CIRJE-F- 1188

Measuring Discrimination in Spatial Equilibrium: 100 Years of *Japan's Invisible Race*

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February 2022; Revised in September 2022

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September 9, 2022

Abstract

This paper provides a novel revealed-preference estimate of the severeness of discrimination over 100 years, focusing on *buraku* discrimination in Japan. Buraku discrimination is distinctive in that the risk of being identified as the discriminated group member crucially depends on whether one lives in certain areas (*buraku areas*), implying that the risk is indirectly traded in the land market. This feature allows us to measure the cost of discrimination risk as the capitalization into land prices. We estimate it using the new land price data of Kyoto spanning from 1912 to 2018 and a border design. We find that the land price discount of buraku areas was 53% in 1912 and 14% in 2018. The discount had declined in the 20th century but the decline has stopped in the 21st century. These results indicate the severe buraku discrimination, especially in the past, and its strong persistence.

Keywords: Discrimination, Land prices, Negative amenity, Spatial discontinuity, Buraku.

JEL classification: J15, J71, N95, R21, R30.

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[*] We are deeply grateful to Steve Redding for his invaluable guidance throughout the project, Leah Boustan and Ellora Derenoncourt for their numerous helpful suggestions. We are also thankful to Elena Aguilar, Yu Awaya, Mark Bamba, Eduard Böehm, Zhang Chen, Lavar Edmonds, Pablo Fajgelbaum, Masao Fukui, Manuel García-Santana, Jun Goto, Masayoshi Hayashi, Satoshi Kasamatsu, Keisuke Kawata, Nobuhiro Kiyotaki, Patrick Kline, Simon Margolin, Eduardo Morales, Mariko Nakagawa, Kentaro Nakajima, Ezra Oberfield, Swapnika Rachapalli, Albert Saiz, Yoichi Sugita, Takatoshi Tabuchi, Kensuke Teshima, Jing Wu, Junichi Yamasaki, and participants of numerous seminars and conferences. We thank Takashi Kirimura for sharing his GIS historical population census data of Kyoto city and Tatsuki Inoue for sharing his dataset on urban health amenities of Kyoto city in the early 1920's. Takashi Fujisawa, Naoya Kobayashi, Yohei Matsushita, Tomoyoshi Taira, and Tomoya Yano provided excellent research assistance. We acknowledge that the land price data in Kyoto 1912 was provided by Art Research Center, Ritsumeikan University and the data on land price assessments for property taxation 2006-2018 was provided by Research Center for Property Assessment System. Yamagishi appreciates the financial support from the International Economics Section and the Program for Research on Inequality, Princeton University, and the Funai Foundation for Information Technology. Sato appreciates the financial supports from JSPS KAKENHI (18H00842; 22H00836), Research Institute of Economy, Trade and Industry, and Center for Research and Education in Program Evaluation and Center for Real Estate Innovation, the University of Tokyo. We take sole responsibility for any errors in this paper.

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> *The buraku issue is about the minority group facing class discrimination among the Japanese race or Japanese citizens.*
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> Dowa Policy Council, the Prime Minister's Office (1965).[1]

> *Since the outcastes [the buraku people] have no distinctive physical traits and today possess few distinctive cultural traits, they can "pass" into the normal society once they are outside their home areas. Still, outcastism is disappearing at a seemingly slow pace.*
>
> John Price (1966, pages 14–15).

> *If you live in a buraku area, the chance that you are regarded as coming from the buraku class emerges. You want to avoid such "risk of being regarded as buraku".... This is the discrimination against a land plot in buraku areas.*
>
> Hitoshi Okuda (2007, page 42).[2]

1 Introduction

Given that discrimination has been one of the most serious social issues around the world, understanding how much people suffer when they face a high discrimination risk is essential. However, despite numerous studies on discrimination, answering this question remains challenging because the risk of being identified as a discriminated group member is typically determined by an immutable characteristic, such as skin color (Sen and Wasow 2016). The innate nature of the discrimination risk poses two key empirical difficulties. First, there is no market price for discrimination risk since people cannot trade the discrimination risk they face. If people could buy and sell their discrimination risk, its market price would measure the cost of facing a discrimination risk as the willingness-to-pay for avoiding the risk. However, such a market cannot exist when the discrimination risk is innately determined, implying that the revealed-preference estimate of the cost of having a higher discrimination risk is unavailable. Second, there is typically no random variation in the risk of being regarded as a discriminated group member. While audit and correspondence studies have creatively provided an experimental variation (e.g., Yinger 1986; Bertrand and Mullainathan 2004; Kline and Walters 2021), such an experiment is available only in special settings in which an experimental intervention is conceptually and ethically feasible. Observational studies about discrimination have also yielded important insights (e.g., Cutler, Glaeser and Vigdor 1999; Card, Mas and Rothstein

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[1] The original source of quotation in Japanese is translated by the authors.

