapp is 1 (the highest).

Proof of Proposition 4. As mentioned in step 1 of Capp, school seats are assigned to applicants $i_1, \dots, i_k$ under μ^C, i.e., $\cup_{s \in S} \mu^C_s(\succ) = \{i_1, \dots, i_k\}$ for all $\succ \in P$. Under assumption 1, any student $i_{k'}$ with $k' > k$ will be rejected at some step of the Student-Proposing Deferred Acceptance Algorithm. Assumption 1 therefore implies that the top k students are assigned to some school under μ^I, i.e., $\cup_{s \in S} \mu^I_s(\succ') = \{i_1, \dots, i_k\}$ for all $\succ' \in P$. Therefore, $\cup_{s \in S} \mu^C_s(\succ) = \cup_{s \in S} \mu^I_s(\succ') = k$ for all $\succ, \succ' \in P$. □

A.4 Additional Tables and Figures

Table A.1: Admission Outcomes of the Centralized Assignment Algorithm

Exam Scores of Entrants in 1917 Under Centralized Admission System

School Name	School 1	School 2	School 3	School 4	School 5	School 6	School 7	School 8
Location	Tokyo	Sendai	Kyoto	Kanazawa	Kumamoto	Okayama	Kagoshima	Nagoya
Total no. of entrants	77	29	38	22	68	36	37	64
Entrants Admitted to their 1st Choice								
No. of entrants	77	14	38	18	23	18	6	18
Max exam score	548	462	521	496	471	456	415	455
Min exam score	451	374	404	364	363	364	364	363
Entrants Admitted to their 2nd Choice								
No. of entrants		15		4	30	18	8	46
Max exam score		450		450	438	433	449	450
Min exam score		442		421	362	369	372	363
Entrants Admitted to their 3rd Choice								
No. of entrants					15		3	
Max exam score					450		450	
Min exam score					393		407	
Entrants Admitted to their 4th Choice								
No. of entrants							9	
Max exam score							400	
Min exam score							366	
Entrants Admitted to their 5th Choice								
No. of entrants							11	
Max exam score							444	
Min exam score							369	

Notes: This figure shows admission outcomes for the Department of Law and Literature in Schools 1-8 in 1917 under the centralized assignment algorithm. See Section A.1 for discussions about this figure.

Figure A.1: Centralized Assignment Rule

第六條　入學ヲ許可スヘキ者ハ左ノ方法ニ依リ之ヲ定ム
一、高等學校ヲ通シ各部毎ニ其ノ部ニ入學セシムヘキ人員ノ總數ト同數ノ人
員ヲ試驗ノ成績順ニ依リ選出ス
二、前號ノ場合ニ於テ試驗成績相同シキトキハ抽籤ニ依ル
三、前號ニ依リ選出セル人員ニ就キ試驗ノ成績順ニ依リ第一部又ハ第二部ノ
志望者ニ在リテハ本人ノ指定スル第一ノ志望類ニ基キ第一ノ志望學校ニ
第三部ノ志望者ニ在リテハ本人ノ指定スル第一ノ志望學校ニ配當ス
四、前號ノ場合ニ於テ試驗成績相同シキトキハ抽籤ニ依ル
五、第三號及第四號ニ依リ配當ノ結果本人ノ指定スル第一ノ志望學校已ニ滿
員トナリタル場合ニ於テハ更ニ成績順ニ依リ本人ノ指定スル第二ノ志望
學校ニ配當ス
六、前號ノ場合ニ於テ試驗ノ成績相同シトキハ抽籤ニ依ル
七、第五號及第六號ニ依リ配當ノ結果本人ノ指定スル第二ノ志望學校已ニ
滿員トナリタル場合ニ於テハ更ニ其ノ第三以下ノ志望學校ニ就キ第五號
及第六號ニ準シ配當ス
八、第一部又ハ第二部ノ志望者ニ在リテハ本人ノ指定スル第一ノ志望類カ
志望學校ニ於テ悉ク滿員トナリタルトキハ更ニ本人ノ指定スル第二以下
ノ志望順中缺員アルモノニ之ヲ配當ス其ノ方法ハ第三號乃至第七號ニ準
ス
九、本人ノ志望スル類及學校悉ク滿員トナリタルトキハ入學スルコトヲ得
サルモノトス
前項ニ依リ配當ノ結果又ハ事故ノ爲メ入學者ニ缺員ヲ生シタルトキハ入學
スルコトヲ得サリシ者ニ就キ更ニ前項ノ方法ニ依リ之ヲ補塡ス

