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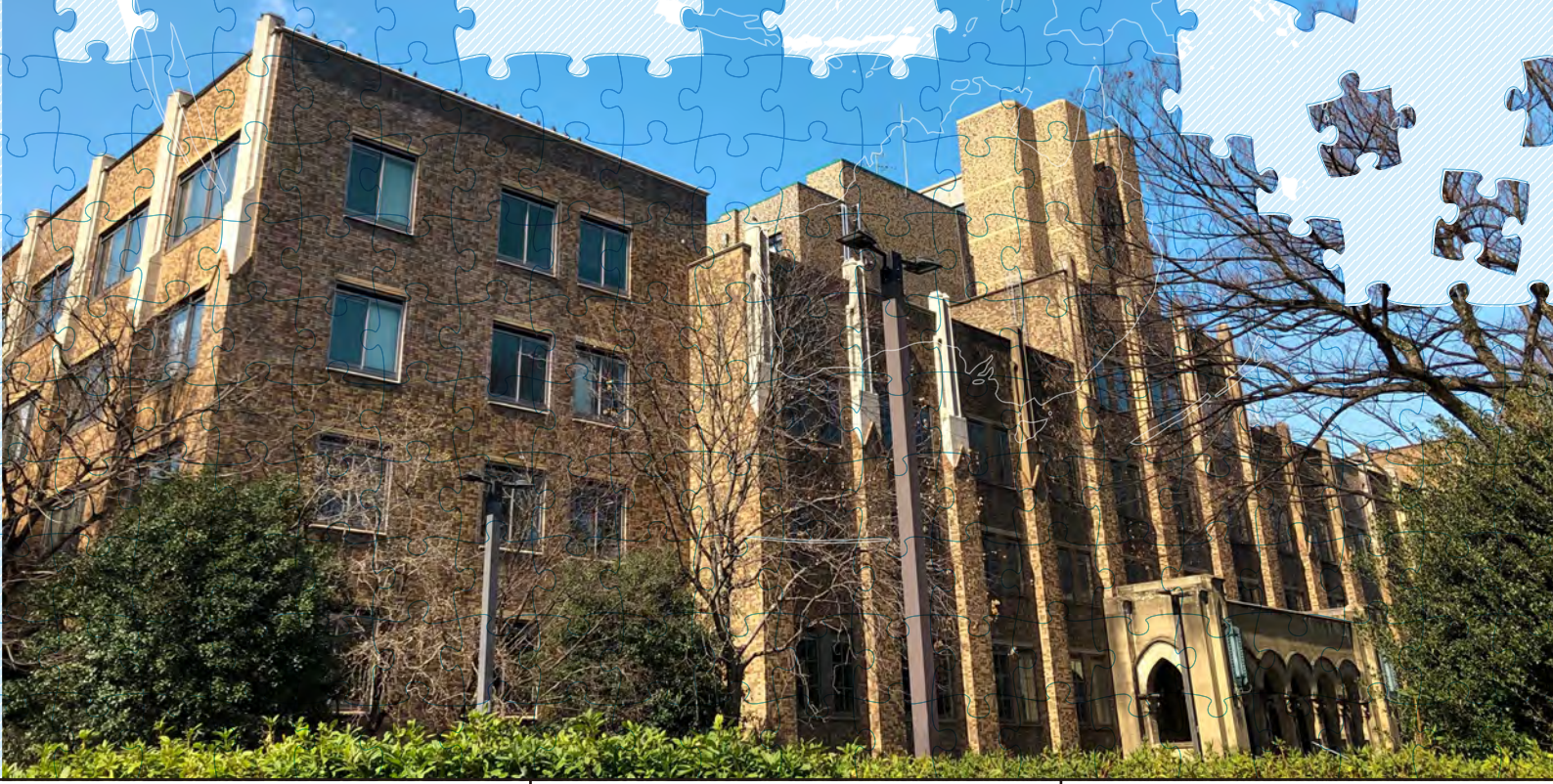
Changing University Accessibility and Inequality of Educational Opportunity in Japan



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Changing University Accessibility and Inequality of Educational Opportunity in Japan

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Abstract

University accessibility has been argued to create educational inequalities based on place of residence. While previous studies have analyzed the cross-sectional relationship between accessibility and enrollment, there is limited evidence on how increases in university accessibility affect individuals' enrollment. Using multiple social survey data for the 1942–1996 cohorts combined with population census data from Japan, we examine how longitudinal changes in university accessibility in individuals' residential and neighboring prefectures affect the likelihood of enrollment and how this effect varies by individuals' socioeconomic background. The results show that increased university accessibility is positively associated with university enrollment. The association is stronger for individuals whose parents are relatively lower class, but no such differences are found in terms of parental education. These findings suggest that increased accessibility to universities in underserved areas can reduce spatial inequality in enrollment, but has a limited impact on inequality based on individuals' social origin.

Keywords: Spatial inequality, educational opportunity, university enrollment, social origin

Introduction

Spatial inequality in access to higher education has received much attention, as have inequalities derived from individuals' socioeconomic backgrounds. Inequality of opportunity for enrollment and degree attainment results in socioeconomic inequality in adulthood (Hout 2012). In addition to various individual characteristics, such as class, gender, and race (Breen and Jonsson 2005; Buchmann, DiPrete, and McDaniel 2008; Kao and Thompson 2003), educational opportunities are also stratified by the residential environment (Chetty et al. 2014; Sharkey and Faber 2014). Studies have shown that the likelihood of enrolling in higher education is significantly affected by where one lives, such as in urban or rural areas (Bæck 2016; Byun, Meece, and Irvin 2012; van Maarseveen 2021; Zahl-Thanem and Rye 2024).

Among the regional environments that influence individuals' educational choices, the location of higher education institutions is an important factor that shapes educational inequality. Since higher education institutions are fewer in number and unevenly distributed across regions (Hillman 2016; Singleton 2016), their geographic distribution creates imbalances in individual accessibility. Greater accessibility to colleges allows local individuals to enroll at a lower economic cost by going to local colleges and provides local individuals with informational advantages about college. Accessibility, as measured by proximity to the nearest colleges, their density, or their presence in one's neighborhood, is shown to be positively associated with the likelihood of enrolling in higher education based on cross-sectional information (Alm and Winters 2009; Denzler and Wolter 2011; Frenette 2004, 2006; Fu et al. 2021; Gibbons and Vignoles 2012; Griffith and Rothstein 2009; Hoxby and Avery 2013; Kjellström and Regnér 1999; Leppel 1993; Newbold and Brown 2015; Parker et al. 2016; Sá, Florax, and Rietveld 2006;

Spiess and Wrohlich 2010; Turley 2009; White and Lee 2020; Zarifa, Hango, and Pizarro Milian 2018).

However, little is known about how changes in accessibility to colleges over time affect local individuals' enrollment decisions. This makes it difficult to disentangle whether increases in accessibility to colleges increase the likelihood of individuals going to college or whether individuals or their families who want to go to college choose to live near colleges. As an exception, Frenette (2009) shows that the opening of colleges in Canadian metropolitan areas increased the probability of college attendance in the surrounding area, but it is not clear whether the impact of college expansion is observed at the national level. It is crucial to examine how changes in college accessibility affect local individuals' enrollment decisions at the national level to understand the source of the relationship between college accessibility and enrollment.

In this paper, we examine how changes in accessibility to four-year universities affect the likelihood of individuals' enrollment, using Japan as a case study. Regional inequality in accessibility to universities has long been recognized as a policy issue in Japan. The increase in the number of students attending university has been driven by the expansion of the size of private colleges and the establishment of new colleges in metropolitan areas (Amano 1997; Ishida 2007). The Japanese government restricted the expansion of universities in metropolitan areas in the mid-1970s to address the growing regional imbalance in accessibility. The restrictions were lifted in the early 1990s, leading to a return to a skewed expansion of universities toward metropolitan areas. Exploiting this change in the regional distribution of universities over time, we measure the impact of a change in the accessibility of universities on local individuals' enrollment.

We also analyze how the effect of changes in accessibility to universities on enrollment differs by individuals' socioeconomic backgrounds in terms of parental class and education. Individuals from disadvantaged backgrounds are expected to be more affected by university accessibility due to the lack of economic and cultural resources for university enrollment. The association between proximity to colleges and the likelihood of enrollment is shown to be stronger for individuals from lower socioeconomic backgrounds (Denzler and Wolter 2011; Frenette 2004, 2006; Gibbons and Vignoles 2012; Hoxby and Avery 2013), suggesting that grater accessibility to universities may reduce educational inequality on the basis of individuals' social origin. On the other hand, recent studies suggest that educational expansion in rural areas does not equalize intergenerational educational mobility (Rogne and Frisli 2023). We provide additional evidence on the impact of changes in accessibility to universities on educational inequality on the basis of social origin.

Specifically, we examine the extent to which the change in accessibility to universities affects individuals' enrollment decisions and how the effect varies by parents' class and education using data that combined prefecture-level aggregate census between 1960 and 2014 with individual-level social survey in Japan. We constructed two types of measures of accessibility to universities: accessibility to local universities and accessibility to universities in surrounding areas (i.e., commutable areas from residential prefectures). Our results show that the increase in accessibility to local and surrounding universities is positively related to the probability of university enrollment for individuals, net of prefecture- and year-specific factors and other controls. The expectation that the effect of accessibility is stronger for individuals from lower-class backgrounds is partially supported, while there are no clear differences by parental education. Based on these results, we conclude that the equal distribution of universities may

contribute to reducing inequality of educational opportunity by place of residence but not inequality by socioeconomic background.