[2] The original source of quotation in Japanese is translated by the authors.

2008; Fryer 2011; Boustan 2016; Aaronson, Hartley and Mazumder 2021; Derenoncourt and Montialoux 2021), but they have not yet found a quasi-experimental variation to identify the overall cost of facing a higher risk of being identified as a discriminated group member.

In this paper, we address the above empirical difficulties and provide the first revealed-preference estimate of the overall cost of facing a higher discrimination risk by focusing on discrimination against the *buraku* class in Japan. We exploit the fact that the risk of being regarded as buraku crucially depends on residential location. The buraku people have little visible distinction from the majority Japanese, but living in a *buraku area*, a small historical community area of discriminated people, signals the group membership and increases the discrimination risk (Price 1966; Okuda 2007). By embedding this situation in a spatial equilibrium model, we show that the land price discount of buraku areas provides a revealed-preference estimate on the cost of facing a higher risk of being identified as belonging to the buraku class. Intuitively, the association between the discrimination risk and particular land plots implies that people are implicitly trading the discrimination risk through the land market. We can infer from the prices of similar land plots but with different levels of the discrimination risk the willingness-to-pay to avoid the discrimination risk. Thus, the strong association between the discrimination risk and particular locations in buraku discrimination provides a rare opportunity to quantify, in a revealed-preference way, the cost of being identified as a discriminated group member with a higher probability.

Then, we quantify how the cost of having a higher discrimination risk, induced by living in a buraku area, has evolved over 100 years by looking at the new land price data of Kyoto spanning from 1912 to 2018. We exploit a quasi-experimental variation in the discrimination risk by comparing two similar land plots with different discrimination risk levels, using a border design and various control variables. We estimate that land prices in buraku areas were 53% lower in 1912 and 14% lower in 2018 than those in nearby non-buraku areas. Newly-digitizing land price data in intermediate years, we also estimate that while the land price discount declined particularly fast during the period of extensive policies and efforts to mitigate buraku discrimination, the decline stopped in the 21st century. Overall, our results suggest that buraku discrimination was historically quite severe and, despite the substantial mitigation, exhibited strong persistence for over 100 years.

Buraku is a historically discriminated group in Japan and buraku discrimination originally emerged because they typically engaged in industries related to killing animals (e.g., leather-crafting and butchering) in the premodern period, resulting in stigma associated with these people in light of Buddhist and Shintoist philosophy. However, the association between discrimination toward the buraku and these occupations has drastically diminished over time after the emancipation of the buraku people, possibly because many non-discriminated people have also entered these formerly discriminated industries and the religious aversion has also weakened in Japanese society. Still, the discriminatory mind toward the descendants of these people remains in society. These discriminated people are now called buraku people (*burakumin* in Japanese), or simply the buraku. They have faced various forms of discrimination, including difficulty in securing a decent job, marring a person one loves, and bullying in various forms. Importantly, buraku people have few differences from the majority Japanese (Dowa Policy Council, the Prime Minister's Office 1965; Price 1966), which is best illustrated by the title of the book, *Japan's invisible race*, by De Vos and Wagatsuma (1966).[3]

What is distinctive about discrimination against the buraku compared to other contexts of discrimination is the role of residence: Someone's residential location is key information that people use to infer whether he or she belongs to the buraku class. In a typical context of discrimination in which the discriminated group has some visible and immutable characteristics such as skin color, such inference is unnecessary except for "blind" settings as in resumes in job applications (Bertrand and Mullainathan 2004) and online markets (Besbris, Faber, Rich and Sharkey 2015). In contrast, the buraku belong to the Japanese race and have little visible distinction from the non-discriminated majority Japanese, implying that discriminatory people need to infer whether someone belongs to the buraku class even after a face-to-face interaction (Price 1966; Okuda 2007). Living in a buraku area, a historical community area of the buraku people, increases the risk of being regarded as belonging to the buraku class, even if someone is originally not from a buraku area (Okuda 2007). Indeed, the Japanese word "buraku" literally means "community area," implying the strong association between discrimination and certain locations. On the other hand, those who were born in these areas might decrease the discrimination risk by leaving these areas and passing as non-discriminated Japanese (Price 1966; Dahis, Nix and Qian 2019).