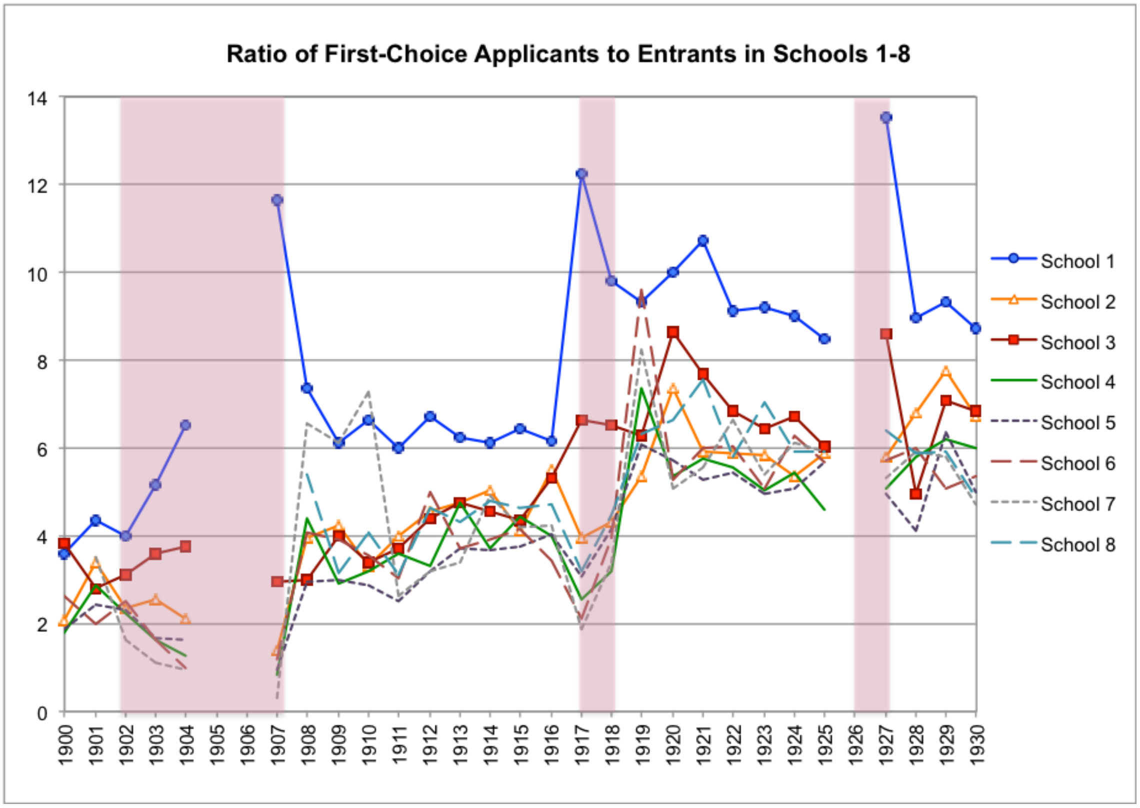
Notes: This figure is a reprint of the assignment algorithm of the centralized admission system stated in the Ordinance of the Ministry of Education No. 4 published in *Government Gazette* No. 1419, pp.580-581, on April 27, 1917. See Section 2 for an English translation and discussions.