Institutional Settings of Japan

Universities and their admission capacity

The Japanese education system is characterized as comprehensive with little stratification and vocational specificity (Shavit and Müller 1998). After nine years of compulsory education (completed at age 15), almost all students enroll in high school, which lasts for three years. At the end of high school, students can take entrance examinations for tertiary education.

The timing of university enrollment is almost entirely limited to the timing of high school graduation. The age of newly enrolled students is concentrated at 18 years old, with very little variation (OECD 2019). While there are three types of higher education institutions, two-year vocational training colleges, two-year junior colleges, and four-year universities, four-year universities (hereafter universities) are associated with the highest economic returns and social status (Ishida 1998; Mugiyama and Toyonaga 2022). Since students want to be admitted to a university, especially a prestigious university, the competition during entrance exams is very intense and has been described as "examination hell" (Ono 2007; Sakamoto and Powers 1995).

Universities are required to set the number of students they can admit to each department, and the admission capacity numbers are strictly controlled by the government (Yonezawa 2007). Universities cannot admit more students than their admission capacity because the government (i.e., the Ministry of Education) punishes them by cutting subsidies if they exceed their capacity. Hence, universities aim to admit as many students as possible within the admission capacity to maximize tuition revenue. When new universities are opened and when existing universities

establish new departments, reorganize departments, or modify their admission capacity, it must be approved by the government. In addition, admission capacity differs among universities. There are 783 universities that have courses for undergraduates in 2023 (Ministry of Education, Culture, Sports, Science and Technology 2024), but their sizes are quite different. On average, approximately 700 undergraduate students are enrolled per university, but the largest university (*Nihon University*) accepts approximately 16,000 undergraduate students every year.

Spatial educational inequality and the uneven distribution of universities

University enrollment rates vary considerably by region. Figure 1(a) shows university enrollment rates by prefecture in Japan in 2010. Compared with their rural counterparts, students living near metropolitan areas are more likely to attend university. While 73% of students who lived in Tokyo and 64% in Kyoto went on to university from high school, the figure was only 34% in Aomori and Iwate, which are in the rural northern part of Japan. Such regional differences have been shown in many studies (Houzawa 2016; Sasaki 2006; Ueyama 2011).

Universities, especially those with greater admission capacities, are concentrated in metropolitan areas, which may contribute to regional differences in enrollment rates. Figure 1(b) shows the accessibility to local universities by prefecture. This is the admission capacity of the prefecture divided by the number of residents aged 18, which measures how many spots are available to local students. Tokyo, which has the highest university enrollment rate, has the highest accessibility to local universities at 1.83. Kyoto also has a high accessibility of 1.54. On the other hand, accessibility to local universities in rural areas is much lower, with Fukushima and Wakayama having the lowest values of approximately 0.11. These figures suggest that

metropolitan areas with a relatively high density of admission capacity provide more options for students living in surrounding areas, leading to disparities in university enrollment by region.

The regional distribution of university admission capacity has changed over time, reflecting changes in educational policy. Before the 1960s, the Japanese government pursued a policy of establishing at least one national or public university in each prefecture to reduce regional disparities in access to higher education. However, following the 1960s, a post-World War II baby boom and increasing high school graduation rates significantly increased the number of students seeking university admission. Although this surge in demand required an expansion of university admission capacity, financial constraints made it difficult for the government to meet this demand solely by increasing the number of national and public universities. To fill this gap, private universities play a pivotal role by significantly expanding their admission capacity. This approach enabled the government to achieve educational expansion without incurring substantial financial costs. Unlike government-funded public universities, private universities operate on a for-profit basis. Consequently, their expansion was predominantly concentrated in metropolitan areas (Umakoshi 2004), resulting in a more pronounced increase in admission capacity in urban areas than in rural regions.

In 1976, the government enacted the rule of the systematic development of higher education, known as the decentralization policy (Shima 1996), to restrict the concentration of universities in the metropolitan area because the government took the widening regional disparities in university enrollment very seriously. Under this rule, private universities are required to obtain government approval to be founded, to establish or reorganize departments, and increase admission capacity (Amano 1997). After the policy was enacted, the pace of educational upgrading was suppressed, and university enrollment rates stagnated (Ishida 2007).

In 1993, the rule of the systematic development of higher education was revised to allow multiple urban areas to satisfy the intensifying competition in university entrance exams, and the restrictions on the establishment of universities were completely abolished in 2002 (Yonezawa 2023). During these periods, university admission capacity has expanded, particularly in metropolitan prefectures (Sasaki 2006), resulting in a more uneven distribution of accessibility to universities across regions. University enrollment rates have also increased since 1993, in line with the expansion of universities (Ishida 2007).

In sum, accessibility to universities varies considerably across regions and the regional differences have changed over time in Japan, reflecting changes in educational policies. These longitudinal variations in accessibility to universities provide us with an opportunity to test how the change in accessibility affects the university enrollment decision of local students.

Theoretical background and hypotheses

Accessibility to universities has been shown to be positively associated with individuals' university enrollment. Accessibility is typically measured by the distance from home to the nearest educational institution (Alm and Winters 2009; Denzler and Wolter 2011; Frenette 2004, 2006; Gibbons and Vignoles 2012; Hoxby and Avery 2013; Kjellström and Regnér 1999; Leppel 1993; Newbold and Brown 2015; Parker et al. 2016; Spiess and Wrohlich 2010; Turley 2009; White and Lee 2020; Zarifa et al. 2018) or the presence or density of institutions within a commutable area (Frenette 2009; Fu et al. 2021; Parker et al. 2016; Sá et al. 2006). Accessibility is also associated with enrollment and application to upper-secondary educational institutions (Dickerson and McIntosh 2013; Falch, Lujala, and Strøm 2013; Prix, Sirniö, and Saari 2024),

educational aspiration (Parker et al. 2016), and enrollment in selective universities (Do 2004; Griffith and Rothstein 2009; Hill and Winston 2010; Ovink et al. 2018).

Theories on the inequality of educational opportunity provide explanations for the influence of opportunity constraints on individuals' enrollment decisions. When deciding to pursue further education, students take into account the costs, benefits, and risks associated with enrollment given their socioeconomic conditions (Boudon 1974; Breen and Goldthorpe 1997). The greater financial costs associated with university enrollment, such as tuition fees, housing rent, living expenses, or moving expenses, discourage educational aspirations (Avery and Kane 2004), particularly for those from lower socioeconomic backgrounds (Carneiro and Heckman 2002; Furuta 2021; West et al. 2015). Based on these theoretical explanations, lower accessibility to universities is expected to decrease the likelihood of university enrollment by increasing financial costs. While students attending universities near their parents' residence can save costs by living with their parents, those attending faraway universities must leave their parental home and incur additional costs.[1]

Lower accessibility to universities also decreases the likelihood of university enrollment by reducing the likelihood of obtaining information on the benefits and risks of university enrollment. Individuals from lower socioeconomic backgrounds tend to underestimate economic returns to degrees and overestimate the risk of dropout due to the lack of information on universities (Barone et al. 2018; Becker and Hecken 2009; Daniel and Watermann 2018). On the

[1] In areas with lower accessibility to universities, having to leave friends or families behind to go to university can incur non-economic costs (Turley 2006). Studies show that students with a better relationship with their parents are less likely to leave their home when they decide to enroll college outside home (Turley, Desmond, and Bruch 2010), suggesting that students with greater choices of universities without leaving home are more likely to enroll universities since they can go to university while maintaining relationships with their family and friends.

other hand, parents from higher socioeconomic backgrounds guide their children's educational trajectories by providing knowledge about university education (Lareau 2011, 2015). Slack et al. (2014) also argue that such "hot knowledge" obtained from the experiences of others plays a critical role in educational decision-making. Similar to an individual's familial background, greater accessibility to universities will be helpful in obtaining information on universities. Living near universities will provide local individuals with information, aspirations, or network advantages by visiting a campus, meeting university students and alumni, or participating in a university fair (Spiess and Wrohlich 2010).

These economic and informational advantages of accessibility can apply to the increased accessibility to universities and enrollment decisions in Japan. Living costs are greater for students who live outside of their parental home than for those who live with their parents due to the lack of free or cheap dormitories for students (Japan Student Services Organization 2021). There are no strong social norms that expect students to leave their parental home when enrolling in university (Fukuda 2009), which weakens the incentive for individuals to leave home to enroll in a university and strengthens the incentive to enroll from home. Against this backdrop, we expect that greater access to universities increases individuals' likelihood of university enrollment.

Hypothesis 1. An increase in accessibility to universities is positively associated with the likelihood of university enrollment.

Increased accessibility to universities, whether it lowers the economic cost of enrollment or serves to provide university information, could increase the likelihood of enrollment more for

disadvantaged individuals. A lower financial cost of participation in education is associated with greater intergenerational educational mobility because it enables individuals with fewer economic resources to enroll in higher educational institutions (Herbaut and Geven 2020). Moreover, the provision of information can increase enrollment more for individuals whose parents have lower education levels than for those whose parents have higher education levels (Ehlert et al. 2017; Peter and Zambre 2017). These studies suggest that increased accessibility has a stronger positive effect on university enrollment for socioeconomically disadvantaged individuals by reducing financial costs for enrollment and providing university information.