Such a distinctive role of residence in buraku discrimination implies that the discrimination risk is indirectly "traded" in the land market. In this context, we show in a spatial model à la Rosen (1979) and Roback (1982) that in spatial equilibrium, the cost of facing a higher discrimination risk is exactly compensated for the land price discount in buraku areas. Thus, by comparing two land plots with similar characteristics but different levels of discrimination risk, we can back out the implicit price of a higher discrimination risk. This way, we can estimate in revealed preference the cost of being identified as a discriminated group member. We also harness our model to obtain additional empirical insights, such as backing out the income data (Heblich, Redding and Sturm 2020) and conducting a counterfactual analysis (see Section 8).

Note that the association between residential location and the perceived group membership is a universal phenomenon that can arise in other contexts when the discriminated group is not visually distinguishable from the majority. Examples include the caste discrimination in India (Gidla 2017) and the passing of Black Americans who have a similar appearance as the Whites by moving away from black community areas (Dahis et al. 2019).[4] Despite the similarities with these instances of discrimination, the particularly strong association between living in a buraku

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[3] Note that the phrase *Japan's invisible race* does not intend to claim that the buraku people belong to a different race from the majority Japanese (Dowa Policy Council, the Prime Minister's Office 1965).

[4] Both buraku discrimination and Indian caste discrimination may be viewed as discrimination among the same race due to the premodern history, in which residence might play a role when that the discriminated group is hard to identify by other clues such as appearance. Other examples include discrimination based on the feudal system in Europe, *cagots* in the western France and northern Spain, and *baekjeong* in Korea.

area and the risk of being identified as a buraku class member, which applies to almost everyone in Japan due to its high ethnic homogeneity, allows us to quantify the overall effect of facing a higher risk by exploiting the capitalization into land prices.

Another distinctive feature of discrimination against the buraku is that they were formally emancipated in 1871, way before many recent attempts to eliminate discrimination such as the civil rights movement in the US. This setting allows us to analyze how persistent discrimination has been for more than 150 years even when formal discriminatory rules are absent. We newly introduce into the economics literature the comprehensive GIS land price data of Kyoto city in 1912 to measure the severeness of discrimination in the early 20th century. Despite the lack of rich individual-level microdata in pre-war Japan, our capitalization approach using land price data allows us to measure the severeness of discrimination. We also newly digitize the land price data of Kyoto city for the period between 1961 and 1991. Combined with the modern land price data of Kyoto city covering the entire city in the 21st century, we uncover the time series of the land price discount of buraku areas for more than 100 years, which is also interpreted as the long-run time series of the cost of having a higher discrimination risk. This might be suggestive considering how discrimination in other contexts, such as racial discrimination in the US, would evolve over time.

Empirically, we estimate the effect of buraku areas on land prices using the land price data of Kyoto city in 1912, 1961–1991, and 2006–2018. We exploit the quasi-experimental variation in the discrimination risk by employing a border design and comparing two very proximate land plots but with different levels of the discrimination risk (c.f., Black 1999; Bayer, Ferreira and McMillan 2007; Dell 2010). We start with the comparison between 1912 and 2018 to obtain a broad picture of the dynamics of buraku discrimination. In 1912, a land plot in a buraku area is estimated to have around 53% lower price than an otherwise identical land plot in a non-buraku area. This substantial land price penalty is indicative of severe discrimination. In 2018, the land price penalty is estimated to be around 14%, which is much lower than that in 1912 but still economically sizable and strongly statistically significant. Adding land price data for the period between 1961 and 2015, we then reveal the time-series pattern of the severeness of discrimination over the century and what potentially contributed to mitigating it. We find that while the land price penalty declined from 1912 to 1961, it did not decrease from 1961 to 1973. However, the land price penalty again started declining since 1973, which might be attributed to the large-scale policies and efforts to mitigate buraku discrimination around the late 1960's and the 1970's. Furthermore, the results for 2006–2015 suggest that the decline in the severeness of discrimination has essentially stopped in the 21st century, starkly highlighting the persistence of discrimination.