Table A.2: Summary Statistics

Variable	Mean	Std. Dev.	Median	N
Year level data on short-run outcomes				
Total number of applicants to Schools 1–8	10613	4221	9997	28
Share of applicants choosing School 1 as first choice	0.314	0.097	0.274	28
Total number of entrants to Schools 1–8	1821	227	1919	31
Applicant level data on short-run outcomes				
Distance between middle school prefecture and the school applied as first choice (km)	224.88	272.03	117	20913
Applying to School 1 as first choice	0.33	0.47	0	20913
Entrant level data on short-run outcomes				
Distance between birth prefecture and the school entered (km)	226.8	258.65	139	66193
Entering the nearest school from birth prefecture	0.49	0.5	0	66193
Born in Tokyo prefecture	0.09	0.29	0	66193
Born in Tokyo area (7 prefectures within 100 km from Tokyo)	0.17	0.38	0	66193
Prefecture-year level data on short-run outcomes				
No. of entrants to Schools 1-8	45.06	37.45	34	1469
No. of entrants to School 1	7.88	14.11	5	1469
No. of entrants to School 2	5.5	10.4	2	1469
No. of entrants to School 3	6.19	10.34	3	1421
No. of entrants to School 4	5.64	9.91	3	1469
No. of entrants to School 5	6.27	14.2	1	1422
No. of entrants to School 6	5.19	11.8	2	1421
No. of entrants to School 7	5.03	12.99	2	1328
No. of entrants to School 8	5.67	12.45	2	1093
No. of public middle school graduates	415.38	350.01	299	1410
No. of private middle school graduates	118.49	435.12	0	1410
No. of national higher schools other than Schools 1-8	0.13	0.43	0	1469
Prefecture-cohort level data on long-run outcomes				
No. of all Imperial University graduates	8.77	7.81	7	705
No. of people earning top 0.01% level of income	1.24	2.06	1	705
No. of people earning top 0.05% level of income	4.76	6.97	3	705
No. of managers in private sector paying a positive amount of tax	13.25	16.34	7	705
No. of scholars, physicians, lawyers, and engineers	6.76	6.11	5	705
No. of Imperial University professors	0.81	1.18	0	705
No. of civilians receiving medal of Order of Fifth Class and above	6.28	5.03	5	705

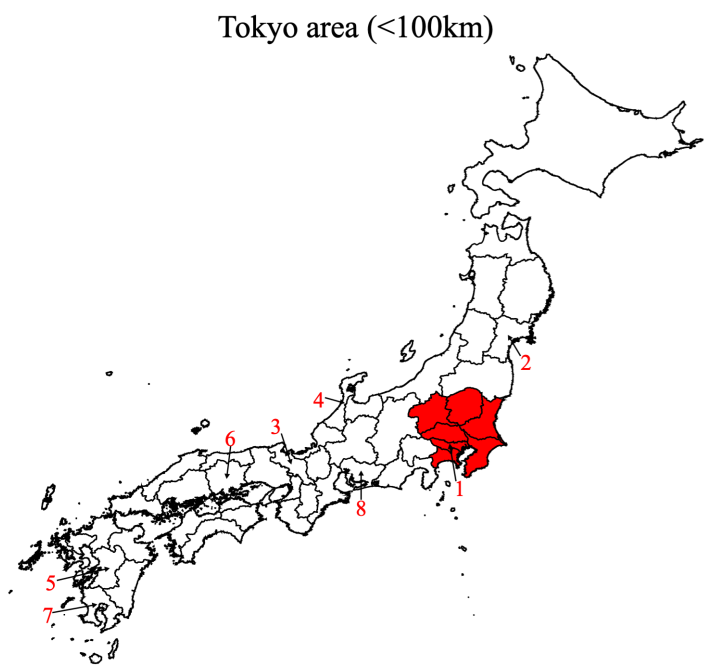
Notes: This table provides summary statistics of variables used in the empirical analysis. The sample period for year level data is from 1900 to 1930. The sample period for applicant level data is during 1916 and 1917. The sample period for entrant level data and prefecture level data for short-run outcomes is from 1900 to 1930. The information on the school "entrants" is based on the first year students in the schools. The long-run outcome variables are based on the prefecture-cohort level data from the JPIR in 1939, counting the number of elites born in the prefecture by birth cohorts between 1880-1894. See Sections 4 and 6 for discussions about this table.