Studies provide inconclusive evidence on this point. Some studies have shown that the positive relationship between accessibility to universities and enrollment is stronger among individuals who have lower-income families (Denzler and Wolter 2011; Frenette 2004, 2006; Gibbons and Vignoles 2012; Hoxby and Avery 2013), suggesting that disadvantaged individuals are more likely to be affected by accessibility, whereas these studies show cross-sectional associations rather than longitudinal variations in accessibility. Other studies have shown that an increase in universities in rural areas does not increase intergenerational educational mobility (Rogne and Frisli 2023), indicating that increased accessibility favors all individuals regardless of their socioeconomic background. Thus, there is still room to examine how greater accessibility to universities affects individuals from different socioeconomic backgrounds.

We examine how the effect of increased accessibility to universities on individual's enrollment varies by parental (occupational) class and education. Due to the limitations of our data, which are explained later, we cannot use direct measures of family economic resources. Nevertheless, parental class and education are important indicators of an individual's social origin and have been utilized in studies on the inequality of educational opportunity. Parental

class is argued to reflect economic resources of social origin, and parental education reflects cultural resources of social origin (Blossfeld 2019; Bukodi et al. 2018; Bukodi and Goldthorpe 2013; Hällsten and Thaning 2018; Jæger and Holm 2007; Meraviglia and Buis 2015). Both have also been used in Japan to measure social origin when analyzing the inequality of educational opportunities (Fujihara and Ishida 2016; Ishida 1998, 2007; Kondo and Furuta 2009). We hypothesize that increased accessibility to universities will have a more positive effect on university enrollment for individuals from a higher class or who have better educated parents than for their less educated counterparts.

Hypothesis 2. The effect of increased accessibility to universities on the likelihood of university enrollment is stronger for individuals with parents in the lower class.

Hypothesis 3. The effect of increased accessibility to universities on the likelihood of university enrollment is stronger for individuals whose parents are less educated.

Methods

Data

To ensure a sufficient sample size, we used combined data from multiple nationally representative surveys conducted in Japan: the Social Stratification and Mobility Survey (SSM), 1995, 2005, and 2015; the Japan General Social Survey (JGSS) in 2000, 2001, 2002, 2003, 2005, 2006, 2008, 2009 (life-course supplement), 2010, 2012, 2015, 2016, 2017, and 2018; the Japanese Life-Course Panel Survey (JLPS) in 2007, 2011, and 2019; and the Education, Social Stratification and Mobility Survey (ESSM) in 2013. All these surveys collect information on respondents' educational attainment, childhood prefecture of residence, and other social origins,

which allows us to analyze the impact of prefecture-level conditions at the time of the university enrollment decision while controlling for social background characteristics. Detailed information on these surveys is provided in the Appendices.

Regional conditions at age 18 will have the greatest impact on individuals' enrollment decisions since they decide to go to university and take entrance examinations at age 18, which is the last year of high school. However, these surveys ask about the prefectures where respondents lived at age 15, not at age 18. Thus, we assume that they lived in the same prefecture at age 15 (referred to as year $t-3$) and at age 18 (referred to as year t) and that individual i is exposed to the environment in prefecture j in year t.

The analytical sample consists of individuals who were born in 1942–1996, which corresponds to those who reached 18 years of age during 1960–2014. The period 1960–2014 covers the expansion (until 1975), suppression (between 1976 and 1992), and re-expansion (after 1993) phases of universities, as explained above.[2] The original sample contains 56,205 respondents. After deleting respondents who did not report information on university enrollment (N = 196), parental class (N = 5,874), or parental education (N = 7,634), the resulting sample size was 44,413.[3]

There are two limitations in our data. First, while our target population is the 18-year-old population for each year, our sample does not represent the population because of the use of multiple survey data and the scarcity of surveys covering recent cohorts. To address this, we

[2] We excluded respondents who lived in Okinawa at age 15 and whose year of residence was before 1972 and those who lived abroad at age 15 as prefecture-level variables were not available.

[3] To assess if the listwise deletion procedure affects the results, we conducted the sensitivity test by using multiple imputation technique (Allison 2009) with 20 imputations using all variables used in the analyses. The results showed substantially similar conclusions as shown in Table A2 in the Appendices. In the main text, we present the results using listwise deleted sample.

constructed the observation weights based on the 18-year-old population in each prefecture for each year. The 18-year-old population was obtained from the number of junior high school graduates in the School Basic Survey, which is explained later. This weight allows us to reproduce the 18-year-old population in each year, as shown in Figure A1 in the Appendices. The main results are not significantly different without this weighting (see Table A3 in the Appendices).

Second, the data do not contain information on administrative units smaller than prefectures (e.g., municipalities) or zip codes, which makes it impossible to construct measures such as distance to the nearest university or presence or density around the exact place of residence. However, the prefecture-level measures are still important because prefectures are physically and socially meaningful areas in the Japanese context. Prefectures are not very large, so it is generally possible to commute within the prefecture of residence in a short time.[4] In addition, almost all students attend schools in their prefecture of residence prior to going on to tertiary education, as public schools from elementary to high school only accept students within the same prefecture. In rural prefectures, children who attend universities in urban areas often do not return to their hometowns. For this reason, teachers and schools are sometimes requested by local boards of education to encourage students to enroll in local universities within their prefectures (Nakamura 2020). Thus, prefecture-level measurement of accessibility to universities can provide insight into the actual accessibility of individuals.

[4] Hokkaido, the northernmost prefecture, is an outlier with an area of 83,450 km² and 22% of Japan's total land area, which is much larger than the other prefectures. As a robustness check, we conducted analyses excluding those who lived in Hokkaido at age 18, but the results were not substantially different (see in Table A4 in the Appendices).

Prefecture-level variables

Accessibility to local universities. Accessibility to local universities is measured by the university admission capacity in a prefecture divided by the number of people aged 18 in the prefecture. This measures the available university admission capacity per potential competitor residing in the same prefecture j at year t, which is defined as

$$ALU_{jt} = \frac{A_{jt}}{P_{jt}}, \quad (1)$$

where A_{jt} denotes the sum of the number of university admission capacity to be accepted in the following year and where P_{jt} denotes the number of those aged 18 years old.[5] The sum of the number of university admission capacity was retrieved from a dataset on the admission capacity of Japanese University (Center for Research and Education in Program Evaluation, University of Tokyo 2021), which contains the admission capacity and the location of all universities in Japan. The number of individuals aged 18 years was retrieved from the number of junior high school (9th grade) graduates three years prior, which is published in the School Basic Survey (Ministry of Education, Culture, Sports, Science and Technology 2024), which collects the number of all graduates every year. Since junior high school graduates take the university entrance exam three years later at the end of high school (12th grade), the number represents the potential candidates at the university entrance examination. An example illustration from 2010 is shown in Figure 1(b).

[5] We should note that women's universities' admission capacities are included regardless of the respondents' gender, which may overestimate accessibility for men. We also constructed gender-specific admission capacities, which excludes admission capacities of women's universities from men's. The results are not largely different from the main results (see in Table A5 in the Appendices).

Accessibility to neighboring universities. Individuals are also affected by accessibility to universities located in prefectures to which they can commute. Because of the highly developed rail networks in metropolitan areas in Japan, residents can commute to neighboring prefectures across prefectural boundaries, especially in metropolitan areas such as Tokyo and Osaka (Adachi et al. 2020). To take accessibility to neighboring prefectures into account, we utilize data on commuting patterns. This measures the extent to which the weighted average of the university admission capacity of the prefecture is outside the home prefecture, which is defined as follows:

$$ANU_{jt} = \frac{1}{P_{jt}} \sum_{k \in \{j \neq k\}} \frac{C_{jt}^{k}}{C_{jt}} \times A_{kt}\,, \tag{2}$$

where C_{jt} denotes the number of 15+ year-old students and workers residing in prefecture j in year t; C_{jt}^{k} denotes the number of students and workers residing in prefecture j and commuting prefecture k in year t, both of which were retrieved from the Population Census (Statistics Bureau of Japan 2023b);[6]; and A_{kt} denotes the total admission capacity in commuting prefecture k. For example, when 20% of the people residing in the 6th prefecture commute to the 7th prefecture and 1% of them commute to the 8th prefecture, the residents in the 6th prefecture are considered to be available for 20% of the admission capacity in the 7th prefecture and 1% of the admission capacity in the 8th prefecture.[7] The more people commuting to surrounding prefectures, the greater the accessibility to surrounding universities. For illustrative purposes, Figure 2 shows the distribution of accessibility to neighboring universities in 2010. Higher values are taken in prefectures surrounding Tokyo, such as Saitama (a prefecture north of

[6] Since the level of education is collected only every ten years in the Population Census, the values of the adjusted university enrollment capacity were linearly interpolated for the period when the census was not conducted.

[7] We can expect that this indicator is not only affected by physical distances between prefectures but also by economic factors such as the level of industrialization of prefectures.

Tokyo), Chiba (a prefecture east of Tokyo), and Kanagawa (a prefecture south of Tokyo). We use this variable as another indicator to measure accessibility to universities.