To shed further light on buraku discrimination, we conduct several additional analyses by exploiting various implications from our model. First, we express the cost of the discrimination risk in terms of compensation in income rather than compensation in land prices to facilitate interpretation and comparison with other studies on discrimination. Our buraku effects on land prices imply that the utility cost is equivalent to 11.2% of income compensation in 1912 and

1.7% of income compensation in 2018. Second, we analyze the income level of buraku areas and show that buraku areas have 74% lower income in 1912, indicating the presence of either discrimination in the labor market or sorting of the poor into buraku areas, or both. However, no income gap is observed today. This pattern is consistent with sociological studies on the living conditions in buraku areas (Akisada 1972; Shima 2016). Third, we conduct a simple counterfactual analysis of reducing discrimination disamenity from the level of 1912 to that of 2018. We find that the observed changes in the population density and the average income in buraku areas are consistent with the model's prediction. Finally, we calculate how much landowners lose their wealth value due to discrimination associated with buraku areas (c.f., Akbar, Li, Shertzer and Walsh 2019).

Overall, by focusing on buraku discrimination in which the discrimination risk is indirectly traded through the land market, we provide a novel revealed-preference estimate of the cost of facing a higher risk of being identified as the discriminated class member. By harnessing a quasi-experimental variation in the discrimination risk, our results over 100 years indicate that severe and persistent discrimination might arise even among the same race. This might underscore the difficulty in eliminating discrimination, especially when the discriminated group has distinct traits and can easily be identified as in a typical context of racial discrimination.

The rest of the paper is organized as follows. Section 2 discusses the related literature. Section 3 provides the institutional background about buraku relevant for our analysis. In Section 4, we introduce a within-city spatial model in which residence determines the discrimination risk. Section 5 describes our empirical strategies and data. We present our empirical results in Section 6 for 1912 and 2018 to show the century-long evolution of the cost of facing a higher discrimination risk. Section 7 analyzes the time-series pattern by further analyzing intermediate years (1961–2015). Section 8 presents results from additional analyses. Section 9 concludes the paper.

2 Related literature

Discrimination in spatial economy. Discrimination has been one of the most important issues in social sciences, including economics, and extensively discussed from various perspectives. The interplay between discrimination and space has also been investigated for a long time, especially in the context of racial discrimination in the US (e.g., Schelling 1971; Yinger 1986; Fujita 1989; Cutler et al. 1999; Bayer et al. 2007; Card et al. 2008; Boustan 2016; Christensen, Sarmiento-Barbieri and Timmins 2022; Aaronson et al. 2021). While it has been argued that housing or land prices can be used to learn about the nature of discrimination (e.g., Cutler et al. 1999), the overall cost of facing a high risk of being identified as the discriminated group member is not identified in such a study. In contrast, we develop and apply the land capitalization approach to directly quantify the overall cost of facing a high discrimination risk by exploiting the distinctive feature of buraku discrimination: the "race" (i.e., the affiliation with the buraku class) can change implicitly through residential location choice and hence it might be traded through the land market.

Other contexts sharing a common feature with buraku discrimination. In some key aspects, our setting resembles a situation analyzed in other studies. First, some areas are regarded as the clustering of the discriminated people (buraku areas), leading to the association between discrimination and particular areas in a city. An example is the "redlining" in the US (e.g., Aaronson et al. 2021). However, unlike our setting, living in a stigmatized area does not change whether someone is regarded as belonging to the discriminated group in society because salient immutable characteristics (e.g., skin color) clearly signal the group.

Second, in a blind setting in which race is not directly observable, there is rich evidence that people use some signals to identify the discriminated group and engage in discriminatory behavior (e.g., Bertrand and Mullainathan 2004; Christensen et al. 2022). Besbris et al. (2015) show that consumers in an online market discriminate against sellers from neighborhoods in which the majority of residents are black, implying that they might infer the seller's race from residence to avoid blacks. This result shows that residence might be used as a signal of the discriminated group, as in buraku discrimination.[5] Unlike these studies, buraku discrimination requires inferring the buraku class even if face-to-face communications take place. Our setting also relates to the argument that hiding the identifying information of discriminated people might prevent discrimination (Goldin and Rouse 2000; Agan and Starr 2018). In buraku discrimination, people focus on residence and engage in discrimination even if the discriminated group has few visible distinctions, highlighting the difficulty in completely concealing the identifying information of the discriminated group.