Figure A.2: Changes in the Competitiveness of Schools 1-8



Notes: This figure shows the changes in the competitiveness of each school (measured by the ratio of the number of applicants who rank the school first to the number of entrants to the school) from 1900 to 1930. No data are available for 1905, 1906, and 1926. Colored years (1902-07, 1917-18, 1926-27) indicate the periods of the centralized system, while other years were under the decentralized system. School 7 in 1901, 1908, 1909, and 1910, and School 8 in 1908 held their exams on different dates from other schools due to special circumstances, attracting a high number of applicants in these years. See Section 5.1 for discussions about this figure.

Figure A.3: Definition of the Tokyo Area



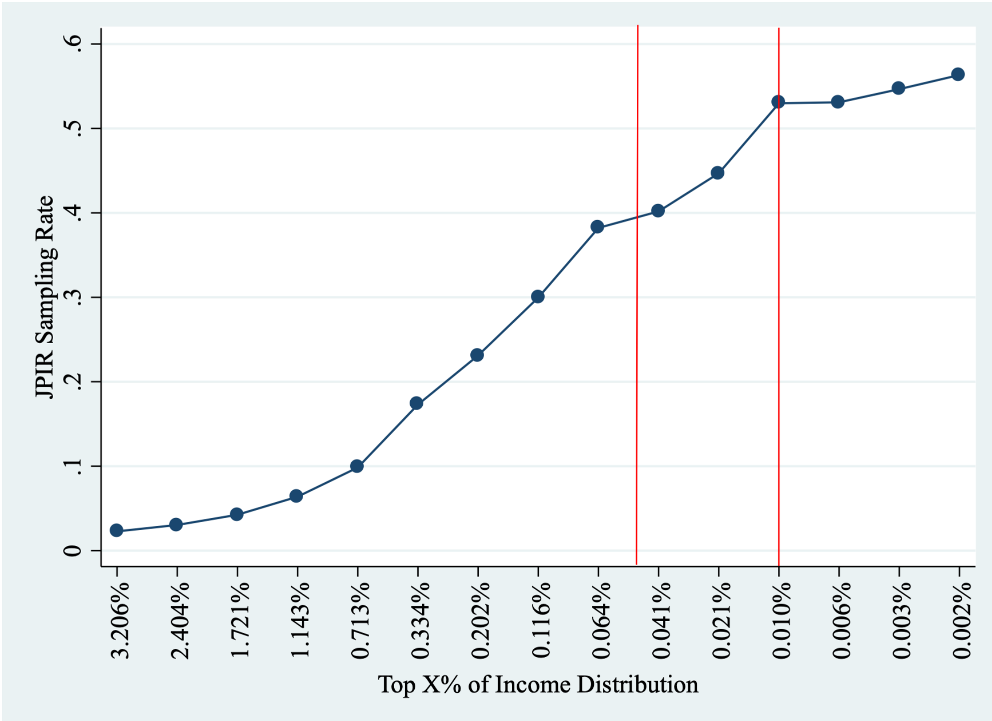
Notes: This figure shows the Tokyo area (in the red color) defined as prefectures that are within 100 km from Tokyo (Tokyo, Chiba, Kanagawa, Saitama, Ibaraki, Tochigi, and Gunma). See Section 5.2 for discussions about this figure.

Table A.3: Testing Exogeneity of Centralization

VARIABLES	(1) No. middle school graduates	(2) No. entrants to Schools 1–7	(3) Share of entrants to School 1	(4) No. applicants to Schools 1–7	(5) Ratio of entrants to applicants	(6) Mean age of entrants	(7) Share of applicants to School 1	(8) Enrollment distance	(9) Share of entrants born in Tokyo area
Centralization	1.351	20.55	-0.00131	-0.189	0.0188	0.116	0.181***	49.36***	0.0371***
	(1.347)	(21.54)	(0.00365)	(0.552)	(0.0132)	(0.0984)	(0.0491)	(11.70)	(0.0100)
No. of middle school graduates		-1.248	-0.000618	-0.134**	0.00179*	0.0549***	-0.00306	1.990***	0.00167**
		(2.705)	(0.000565)	(0.0550)	(0.00101)	(0.0175)	(0.00300)	(0.698)	(0.000737)
Law Department		315.9***	-0.00512	1.144	-0.0484	0.437	0.234	-38.41	-0.0120
		(42.43)	(0.0122)	(1.461)	(0.0400)	(0.348)	(0.161)	(23.60)	(0.0193)
Observations	31	31	31	28	28	26	28	31	31
R-squared	0.921	0.952	0.834	0.899	0.931	0.856	0.741	0.905	0.807
Mean dep var	23.42	1821	0.196	9.578	0.219	19.03	0.314	228.9	0.174