Other prefecture-level variables. We control for several prefecture-level variables. Disadvantaged neighborhood characteristics are negatively associated with residents' educational attainment (Harding, 2003; Chetty et al., 2016; Wodtke et al., 2011). To account for this, we use prefectural income per capita as the measure of the economic well-being of prefectures. Because prefecture poverty rates are not available, we use prefecture income per capita, which is published in the Prefectural Economic Calculation (Cabinet Office 2021), as the proxy. We adjusted the values to 2020 prices using the Consumer Price Index (Statistics Bureau of Japan 2023a). We also control for the prefecture unemployment rate, which was retrieved from the Population Census (Statistics Bureau of Japan 2023b).[8] Furthermore, we use the prevalence of university graduates to control for the prefecture education level, which is positively associated with residents' enrollment decisions (Wodtke, Harding, and Elwert 2011). This was the proportion of residents with a bachelor's degree to residents who are not currently enrolled in school, which was obtained from the Population Census (Statistics Bureau of Japan 2023b).[9]

Individual-level variables

[8] We cannot use the Labor Force Survey because the prefecture-level unemployment rate was not published until 1997, so it precludes intertemporal analysis. Since the Population Census is conducted every five years, we assigned the values between the survey periods by linear interpolation of the values between the consecutive periods.

[9] Since the Population Census asks about respondents' educational backgrounds only once every 10 years, we assigned the values between the survey periods by linear interpolation of the values between the consecutive periods.

University enrollment. The dependent variable is whether respondents have been enrolled in university. We measured it as whether they went on to or were being enrolled in the four-year university or not at the time of survey.

Parental class. Parental class is measured by the father's class when the respondent is 15 years old. If the respondent's father was not present, did not work, or did not know or do not answer their father's occupation, then their mother's class was used.[10] This procedure assumes that the father's class takes priority over the mother's class. Studies show that the conventional male dominance measure of class is not that different from the dominance approach, which uses the mother's class as a supplement in Japan (Shirahase 2001). The class is categorized following the Erikson-Goldthorpe-Portocarero (EGP) class scheme (Erikson and Goldthorpe 1992): I+II (professionals and managers), III (routine non-manual), IV (small employers and farmers), V+VI (skilled manual), and VII (semi-skilled manual).[11]

Parental education. The parental level of education is measured by the higher level of the father's or mother's educational attainment if both are available. If either one is missing, then the one with valid responses is used. We classified the levels of education into three categories: lower secondary (junior high school or less), upper secondary (high school), and tertiary (vocational training college, junior college, university, or higher).

[10] Because JGSS (except for JGSS 2009) does not collect the mother's occupational information, the complementation of parental class by mothers' score was carried out only in SSM, JLPS, JGSS 2009, and ESSM.

[11] Our survey data provides occupational code by SSM occupational classification, which is different from the International Standard Classification of Occupations. We assigned the SSM occupational codes to their equivalent EGP class scheme by following the procedure proposed by Kanomata, Tanabe, and Takenoshita (2008).

Other controls. We control for respondents' gender, which is categorized into men and women. We also introduce the dummy variables of the survey to control for survey-specific fluctuations.

Analytical methods

We estimate logit models predicting an individual's probability of university enrollment by time-varying accessibility while controlling for individual-level and prefecture-level variables and prefecture- and year- fixed effects (i.e., two-way fixed effects). For respondent i residing in prefecture j in year t at age 18, the estimated model is as follows:

$$\log\frac{\Pr(Y_{ijt}=1)}{1-\Pr(Y_{ijt}=1)} = \alpha + \beta_1 \mathrm{ALU}_{jt} + \beta_2 \mathrm{ANU}_{jt} + \beta_3 X_{jt} + \gamma_1 \mathrm{Class}_{ijt} + \gamma_2 \mathrm{Edu}_{ijt} + \gamma_3 \mathrm{Gender}_{ijt} + \gamma_4 Z_{ijt} + \phi_1 \mathrm{Prefecture}_j + \phi_2 \mathrm{Year}_t + \phi_3 \mathrm{Year}_t \times \mathrm{Gender}_{ijt}, \quad (3)$$

where Y_{itj} refers to whether an individual is enrolled in university (=1) or not (=0); ALU_{jt} refers to accessibility to local universities; ANU_{jt} refers to accessibility to neighboring universities; X_{jt} refers to other prefecture-level variables; Class_{ijt} refers to the respondent's parental class; Edu_{ijt} refers to parental education; Gender_{ijt} refers to gender; Z_{ijt} refers to other individual-level controls (i.e., survey dummies); and $\mathrm{Prefecture}_j$ and Year_t refer to dummy variables for the prefecture of residence and year at age 18 (i.e., prefecture and year fixed effects). We allow year fixed effects to differ by gender because the increase in university enrollment rates over the years differs between men and women. By controlling for these prefecture and year fixed effects, we can exploit the within-prefecture temporal variation in accessibility to universities. The focal parameters are β_1 and β_2 to test Hypothesis 1. We then estimate the model incorporating the

interaction terms between the accessibility measures, ALU_{jt} and ANU_{jt}, and the individual-level variables, Class_{ijt} and Edu_{ijt}, to test Hypotheses 2 and 3. Statistical tests are conducted by using prefecture-clustered robust standard errors following the advice of Cameron and Miller (2015).[12]

Results

Descriptive trends

Figure 3 shows the trends in accessibility to local and neighboring universities. The trends in accessibility to local universities reflect the phases of educational expansion (see the left panel). In the earlier periods of educational expansion, from 1960 to 1975, accessibility to local universities increased rapidly in metropolitan prefectures, typified by Tokyo (the top line) and Kyoto (the second top line). In 1975, individuals residing in these regions had greater admission capacities in their home prefectures, with 0.9 capacities per 18-year-old population in Tokyo and 0.7 in Kyoto. From 1976 to 1992, accessibility to local universities in these prefectures decreased, reflecting the educational policy change (decentralization policy) in 1976. The level of accessibility to local universities decreased and remained at approximately 0.8 in Tokyo and approximately 0.6 in Kyoto. Since 1993, when restrictions on university establishment in urban areas began to be lifted, accessibility to local universities has increased again, especially in urban prefectures. In 2008, accessibility to local universities reached 1.8 in Tokyo and 1.5 in Kyoto, resulting in the largest regional differences in accessibility to date.

[12] We decided to use log-odds ratio as the scale to measure the effects, following the literature on inequality in educational attainment. However, in discrete choice models, it is debated that the choice of scale affects the conclusions (Bloome and Ang 2022; Kuha and Mills 2020). For the sake of the information, we have presented linear probability models as the supplements in Table A6. The results show that we can reach the same conclusions regarding the main effect of accessibility to universities but the interactions with parental class and education are different.

The increased admission capacity in urban prefectures spilled over to university accessibility for individuals residing in neighboring prefectures. The right panel shows that accessibility to neighboring universities, which reflects the increase in university admission capacity in neighboring prefectures and commutes to the prefectures, increased more in prefectures located in the Tokyo and Osaka metropolitan areas. The three higher red lines, indicating Chiba (eastern part of Tokyo), Saitama (northern part of Tokyo), and Kanagawa (southern part of Tokyo), show increasing trends in accessibility in the earlier educational expansion period (1960–1975) and the later educational expansion period (after 1993). An increasing trend is also observed in the Osaka metropolitan area. Among them, Nara (southern part of Kyoto, shown in the top red line) dramatically increased accessibility to neighboring universities, reflecting the increase in admission capacities in neighboring prefectures.

These trends reveal that there are large variations in accessibility to universities, which are generally greater in urban prefectures, and that regional variations have changed unevenly, reflecting the introduction and removal of policies to limit admission capacity in urban areas. In the next section, we examine how changes in accessibility to local and neighboring universities over time are associated with individuals' university enrollment.

Results for logit models

Table 2 shows the results of logit models predicting individuals' university enrollment. Model 0 introduces only accessibility to local universities and to neighboring universities as the independent variables for descriptive purposes. Both measures are significantly positively associated with university enrollment. A 0.1-point increase in accessibility to local universities is associated with a 1.13 times ($= \exp(0.1 \times 1.236)$) greater odds of university enrollment, and a

0.1-point increase in accessibility to neighboring universities is associated with a 1.15 times ($= \exp(0.1 \times 1.418)$) greater odds.

In Model 1, we introduced various prefecture- and individual-level characteristics as well as prefecture and year fixed effects to isolate the net effects of accessibility measures on individuals' university enrollment. The results show that two accessibility measures remain significantly positively associated with university enrollment. A 0.1-point increase in accessibility to local universities is associated with a 1.08 times ($= \exp(0.1 \times 0.763)$) greater odds of university enrollment, and a 0.1-point increase in accessibility to surrounding universities is associated with a 1.18 times ($= \exp(0.1 \times 1.661)$) greater odds. These results are consistent with Hypothesis 1, insisting that the increase in accessibility to universities is associated with individuals' likelihood of university enrollment.

The magnitude of the effect of accessibility to universities is more substantial than that of parental socioeconomic characteristics. As shown in Figure 3, there are differences of more than 1 point between prefectures with the highest accessibility to universities and those with relatively low accessibility to universities in 2014, the last year in our sample. The differences in the log-odds ratio of a 1-point change in accessibility to local universities (0.763) are almost 85% of the differences between professional/managerial and routine non-manual class backgrounds (0.899) and of the differences between having parents with tertiary and upper secondary education (0.872). This is also the case for accessibility to neighboring universities. There are differences of more than 0.5 points between the highest and lowest groups of prefectures in the last year, which reaches a 0.831 (=1.661/2) log-odds ratio.