Finally, in buraku discrimination, we may interpret that people choose whether or not to assimilate into the majority implicitly through their residential location choice. In the US, a minority group has taken actions to facilitate the assimilation, such as passing as the white (Dahis et al. 2019) and changing names (Fryer and Levitt 2004; Saavedra 2021). More broadly, our paper contributes to the literature on identity economics that analyzes the trade-off in choosing own identity among alternatives (e.g., Akerlof and Kranton 2000; Cassan 2015; Atkin, Colson-Sihra and Shayo 2021; Grossman and Helpman 2021). Unlike these studies, the dependence of the buraku membership on the location choice implies that the discrimination risk is indirectly traded in the land market, allowing us to identify the overall cost of facing a higher discrimination risk from land price data.

The long-run impacts of history. This paper also relates to the literature on the long-run impact of history (see Nunn 2009 and Lin and Rauch 2022 for surveys). Our paper suggests the long-run persistence of discrimination against the former discriminated class, which is consis-

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[5] Theoretically, Zenou and Boccard (2000) develop a monocentric city model in which someone living in the city center is, regardless of their race, discriminated against by employers because residence in the city center is used as a proxy for (unobserved) criminal behavior or education. Unlike our model, capitalization of discrimination associated with the stigma of the center is not their focus.

tent with Voigtländer and Voth (2012) showing the centuries-long persistence of anti-semitism in Germany.[6] Moreover, by showing the persistent importance of buraku areas, our paper also suggests the persistence of the spatial distribution of economic activities. In the Japanese context, the seminal work by Davis and Weinstein (2002) finds that the cross-city population distribution across cities quickly recovered back to the pre-war trend after the extensive bombing during the World War 2 (WW2), but subsequent studies find persistence in other outcomes or historical events (e.g., Harada, Ito and Smith 2020; Yamasaki, Nakajima and Teshima 2022). Using the border design as in Dell (2010), we also find the persistence of history in that buraku areas persistently have lower land prices despite the emancipation of the buraku long ago. Our results might provide a better understanding of what situations or historical events have persistent impacts on the spatial economy.

Studies on buraku discrimination. Buraku discrimination in Japan has not yet been studied by economists and to our knowledge, this is the first study that combines a formal economic theory and an econometric framework to analyze it. In contrast to the omission in economics, sociological and historical studies on buraku have been prolific (e.g., De Vos and Wagatsuma 1966; Teraki and Kurokawa 2016), which we build on as needed throughout the paper. Okuda (2000, 2006, 2007) is the only study that focuses on the land price data of buraku areas. Based on several case studies in late-20th and early-21st century Osaka, he demonstrates that land prices in buraku areas are lower than nearby non-buraku areas and argues that aversion toward living in buraku areas might induce the lower price.[7] While this is an important insight, his result remains suggestive because in the presence of many confounding determinants of land prices, the lack of econometric modelling and identification strategy casts concerns on the statistical significance and internal validity of his results. Our study makes at least three significant advancements beyond his suggestive evidence. First, we adopt modern econometric techniques and empirical strategies to address concerns about statistical significance and identification using comprehensive land price data of Kyoto. Second, our focus on Kyoto allows us to investigate the time-series of the land price discount from 1912 to 2018. Given that the buraku were formally emancipated in 1871, we can investigate how the degree of discrimination evolved over a century since almost 40 years after the formal discriminatory schemes were abolished. Finally, by building an economic model, we introduce a capitalization approach in the land market that allows us to measure in revealed preference the cost of facing a higher discrimination risk. We

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[6] Although showing why living in a buraku area carries a persistent stigma is beyond the scope of this paper, one hypothesis is that despite active migration flows of buraku areas, some people keep living in the area for a long time potentially due to attachment to a buraku area or mobility costs. See Section 3.2 for more discussions.

[7] Available qualitative evidence also suggests that buraku areas have lower land prices due to discrimination. For example, Uehara (2009) records the following his own conversation with a man working for a real estate company:

> Uehara: Looking at buraku areas from the viewpoint of real estate agencies, does a buraku area count negatively for real estate values?
> A man working for a real estate company: Yes, buraku areas count negatively. ...I think it means the prejudice toward the buraku still persists....

also exploit the model to conduct several additional analyses.