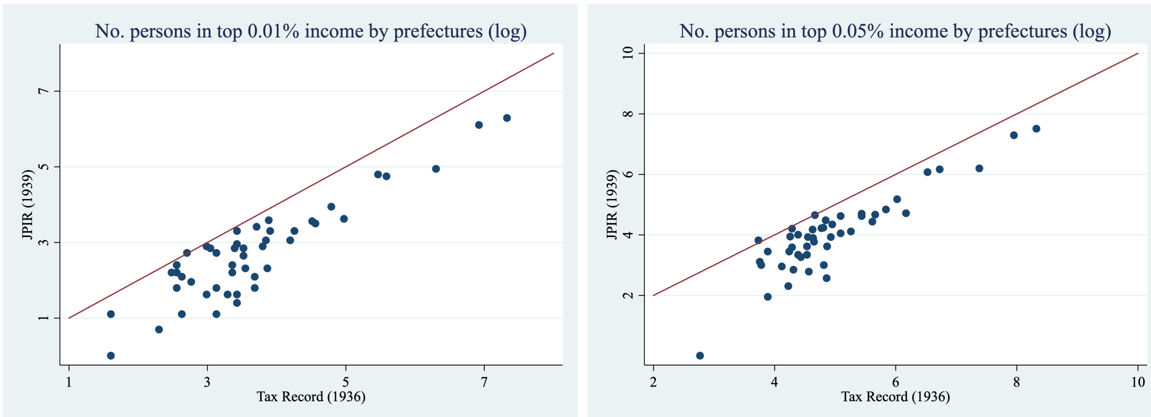
Notes: Columns (1)–(6) of this table test if important institutional variables are correlated with the timing of centralization using year-level data. Columns (7)–(9) of this table examine the robustness of our main short-run outcomes using year-level data. All numbers are at the national-level from 1900 to 1930. We focus on Schools 1-7 when calculating the number of of entrants, the share of entrants to School 1, the number of applicants, the entrants to applicants ratio, and the share of applicants to school 1. The numbers of middle school graduates and applicants are denominated by 1,000. "Law Department" is an indicator variable that takes 1 in 1907 and afterwards to control for the creation of the Law Department in each School 1-8 that increased school capacity. Robust standard errors are shown in the parentheses. See Section 5.5 for discussions about this figure.

Figure A.4: Sampling Rates of High Income Earners in the JPIR



Notes: This figure plots the sampling rate of the high income earners in JPIR (1939) by the income level expressed as a top percentile of the national income distribution. The sampling rates and the top income percentiles are computed from income tax statistics in the Tax Bureau Yearbook. The vertical lines indicate the top 0.05% and top 0.01%. See Section 6.1 for discussions about this figure.

Figure A.5: High Income Earners in JPIR vs Income Tax Statistics across Prefectures



Notes: These figures compare the number of high income earners in each prefecture listed in the JPIR (1939) and the number of all high income earners in each prefecture reported in the tax statistics in the Tax Bureau Yearbook (1936). The vertical axis is log of the number of individuals in JPIR (1939) who earned more than 50,000 taxable income (or top 0.01% income group) or 18,000 taxable income (corresponding to the top 0.05% income group) in 1938. The horizontal axis is log of the number of individuals in tax statistics who earned more than 30,000 taxable income (corresponding to top 0.013% of income group) or 10,000 taxable income (corresponding to the top 0.08% income group) in 1936 (the closest year to 1938 for which prefecture-level data are available). See Section 6.1 for discussions about this figure.