We then examine whether the effects of accessibility to universities vary by an individual's socioeconomic background. Model 2 introduces interactions between parental class

or education and access to local or neighboring universities. With respect to the parental class, those from the semi-skilled manual class are affected more by accessibility to local universities: the increase in the odds of enrolling in university for a 0.1-point increase in accessibility to local universities is approximately 2.3% greater ($= \exp(0.227 \times 0.1)$) for those from semi-skilled classes than for those from professional/managerial classes. In addition, those from nonroutine manual classes are affected more by accessibility to surrounding universities. The increase in the odds of enrolling in university for a 0.1-point increase in accessibility to neighboring universities is 4.7% greater for those from the routine nonmanual class than for those from the professional/managerial class. These results suggest that, although not a clear class gradient, the accessibility to local and neighboring universities is generally greater among individuals from relatively lower classes, the results of which are consistent with Hypothesis 2.

With respect to the interaction with parental education, those who have parents with upper secondary education are less likely to be affected by the increase in accessibility to local universities than those who have parents with lower secondary education. There are no significant interactions between tertiary education and access to local or neighboring universities. Thus, we did not find a negative educational gradient in the effect of accessibility to universities, which is not in line with Hypothesis 3, expecting that those from highly educated parents are weakly affected by the increase in accessibility to universities.

Discussion and Conclusion

Residential environments, such as university accessibility, shape individuals' enrollment decisions and lead to spatial inequalities in educational opportunities. While studies have analyzed the relationship between university accessibility and enrollment, few studies have

examined the effects of longitudinal changes in accessibility. We examined how changes in university accessibility, measured by accessibility to universities in one's residential prefecture and neighboring prefectures, affect the likelihood of enrolling in universities in Japan. We also examined how the effect of accessibility varies according to individuals' socioeconomic backgrounds, such as parental class and education.

We find that increased accessibility to both local and neighboring universities is positively associated with the likelihood of university enrollment, controlling for prefecture- and year-specific factors and other characteristics. In addition to the cross-sectional associations between accessibility and enrollment, the results show that increased accessibility to universities has an impact on local individuals' enrollment. Its impact is comparable to that of an individual's socioeconomic background. The results highlight the importance of residential environments, such as the geographic location of universities, in shaping the spatial inequality of educational opportunities.

The results also revealed that individuals' enrollment decisions are influenced not only by the accessibility of their residential prefecture but also by the accessibility of neighboring prefectures, which is affected by admission capacity as well as commutability. While previous studies in Japan only use information on the residential prefecture (Sasaki 2006; Ueyama 2011), the results show that accessibility to universities in neighboring prefectures is also important. The results suggest that individuals consider accessibility to universities outside of their home prefecture, reflecting frequent cross-prefecture commuting. Even if the distances to universities are the same, accessibility depends on the transportation network. Future studies should consider commuting zones to measure university accessibility and analyze the relationship with enrollment decisions.

An analysis of the interaction between university accessibility and individuals' socioeconomic background yielded nuanced results. Access to local and neighboring universities tends to have a more positive effect on individuals with lower-class parents, such as those from the semi-skilled manual or routine nonmanual groups. The results are generally consistent with expectations that increased university accessibility favors enrollment by reducing economic costs (Denzler and Wolter 2011; Frenette 2004, 2006; Gibbons and Vignoles 2012; Hoxby and Avery 2013), given that parental class corresponds to their economic resources. Increasing university accessibility may benefit individuals from lower class backgrounds by enabling their university enrollment.

On the other hand, there is no clear educational gradient in the effect of university accessibility: the positive effect of accessibility to local universities is weakest for those with medium-educated (i.e., upper secondary) parents. Highly educated parents may increase their educational expectations in the presence of higher university accessibility relative to parents with medium education. The finding that increased accessibility does not reduce educational inequality based on the basis of parental education is consistent with the findings of a recent study (Rogne and Frisli 2023) that showed that increased access in rural areas does not equalize intergenerational educational associations. It is also possible that universities do not provide sufficient information to local individuals. In any case, the different findings between parental class and education underscore that the consequences for educational inequality can vary according to the resources associated with social origin (Blossfeld 2019; Bukodi et al. 2018; Bukodi and Goldthorpe 2013; Hällsten and Thaning 2018; Jæger and Holm 2007; Meraviglia and Buis 2015).

There are several limitations to this study. First, the measurement of university accessibility is based on prefecture-level data, which may not capture finer geographic variations or individual commuting patterns. Future studies should use finer measures of place of residence. Second, we used parental class and education as a measure of social origin, which may not fully reflect family economic resources such as income or wealth. Third, we do not distinguish horizontal differentiation between universities (Do 2004; Griffith and Rothstein 2009; Hill and Winston 2010; Ovink et al. 2018). Individuals' enrollment decisions may not change if a nearby university does not offer a major that they prefer or is extremely selective. Fourth, our analyses do not rule out all possible selection problems. If universities choose their locations or admission capacity in anticipation of future high demand for enrollment, then the effect of accessibility will be overstated. Fifth, we do not empirically test the possible explanations for how increased accessibility contributes to higher enrollment rates by reducing economic costs or providing informational advantages.

Despite its limitations, this study provides evidence that changes in university accessibility are salient residential factors in shaping individuals' enrollment decisions. The results suggest that increasing accessibility to universities, particularly in underserved areas, can help reduce the spatial inequality of educational opportunity. However, accessibility alone cannot fully address broader inequalities, such as inequalities by social origin. A broader policy approach is needed to ensure equitable access to higher education for all.

Research ethics statement

This study is based on the secondary use of anonymous social survey data and is exempt from ethics committee approval. Upon using confidential information on place of residence on the

Japanese General Social Survey (JGSS) and the Education, Social Stratification and Mobility Survey (ESSM), we followed the agreements on the use of confidential information.

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Tables

Table 1. Descriptive statistics

	Mean/Prop.	SD	Min.	Max.
Accessibility to local universities	0.289	0.322	0.011	1.831
Accessibility to surrounding universities	0.081	0.160	0.000	0.968
Prefecture income per capita (million JPY)	2.644	1.043	0.435	6.344
Unemployment rate (%)	3.022	1.571	0.312	11.854
Proportion of university graduates (%)	11.334	6.781	1.077	38.079
University enrollment				
No	0.683			
Yes	0.317			
Parental class				
I+II (Professionals and managers)	0.263			
III (Routine nonmanual)	0.118			
IV (Small employers and farmers)	0.318			
V+VI (Skilled manual)	0.153			
VII (Semi-skilled manual)	0.148			
Parental education				
Tertiary	0.301			
Upper secondary	0.416			
Lower secondary	0.284			
Gender				
Men	0.459			
Women	0.541			
N	44413			

Notes. Proportions of survey dummies, cohort, and prefecture are not shown. The sample is weighted by the prefecture's 18-year-old population in each year.

Table 2. Log-odds ratios estimated from logit models predicting individuals' university enrollment

	Model 0	Model 1	Model 2
Accessibility to local universities	1.236***	0.763*	0.780*
	(0.184)	(0.313)	(0.347)
Accessibility to neighboring universities	1.418***	1.661**	1.460*
	(0.324)	(0.560)	(0.598)
Prefecture income per capita (million JPY)		-0.079	-0.089
		(0.100)	(0.105)
Unemployment rate (%)		-0.074	-0.068
		(0.043)	(0.042)
Percent of university graduates (%)		-0.046	-0.043
		(0.035)	(0.036)
Parental class (ref: I+II professionals/managers)			
III routine non-manual		-0.463***	-0.515***
		(0.052)	(0.067)
IV small employers/farmers		-0.852***	-0.914***
		(0.060)	(0.096)
V+VI skilled manual		-0.899***	-0.933***
		(0.057)	(0.084)
VII semi-skilled manual		-1.302***	-1.413***
		(0.053)	(0.071)
Parental education (ref: Tertiary)			
Upper secondary		-0.872***	-0.752***
		(0.068)	(0.055)
Lower secondary		-1.851***	-1.812***
		(0.080)	(0.079)
Interactions with parental class (ref: I+II)			
Accessibility to local universities x III			0.010
			(0.087)
Accessibility to local universities x IV			0.218
			(0.118)
Accessibility to local universities x V+VI			-0.021
			(0.090)
Accessibility to local universities x VII			0.227*
			(0.098)
Accessibility to surrounding universities x III			0.470**
			(0.153)
Accessibility to surrounding universities x IV			-0.192
			(0.312)
Accessibility to surrounding universities x V+VI			0.356
			(0.259)
Accessibility to surrounding universities x VII			0.416
			(0.282)
Interactions with parental education			
Accessibility to local universities x Upper secondary			-0.336***

			(0.058)
Accessibility to local universities x Lower secondary			-0.078
			(0.092)
Accessibility to surrounding universities x Upper secondary			-0.084
			(0.271)
Accessibility to surrounding universities x Lower secondary			0.206
			(0.217)
Gender	No	Yes	Yes
Survey dummies	No	Yes	Yes
Prefecture fixed effects	No	Yes	Yes
Year fixed effects	No	Yes	Yes
Year fixed effects x gender	No	Yes	Yes
N	44413	44413	44413
Pseudo R^2	0.032	0.224	0.224

Notes. $^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$ (two-tailed tests). Prefecture-clustered robust standard errors are in parentheses.