3 Background: Discrimination against the buraku

We first briefly introduce the historical background of *buraku* in Japan. We mainly follow Teraki and Kurokawa (2016), who present a standard textbook treatment of the history of the buraku, to convey its widely accepted view. We then argue that in the absence of visible distinctions of the discriminated class, current residence plays a key role in identifying who belongs to the buraku class, that is, living in a particular area in a city increases the risk of being identified as buraku. The importance of residence provides the basis for our capitalization approach to estimate in revealed preference the cost of facing a higher discrimination risk by land price data.

The historical origin of discrimination against the buraku is an actively debated topic in the history literature and some might disagree with the exposition presented below. While precisely identifying the historical origin of discrimination is important in itself, we contend that it is not essential for our purpose. What is essential for our argument is that, whatever the reason may be, there have been discriminated groups of people from 1912 and onward and living in particular areas increases the probability of being identified as a member of the discriminated group. Readers interested in more details may read, for example, De Vos and Wagatsuma (1966), Sumimoto and Itakura (1998), and Teraki and Kurokawa (2016).

3.1 Brief overview of the history of the buraku

Discrimination against the buraku class in the modern era is considered to typically stem from aversion toward people in stigmatized industries such as the leather industry and butchering. The stigma dates back to the pre-modern period and these industries were stigmatized because killing animals is considered sinful in Buddhism and Shintoism. In the pre-modern period, people engaging in such industries were called *eta* (literally meaning “greatly polluted”).[8] The target of discrimination during this period was determined based on occupation, although occupation plays a smaller role in the modern period (see Section 3.2). There is no convincing evidence that these discriminated people have distinctively different appearances from non-discriminated Japanese people, which are often the basis for discrimination in other contexts (e.g., skin color).[9] There are subtle cultural differences between the two groups such as accents (Sasaki and De Vos 1966), but the cultures are quite similar in most aspects and even the slight differences also seem to be diminishing over time. As the penetration of Buddhism into Japan had started around Kyoto area, the political center at that time, the discrimination toward them started in the 10th century. At this initial stage of discrimination, there was no formal discriminatory rule but the

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[8] Depending on periods and regions, the similar people were called by a different name (e.g., *kawata*). However, to avoid unnecessary confusion for our purpose, we use the name *eta* throughout the paper, which is a comprehensive name of the class of such people in the Edo period.

[9] Scientific attempts to find an anthropomorphic difference between the buraku and non-buraku people failed (De Vos and Wagatsuma 1966).

discrimination spontaneously started based on religious philosophies.

However, the discrimination was later formalized by samurai governments.[10] Around 1600, they started a formal family and land registration system at the national scale for taxation. The registry noted some people as belonging to the discriminated class. The largest discriminated group was *eta*. Another major example of a discriminated class was the *hinin* (literally meaning "not a human being"), who were mainly beggars and criminals. The first formal discriminatory control on the behavior of the discriminated classes (*fuzoku torishimari rei*) by the Tokugawa shogunate government was issued in 1776. Several local governments (*han*) had already implemented specific controls on their life prior to 1776, while many other local governments also implemented such control after 1776. After these governmental orders, the interaction between discriminated people and non-discriminated Japanese was restricted, although non-discriminated people tended to voluntarily avoid an interaction even before the order (Sumimoto and Itakura 1998).

The aversion and restriction toward interacting with discriminated groups led to their residential clustering. Combined with formal restrictions on geographical mobility in the Edo period, this created the residential areas for discriminated people. The residential cluster was later called the *buraku* or *buraku area* and the residents in these areas were later called buraku people (*burakumin*).[11] The Japanese word "buraku" literally means a small residential community, but it is also used to refer to the discriminated social class, rather than the residential clustering. In this paper, to avoid ambiguity, we use the term "buraku area" to refer to a historical residential area of buraku people and "buraku" to indicate the discriminated class. Buraku areas are spatially scattered and small. In our empirical analysis on Kyoto city, buraku areas in total constitute only around 1.5% of the total area in the data (see Section 5.2). The small size of buraku areas reflects the small population share of such discriminated people, which was estimated to be less than 2% in the Edo period.