Table A.4: Correlations between Prefecture-level Sampling Rates and Outcome Variables

VARIABLES	Top 0.01% income earners	Top 0.05% income earners	Top 0.01% income earners	Top 0.05% income earners
Entrants to Schools 1–8	-0.000035	0.00005		
	(0.000059)	(0.000038)		
Imperial Univ. grads			-0.000052	0.000029
			(0.000032)	(0.00002)
Observations	47	47	47	47
R-squared	0.003	0.032	0.006	0.009
Mean dep var	0.444	0.218	0.444	0.218

Notes: This table shows the results of regressing the sampling rates of the JPIR (1939) on our outcome variables using prefecture-level data. "Top 0.01% income earners" is the sampling rate of the top 0.01% income earners in the JPIR defined by the number of individuals in the JPIR with more than 50,000 yen of taxable income in 1938 divided by the complete count of the number of individuals with more than 30,000 yen of taxable income in 1936. "Top 0.05% income earners" is the sampling rate of the top 0.05% income earners in the JPIR defined by the number of individuals in the JPIR with more than 18,000 yen of taxable income in 1938 divided by the complete count of the number of individuals with more than 10,000 yen of taxable income in 1936. "Entrants to Schools 1–8 " is the number of entrants to Schools 1–8 during 1900–1911 who were born in the prefecture (mean=590 and SD=383). "Imperial Univ. grads" is the number of individuals in the JPIR residing in the prefecture in 1938 who graduated from one of the Imperial Universities (mean=224 and SD=349). See Section 6.1 for discussions about this figure.

Table A.5: Long-run Impacts of Centralization: Difference-in-Differences Estimates excluding Cohorts who Turned Age 17 in 1901 or 1907

VARIABLES	Imperial Univ. grads	Top 0.01% income earners	Top 0.05% income earners	Managers	Professionals	Imperial Univ. professors	Medal recipients
				A. Baseline Specification			
Age 17 during Centralization	3.05***	0.69***	1.47**	3.34*	1.63***	0.48*	2.65***
× Tokyo area (<100 km)	(0.97)	(0.24)	(0.70)	(1.67)	(0.58)	(0.24)	(0.93)
				B. Adding Control Variables			
Age 17 during Centralization	1.76**	0.60**	1.28**	2.43**	0.83	0.46*	2.10***
× Tokyo area (<100 km)	(0.72)	(0.23)	(0.48)	(0.94)	(0.77)	(0.26)	(0.55)
Observations	611	611	611	611	611	611	611
Birth cohort FE	YES	YES	YES	YES	YES	YES	YES
Birth prefecture FE	YES	YES	YES	YES	YES	YES	YES
Mean dep var	8.684	1.229	4.727	9.830	6.682	0.750	6.149
Mean dep var (Tokyo area during Dapp)	10.38	1.411	6.054	13.25	8.357	0.857	6.679

Notes: In this table, we repeat the same analysis in Table 4, but excluding the cohorts who turned age 17 (main application age) in 1901 or 1907 from the sample as these cohorts were exposed to both Capp and Dapp. All the variables are defined in the same way as in Table 4. See Section 6 for discussions about this table.

Table A.6: Pre-event Trends Are Parallel

VARIABLES	Imperial Univ. grads	Top 0.01% income earners	Top 0.05% income earners	Managers	Professionals	Imperial Univ. professors	Medal recipients
				A. Baseline Specification			
Tokyo area (< 100 km)	0.189	-0.017	0.073	0.224	0.202	0.019	0.178
× Time trend	(0.445)	(0.065)	(0.303)	(0.478)	(0.239)	(0.082)	(0.253)
				B. Adding Control Variables			
Tokyo area (< 100 km)	-0.054	-0.041	-0.112	-0.003	0.079	-0.017	0.050
× Time trend	(0.108)	(0.050)	(0.121)	(0.167)	(0.069)	(0.033)	(0.094)
Observations	470	470	470	470	470	470	470
Birth cohort FE	YES	YES	YES	YES	YES	YES	YES
Birth prefecture FE	YES	YES	YES	YES	YES	YES	YES
Mean dep var	5.023	1.209	4.151	7.070	3.994	0.381	4.402
Mean dep var (Tokyo area during Dapp)	6.471	1.286	5.457	9.986	5.486	0.500	5.329