Figures

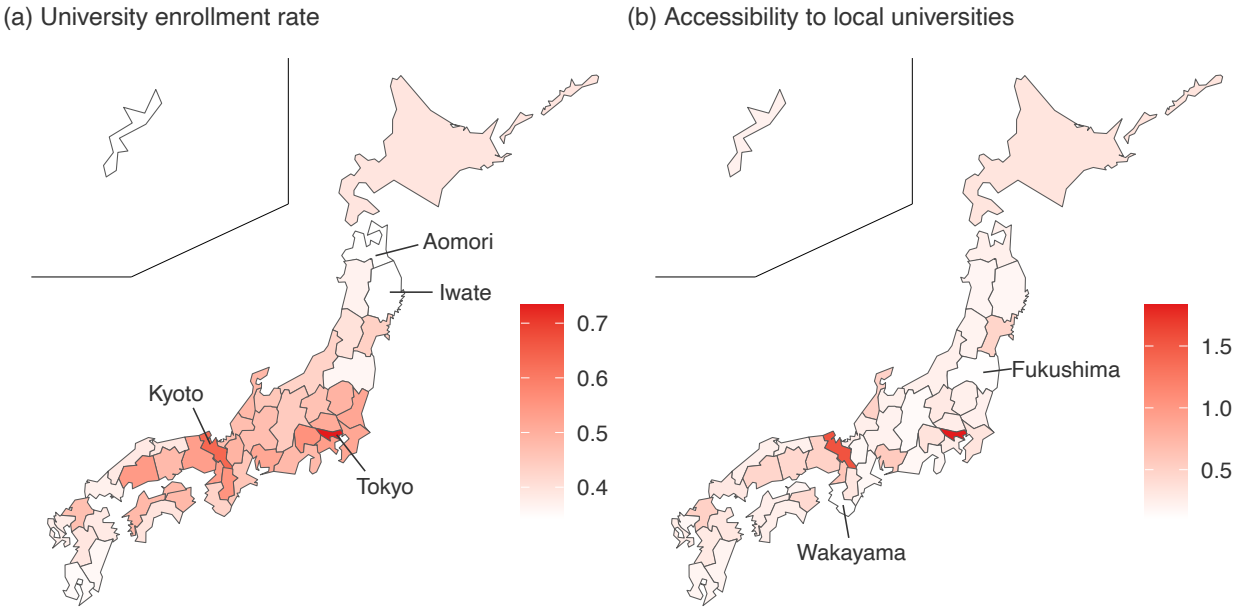

Figure 1. University enrollment rate and accessibility to local universities by prefecture in 2010.
Source. School Basic Survey (Ministry of Education, Culture, Sports, Science and Technology 2024).
Note. The university enrollment rate refers to the number of university enrollments in the following year divided by the number of 18-year-old population, which was calculated by School Basic Survey (Ministry of Education, Culture, Sports, Science and Technology 2024). The accessibility to local universities is the total number university admission in the prefecture divided by the number of 18-year-old population. The number of admission capacity was retrieved from (Center for Research and Education in Program Evaluation, University of Tokyo 2021) and the 18-year-old population was retrieved from the number of junior high school graduates three years earlier (Ministry of Education, Culture, Sports, Science and Technology 2024).

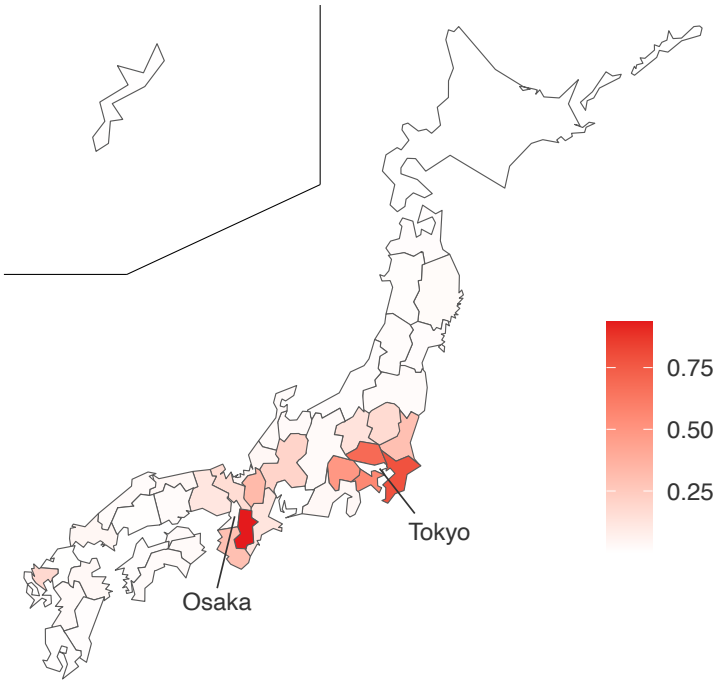

Figure 2. Accessibility to neighboring universities by prefecture in 2010.
Source. School Basic Survey (Ministry of Education, Culture, Sports, Science and Technology 2024) and Population Census (Statistics Bureau of Japan 2023b).

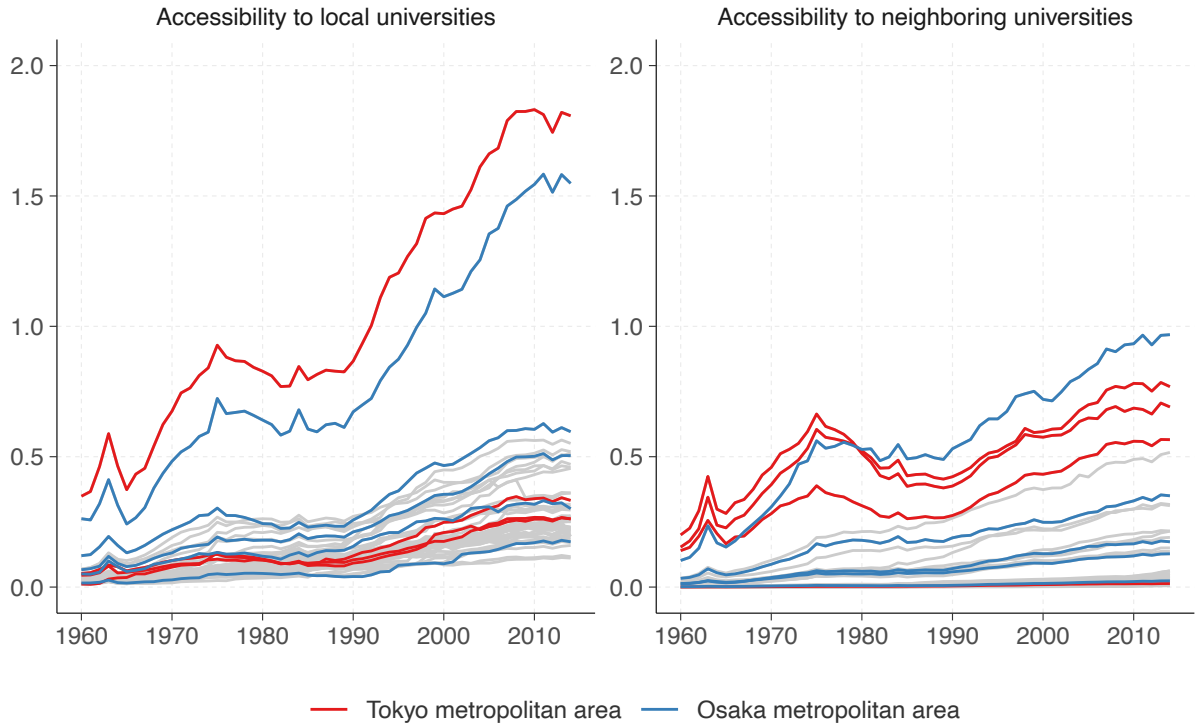

Figure 3. Trends in accessibility to local and neighboring universities by prefectures, 1960–2014.

Source. Data Set on Admission Capacity of Japanese Universities (Center for Research and Education in Program Evaluation, University of Tokyo 2021), School Basic Survey (Ministry of Education, Culture, Sports, Science and Technology 2024), and Population Census (Statistics Bureau of Japan 2023b).

Notes. The detailed definition of these indicators is shown in Methods section. Tokyo metropolitan area includes Tokyo, Saitama, Kanagawa, Chiba prefecture; Osaka metropolitan area includes Osaka, Kyoto, Hyogo, Shiga, and Nara prefecture. The definition of accessibility to local universities and neighboring universities and shown in equation (1) and (2).

Appendices

A. Details of the survey

We used multiple social survey data. The Social Stratification and Mobility (SSM) survey aims to reveal social stratification and mobility in Japan and has been conducted every 10 years since 1955. We used the survey from 1995 since the variables of prefecture of residence at age 15 are not publicly available before the 1985 survey. The 1995 and 2005 survey collected data from 20- to 69-year-old respondents, and the 2015 survey collected data from 20- to 79-year-old respondents. The data were collected via in-person interviews with additional on-the-spot questionnaires. More details for the 2005 and 2015 surveys are presented in Miwa and Kobayashi (2008) and Miwa and Shirahase (2021).

The Japanese General Social Survey replicates the design of the General Social Survey project in the US. Data from 2000 to 2018 were available at the time of writing. Except for the 2009 and 2016 surveys, the JGSS collects data from 20- to 89-year-old respondents. Notably, the JGSS does not collect detailed information on mothers' occupation when the respondents were 15 years old, except for the 2009 survey, which targeted young and middle-aged respondents. Thus, the respondents who did not report their father's occupation in the JGSS were treated as missing. The data were collected via in-person interviews with additional on-the-spot questionnaires. More details are provided by the JGSS Research Center (2022).