During the Meiji restoration following the breakdown of the Tokugawa shogunate, the liberation edict (*kaiho rei*) in 1871 eliminated all formal discrimination toward groups of people such as the eta and the hinin. Specifically, the edict states the following (Teraki and Kurokawa 2016):

> The names eta, hinin, etc. shall be abolished. Henceforth, people belonging to these classes shall be treated in the same manner, both in occupation and social standing as commoners.

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[10] Although why the governments formalized discrimination is still debated, one hypothesis is that the formalization helped in maintaining the class system and venting people's frustration (Teraki and Kurokawa 2016).

[11] Note, however, that all buraku areas in the modern era do not necessarily trace back to the historical residential communities in the pre-modern period because some new buraku areas were established after the Meiji restoration perhaps due to aversion toward new jobs such as coal mining (Sumimoto and Itakura 1998). However, buraku areas around the center of Kyoto city are known to have long histories (Kyoto City Government 1940), implying that their location is determined in the pre-modern period and arguably unrelated to confounders of land prices in the modern period (Ciccone and Hall 1996). We show in Appendix I.5 that focusing on such buraku areas does not change our main conclusion.

The edict clarifies that the former discriminated classes were abolished and ensures that formerly discriminated people are treated equally as ordinary Japanese people. Notably, as the Meiji restoration permitted free occupational and residential choice, it also permitted this free choice for formerly discriminated people.[12] Following the liberation edict, discriminated classes like hinin merged into the non-discriminated majority Japanese in most cases.[13]

In contrast, the residential clustering of the eta, the largest discriminated group before the liberation edict, persisted in society.[14] The discriminatory mindset toward them also remained. One reason is that the religious stigma associated with the eta did not immediately disappear just by eliminating the formal discriminatory framework. Moreover, somewhat ironically, the liberation edict might actually have worsened the socioeconomic conditions of the discriminated people as it also eliminated the entry barriers into the stigmatized industries by non-discriminated Japanese (Research Center of Kyoto Buraku History 1991; Sumimoto and Itakura 1998). The poverty contributed to sustaining the discriminatory views. The entry of the non-discriminated people implies that the connection between occupation and discrimination against the (descendants of) eta became weaker, but discrimination remained in society. This is best illustrated by the formation of *zenkoku suihei sha* in 1922, a renowned party of the buraku people aiming to eliminate discrimination, 51 years after the liberation edict.

In the 20th century, the government acted to improve the living standards of people in buraku areas. Generally, the aim was to facilitate the integration of the discriminated people into the non-discriminated majority Japanese by improving the poor living conditions of the buraku after the Meiji restoration. In 1920, the central government allocated 50 thousand yen specifically for improving the buraku issues. Local governments had also started such policies. For example, during the period between 1920 and 1942, Kyoto city spent on sanitation (public bathhouse), childcare, settlement houses (*rinpokan*), medication (preventing and curing chlamydia trachomatis), and infrastructure (Akisada 1972). The efforts to reduce discrimination accelerated since the late 1960's. From the late 1960's, the large place-based policy (*dowa taisaku jigyo*) has invested around 15 trillion yen in total to improve the living conditions of people in buraku areas through investing in infrastructure and housing. As a result, today buraku areas receiving such public investment have few disadvantages in these dimensions

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[12] Not only guaranteeing the freedom of mobility under the law, we expect that the private collective actions to prevent the mobility of buraku people are limited unlike racial discrimination in the US (Cutler et al. 1999). The buraku have little visible distinction from the majority and it would be difficult to identify who to ostracize.

[13] The English translation of Teraki and Kurokawa (2016, p119) states the following:

> However those who are connected with the discriminated Buraku communities today are mainly people whose lineage can be traced back to those with eta status. It is sometimes thought that, as it were, eta and hinin were forced together into Buraku communities and became the 'Buraku problem' but in fact the hinin status in many cases disappeared soon after the Liberation Declaration.

Teraki and Kurokawa (2016) also state that the hinin merged into the society because they mainly engaged in policing in the samurai period and they immediately lost their job after the samurai regime went down. As a result, people no longer had a reason to maintain the historical community.

[14] A reason behind why they tended to remain in the same place is that unlike hinin, they did not immediately lose their job after the regime shift and the historical communities still provide advantages for their job. However, it does not mean that buraku areas experienced little migration flow. See footnote 20 for evidence on the active migration behavior.