Notes: This table tests if there are differences in pre-event trends between urban and rural areas in the difference-in-differences analysis in Table 4. The estimates are based on the birth-prefecture-cohort level data compiled from the JPIR in 1939, which includes cohorts born in 1874-1883 who turned age 17 (main application age) in 1891-1900. This table runs the following regression:

$$Y_{pt} = \beta \times Timetrend_t \times Urban_p + \alpha_p + \alpha_t + \epsilon_{pt},$$

where $Timetrend_t$ is defined as the cohort's birth year minus 1870 (the linear time trend). All the other variables are defined in the same way as in Table 4. See Section 6 for discussions about this figure.

Table A.7: Using the JPIR in 1934

VARIABLES	(1) Imperial Univ. grads	(2) Top 0.01% income earners	(3) Top 0.05% income earners	(4) Managers	(5) Professionals	(6) Imperial Univ. professors	(7) Medal recipients
Age 17 during Centralization	1.68**	0.46*	1.63**	1.30***	1.17**	0.15	1.40*
× Tokyo area (<100 km)	(0.64)	(0.24)	(0.72)	(0.42)	(0.56)	(0.17)	(0.76)
Observations	705	705	705	705	705	705	705
Birth cohort FE	YES	YES	YES	YES	YES	YES	YES
Birth prefecture FE	YES	YES	YES	YES	YES	YES	YES
Mean dep var	4.790	0.810	3.635	3.216	3.281	0.468	3.933
Mean dep var (Tokyo area during Dapp)	5.683	1.111	6.175	5.063	4.175	0.587	4.524

Notes: In this table, we repeat the same analysis as in Table 4 Panel B, but alternatively using the data from JPIR published in 1934. In the 1934 JPIR, we observe the cohorts born in 1880–1894 when they are 40 to 54 years old. Sampling rates in the 1934 JPIR for top income earners are similar to those in the 1939 JPIR: 51% and 40% for top 0.01% and top 0.05% income earners. All the variables are defined in the same way as in Table 4. See Section 6 for discussions about this table.

Table A.8: Long-run Impacts of Centralization: Professionals and Government Elites

VARIABLES	Professionals: Scholars	Professionals: Physicians & Lawyers	Professionals: Engineers	Government
Age 17 during Centralization	1.007**	0.603*	0.801	1.107**
× Tokyo area (<100 km)	(0.420)	(0.337)	(0.674)	(0.499)
Observations	705	705	705	705
Birth cohort FE	YES	YES	YES	YES
Birth prefecture FE	YES	YES	YES	YES
Mean dep var	3.587	2.959	2.401	3.373
Mean dep var (Tokyo area during Dapp)	4.746	3.603	3.016	3.937

Notes: This table shows difference-in-differences estimates of the long-run effects of the centralized admission system. The estimates are based on the birth-prefecture-cohort level data from the JPIR in 1939, which includes cohorts who were born in 1880-1894 and turned age 17 (main application age) in 1897-1911. All regressions control for birth-prefecture fixed effects and cohort fixed effects. All outcome variables below are measured at the prefecture-cohort level. "Scholars," "Physicians & Lawyers," and "Engineer" are defined as the number of individuals in the JPIR whose occupation is scholar, physician or lawyer, and engineer, respectively. "Government" is the number of individuals in the JPIR who work at the central government either as an officer or a politician. "Age 17 during Centralization" takes 1 if the cohort turned 17 years old during 1902–1907, and takes 0 otherwise. "Mean dep var" shows the mean of the dependent variable for all prefecture-cohort observations. "Mean dep var (Tokyo area)" shows the mean of the dependent variable in the Tokyo area during decentralization. Standard errors are clustered at the prefecture level. See Section 6 for discussions about this figure.