The Japan Life-Course Panel Survey was planned as a panel survey targeting young and middle-aged people that collected information on respondents' backgrounds in the first year of the survey. The original survey respondents were 20 to 40 years old in 2007. The sample was replenished in 2011 and covered those aged 24 to 44. A new sample was added in 2019 comprising individuals aged 20 to 31. The data were collected by mail and visit collection

methods. The waves of first entry into the survey of each respondent were used. More details are given in Ishida (2013) and Naka and Miwa (2020).

The Education, Social Stratification, and Mobility survey (ESSM) 2013 was designed to disentangle the relationships among social origin, education, and destination. The survey targeted individuals aged 30–69 in 2013. The data were collected through mail and visit collection methods. More details are given in Nakamura et al. (2018).

All surveys randomly selected respondents based on a national, two-stage stratified probability sample of Japanese men and women. The locales based on census tract distribution were randomly selected, and several individuals were randomly selected within each locale. This is the standard method of data collection for social surveys in Japan. Table A1 summarizes the characteristics of these surveys. Since the analytical sample comprises different survey data covering different age ranges and sample sizes.

Table A1. List of surveys and sample size

Survey	Age at survey	Birth cohort	Original sample size	Response rate (%)	Analytical sample size
SSM1995A	20–69	1926–1974	2,653	65.8	1,471
SSM1995B	20–69	1926–1974	2,704	67.2	1,507
SSM2005	20–69	1935–1984	5,742	44.1	3,729
SSM2015	20–79	1935–1994	7,817	50.1	5,756
JGSS2000	20–89	1910–1979	2,893	64.9	1,371
JGSS2001	20–89	1911–1980	2,790	62.4	1,309
JGSS2002	20–89	1912–1981	2,953	62.3	1,504
JGSS2003	20–89	1913–1982	3,663	51.5	1,767
JGSS2005	20–89	1915–1984	2,023	50.5	979
JGSS2006	20–89	1916–1985	4,254	59.8 / 59.8*	2,197
JGSS2008	20–89	1918–1987	4,220	58.2 / 60.6*	2,387
JGSS2009LCS	28–42	1966–1982	2,727	51.1	2,407
JGSS2010	20–89	1920–1989	5,003	62.2 / 62.1*	2,950
JGSS2012	20–89	1922–1911	4,667	59.1 / 58.8*	2,786
JGSS2015	20–89	1925–1994	2,079	52.6	1,311
JGSS2016	25–49	1966–1991	968	50.8	774
JGSS2017	20–89	1927–1996	744	55.6	470
JGSS2018	20–89	1928–1997	1,916	54.3	1,225

JLPS2007	20–40	1967–1987	4,800	40.4	3,736
JLPS2011	24–44	1967–1987	963	31.0	731
JLPS2019	20–31	1988–1999	2,380	41.3	1,526
ESSM2013	30–69	1948–1983	2,893	60.3	2,520

Note: * Values represent the response rate in the questionnaire forms A and B.

Because the sample does not represent the actual distribution of the cohort- and prefecture-specific population due to the timing of the survey, we weighted the sample based on the population of each year and prefecture, which is obtained from the School Basic Survey (Ministry of Education, Culture, Sports, Science and Technology 2024). Figure A1 shows the original distribution by year at age 18 (left panel) and the distribution after weighting (right panel). The weighted sample approximates the actual population distribution by year at age 18.

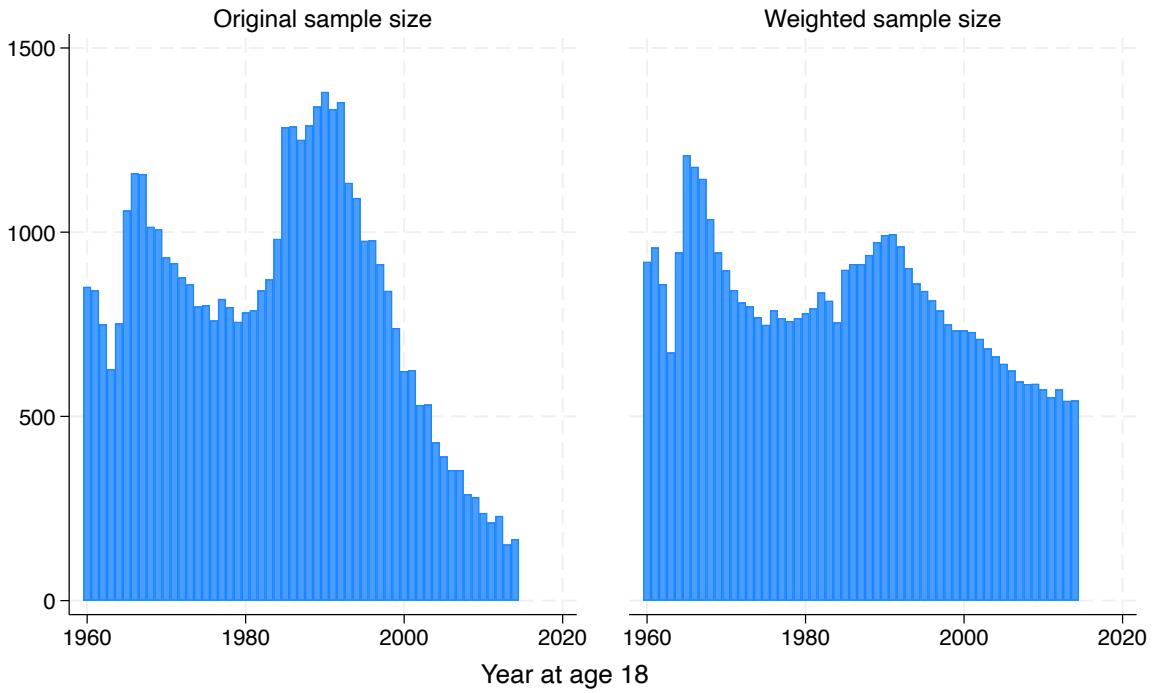

Figure A1 Original and weighted sample size by year at age 18

B. Supplementary Tables

Table A2. Log-odds ratios estimated from logit models predicting individuals' university enrollment, using multiple imputation

	Model 0	Model 1	Model 2
Accessibility to local universities	1.242***	0.780**	0.817**
	(0.182)	(0.266)	(0.299)
Accessibility to neighboring universities	1.486***	1.584***	1.416**
	(0.336)	(0.470)	(0.508)
Prefecture income per capita (million JPY)		-0.115	-0.129
		(0.079)	(0.083)
Unemployment rate (%)		-0.097*	-0.092*
		(0.044)	(0.042)
Percent of university graduates (%)		-0.046	-0.045
		(0.032)	(0.032)
Parental class (ref: I+II professionals/managers)			
III routine non-manual		-0.511***	-0.545***
		(0.049)	(0.060)
IV small employers/farmers		-0.921***	-0.992***
		(0.054)	(0.087)
V+VI skilled manual		-0.944***	-0.966***
		(0.054)	(0.082)
VII semi-skilled manual		-1.353***	-1.462***
		(0.047)	(0.071)
Parental education (ref: Tertiary)			
Upper secondary		-0.886***	-0.755***
		(0.073)	(0.061)
Lower secondary		-1.855***	-1.776***
		(0.083)	(0.082)
Interactions with parental class (ref: I+II)			
Accessibility to local universities x III			-0.012
			(0.092)
Accessibility to local universities x IV			0.236
			(0.125)
Accessibility to local universities x V+VI			-0.066
			(0.118)
Accessibility to local universities x VII			0.226
			(0.123)
Accessibility to surrounding universities x III			0.364*
			(0.173)
Accessibility to surrounding universities x IV			-0.141
			(0.261)
Accessibility to surrounding universities x V+VI			0.376
			(0.259)
Accessibility to surrounding universities x VII			0.385
			(0.259)
Interactions with parental education			

Accessibility to local universities x Upper secondary			-0.370***
			(0.070)
Accessibility to local universities x Lower secondary			-0.202
			(0.106)
Accessibility to surrounding universities x Upper secondary			-0.051
			(0.222)
Accessibility to surrounding universities x Lower secondary			0.110
			(0.192)
Gender	No	Yes	Yes
Survey dummies	No	Yes	Yes
Prefecture fixed effects	No	Yes	Yes
Year fixed effects	No	Yes	Yes
Year fixed effects x gender	No	Yes	Yes
N	56205	56205	56205

Notes. *** $p < .001$, ** $p < .01$, * $p < .05$ (two-tailed tests). Prefecture-clustered robust standard errors are in parentheses.

Table A3. Log-odds ratios estimated from logit models predicting individuals' university enrollment, without sample weight

	Model 0	Model 1	Model 2
Accessibility to local universities	1.434***	0.657**	0.622*
	(0.300)	(0.219)	(0.257)
Accessibility to neighboring universities	1.374***	1.564***	1.375**
	(0.265)	(0.459)	(0.465)
Prefecture income per capita		0.024	0.020
		(0.102)	(0.106)
Unemployment rate		0.015	0.019
		(0.047)	(0.047)
Percent of university graduates		-0.044	-0.042
		(0.023)	(0.023)
Parental class (ref: I+II professionals/managers)			
III routine non-manual		-0.447***	-0.506***
		(0.037)	(0.054)
IV small employers/farmers		-0.872***	-0.938***
		(0.043)	(0.060)
V+VI skilled manual		-0.894***	-0.941***
		(0.052)	(0.077)
VII semi-skilled manual		-1.279***	-1.378***
		(0.044)	(0.069)
Parental education (ref: Tertiary)			
Upper secondary		-0.861***	-0.791***
		(0.039)	(0.047)
Lower secondary		-1.837***	-1.833***
		(0.055)	(0.067)
Interactions with parental class (ref: I+II)			
Accessibility to local universities x III			0.089
			(0.135)
Accessibility to local universities x IV			0.290*
			(0.130)
Accessibility to local universities x V+VI			0.030
			(0.153)
Accessibility to local universities x VII			0.302
			(0.191)
Accessibility to surrounding universities x III			0.366*
			(0.145)
Accessibility to surrounding universities x IV			-0.064
			(0.291)
Accessibility to surrounding universities x V+VI			0.401
			(0.245)
Accessibility to surrounding universities x VII			0.311
			(0.230)
Interactions with parental education			
Accessibility to local universities x Upper secondary			-0.267***

			(0.066)
Accessibility to local universities x Lower secondary			0.071
			(0.146)
Accessibility to surrounding universities x Upper secondary			-0.062
			(0.228)
Accessibility to surrounding universities x Lower secondary			0.135
			(0.214)
Gender	No	Yes	Yes
Survey dummies	No	Yes	Yes
Prefecture fixed effects	No	Yes	Yes
Year fixed effects	No	Yes	Yes
Year fixed effects x gender	No	Yes	Yes
N	44413	44413	44413
Pseudo R^2	0.030	0.214	0.215

Notes. *** $p < .001$, ** $p < .01$, * $p < .05$ (two-tailed tests). Prefecture-clustered robust standard errors are in parentheses.

Table A4. Log-odds ratios estimated from logit models predicting individuals' university enrollment, excluding Hokkaido residents

	Model 0	Model 1	Model 2
Accessibility to local universities	1.181***	0.933***	0.993***
	(0.167)	(0.257)	(0.277)
Accessibility to neighboring universities	1.321***	1.707**	1.565*
	(0.305)	(0.570)	(0.619)
Prefecture income per capita		-0.086	-0.099
		(0.081)	(0.084)
Unemployment rate		-0.067	-0.062
		(0.055)	(0.055)
Percent of university graduates		-0.081***	-0.080***
		(0.022)	(0.022)
Parental class (ref: I+II professionals/managers)			
III routine non-manual		-0.451***	-0.495***
		(0.056)	(0.074)
IV small employers/farmers		-0.817***	-0.839***
		(0.047)	(0.073)
V+VI skilled manual		-0.883***	-0.907***
		(0.058)	(0.092)
VII semi-skilled manual		-1.282***	-1.378***
		(0.052)	(0.073)
Parental education (ref: Tertiary)			
Upper secondary		-0.877***	-0.746***
		(0.072)	(0.062)
Lower secondary		-1.844***	-1.789***
		(0.087)	(0.089)
Interactions with parental class (ref: I+II)			
Accessibility to local universities x III			-0.009
			(0.089)
Accessibility to local universities x IV			0.134
			(0.088)
Accessibility to local universities x V+VI			-0.034
			(0.098)
Accessibility to local universities x VII			0.188*
			(0.092)
Accessibility to surrounding universities x III			0.431**
			(0.166)
Accessibility to surrounding universities x IV			-0.350
			(0.272)
Accessibility to surrounding universities x V+VI			0.301
			(0.271)
Accessibility to surrounding universities x VII			0.355
			(0.277)
Interactions with parental education			
Accessibility to local universities x Upper secondary			-0.349***

			(0.063)
Accessibility to local universities x Lower secondary			-0.125
			(0.082)
Accessibility to surrounding universities x Upper secondary			-0.101
			(0.270)
Accessibility to surrounding universities x Lower secondary			0.127
			(0.228)
Gender	No	Yes	Yes
Survey dummies	No	Yes	Yes
Prefecture fixed effects	No	Yes	Yes
Year fixed effects	No	Yes	Yes
Year fixed effects x gender	No	Yes	Yes
N	42084	42084	42084
Pseudo R^2	0.029	0.220	0.220

Notes. $^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$ (two-tailed tests). Prefecture-clustered robust standard errors are in parentheses.

Table A5. Log-odds ratios estimated from logit models predicting individuals' university enrollment, using gender-specific accessibility indicator

	Model 0	Model 1	Model 2
Accessibility to local universities	1.205***	0.787*	0.805*
	(0.174)	(0.319)	(0.352)
Accessibility to neighboring universities	1.384***	1.690**	1.486*
	(0.330)	(0.605)	(0.641)
Prefecture income per capita		-0.083	-0.093
		(0.100)	(0.105)
Unemployment rate		-0.075	-0.070
		(0.044)	(0.043)
Percent of university graduates		-0.045	-0.043
		(0.035)	(0.035)
Parental class (ref: I+II professionals/managers)			
III routine non-manual		-0.463***	-0.518***
		(0.052)	(0.067)
IV small employers/farmers		-0.853***	-0.916***
		(0.059)	(0.096)
V+VI skilled manual		-0.899***	-0.936***
		(0.057)	(0.083)
VII semi-skilled manual		-1.302***	-1.411***
		(0.053)	(0.070)
Parental education (ref: Tertiary)			
Upper secondary		-0.871***	-0.751***
		(0.068)	(0.055)
Lower secondary		-1.851***	-1.810***
		(0.080)	(0.080)
Interactions with parental class (ref: I+II)			
Accessibility to local universities x III			0.015
			(0.092)
Accessibility to local universities x IV			0.226
			(0.123)
Accessibility to local universities x V+VI			-0.018
			(0.090)
Accessibility to local universities x VII			0.224*
			(0.096)
Accessibility to surrounding universities x III			0.496**
			(0.156)
Accessibility to surrounding universities x IV			-0.185
			(0.320)
Accessibility to surrounding universities x V+VI			0.378
			(0.267)
Accessibility to surrounding universities x VII			0.437
			(0.292)
Interactions with parental education			
Accessibility to local universities x Upper secondary			-0.346***

			(0.058)
Accessibility to local universities x Lower secondary			-0.078
			(0.098)
Accessibility to surrounding universities x Upper secondary			-0.098
			(0.275)
Accessibility to surrounding universities x Lower secondary			0.189
			(0.223)
Gender	No	Yes	Yes
Survey dummies	No	Yes	Yes
Prefecture fixed effects	No	Yes	Yes
Year fixed effects	No	Yes	Yes
Year fixed effects x gender	No	Yes	Yes
N	44413	44413	44413
Pseudo R^2	0.028	0.224	0.224

Notes. *** $p < .001$, ** $p < .01$, * $p < .05$ (two-tailed tests). Prefecture-clustered robust standard errors are in parentheses.

Table A6. Coefficients estimated from linear probability models predicting individuals' university enrollment

	Model 0	Model 1	Model 2
Accessibility to local universities	0.279***	0.137*	0.157**
	(0.040)	(0.055)	(0.057)
Accessibility to neighboring universities	0.310***	0.265**	0.262*
	(0.073)	(0.096)	(0.105)
Prefecture income per capita		-0.017	-0.023
		(0.019)	(0.020)
Unemployment rate		-0.007	-0.006
		(0.008)	(0.007)
Percent of university graduates		-0.001	-0.002
		(0.006)	(0.006)
Parental class (ref: I+II professionals/managers)			
III routine non-manual		-0.099***	-0.109***
		(0.009)	(0.012)
IV small employers/farmers		-0.167***	-0.168***
		(0.009)	(0.013)
V+VI skilled manual		-0.176***	-0.173***
		(0.009)	(0.013)
VII semi-skilled manual		-0.223***	-0.217***
		(0.007)	(0.010)
Parental education (ref: Tertiary)			
Upper secondary		-0.180***	-0.146***
		(0.013)	(0.009)
Lower secondary		-0.295***	-0.261***
		(0.016)	(0.011)
Interactions with parental class (ref: I+II)			
Accessibility to local universities x III			0.005
			(0.015)
Accessibility to local universities x IV			0.022
			(0.013)
Accessibility to local universities x V+VI			-0.019
			(0.011)
Accessibility to local universities x VII			-0.022
			(0.013)
Accessibility to surrounding universities x III			0.089**
			(0.028)
Accessibility to surrounding universities x IV			-0.069
			(0.052)
Accessibility to surrounding universities x V+VI			0.024
			(0.051)
Accessibility to surrounding universities x VII			-0.021
			(0.043)
Interactions with parental education			
Accessibility to local universities x Upper secondary			-0.086***

			(0.012)
Accessibility to local universities x Lower secondary			-0.099***
			(0.012)
Accessibility to surrounding universities x Upper secondary			-0.041
			(0.055)
Accessibility to surrounding universities x Lower secondary			-0.030
			(0.046)
Gender	No	Yes	Yes
Survey dummies	No	Yes	Yes
Prefecture fixed effects	No	Yes	Yes
Year fixed effects	No	Yes	Yes
Year fixed effects x gender	No	Yes	Yes
N	44413	44413	44413
R^2	0.040	0.248	0.250

Notes. *** $p < .001$, ** $p < .01$, * $p < .05$ (two-tailed tests). Prefecture-clustered robust standard errors are in parentheses.

C. References in Appendices

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