(Management and Coordination Agency 1993).[15] Almost around the same time, there were also efforts to reduce buraku discrimination by restricting access to one's history of residential addresses and the location information of buraku areas. We further discuss these efforts since the late 1960's in Section 7.

Although discrimination in the modern period can take various forms, generally speaking, discriminating people tend to avoid interacting with the buraku, especially in the realm of marriage and the workplace (Okuda 2007). Other forms of discrimination, such as bullying, have also been reported. Various reasons for discrimination have been pointed out (e.g., Sumimoto and Itakura 1998; Okuda 2007; Teraki and Kurokawa 2016). People may think that buraku people are "polluted" as in the pre-modern period. Alternatively, Okuda (2007) argues that even if people do not spite buraku people themselves, people might still discriminate against buraku because it signals that they do not belong to the buraku class and helps them avoid being discriminated against. Whatever the reason may be, discrimination against the buraku would reduce utility either directly or indirectly through labor market outcomes.[16] We incorporate both channels in our model in Section 4.

Our empirical analysis focuses on Kyoto city for the reasons stated at the beginning of Section 5.2. To understand the generalizability of our results to other Japanese cities, note that the distribution of the buraku people has a large regional variation. Generally speaking, Western Japan, to which Kyoto belongs, tends to have more buraku people than Eastern Japan.[17] Kyoto also has the longest history of discrimination, as discussed at the beginning of this subsection. Thus, Kyoto, our focus area, has the most persistent discrimination over centuries and the discriminated class is relatively prevalent.[18]

3.2 Residence as identifying information of the buraku class

The liberation edict in 1871 eliminated the discriminated class in a formal setting, implying that no formal definition of the discriminated class is available since then.[19] Thus, those trying to discriminate against the buraku need to *infer* who is strongly associated with the discriminated class. However, this is not a trivial task in Japan because the discriminated group has no clearly

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[15] Indeed, without prior knowledge, it is difficult today to even roughly identify buraku areas by just walking around the city. Uehara (2009) states, "...every buraku area that went through neighborhood improvement now looks like an ordinary residential area."

[16] Consistent with this, Tabuchi, Fukuhara and Iso (2012) document significantly poorer mental health conditions in a buraku area.

[17] While the reason behind this is still debated, one hypothesis is that the lucrativeness of leather industry was heterogeneous (Teraki and Kurokawa 2016).

[18] Right after the Meiji restoration, the former discriminated classes of people constitute around 3.3% of the population in Kyoto prefecture (Research Center of Kyoto Buraku History 1991), which was larger than the national average of around 1.5%-2% (Sumimoto and Itakura 1998).

[19] Although the central government intended not to record a former discriminated class, population registry created in 1872 (*Jinshin koseki*) sometimes mistakenly recorded the former class because some local public workers did not understand the directions by the government (Teraki and Kurokawa 2016). However, Kyoto prefecture seems to have correctly understood the intention of the government and have not recorded it (Research Center of Kyoto Buraku History 1991).

visible features, such as skin color. Furthermore, cultural factors such as accents are also quite similar and indeed they belong to the Japanese race just like the non-discriminated people (Dowa Policy Council, the Prime Minister's Office 1965). The invisibility of the discriminated group is a distinctive aspect of the discrimination against the buraku, which indeed motivated the title of the well-known book *Japan's invisible race* by De Vos and Wagatsuma (1966).

Without distinctive physical and cultural traits, the buraku may "pass" as non-discriminated people (Price 1966; Dahis et al. 2019), which forces discriminating people to use pieces of information in inferring who is actually associated with the buraku class. Two important candidates for a "signal" indicating the discriminated class would be occupation and residence (Okuda 2007). Regarding occupation, as discussed in the previous subsection, the discriminated people historically tended to engage in the leather and butchery industries. However, these industries were lucrative and many non-discriminated Japanese entered them after the liberalization order. Moreover, the former discriminated class of people start choosing different occupations as the industrial revolution began in Japan after the 1870's. As a result, occupation has become less and less informative of the former discriminated class.

In contrast, residence remains an important signal of the discriminated class (Price 1966; Okuda 2007). Before 1871, discriminated people were geographically clustered in certain areas (*buraku areas*) because the interaction with non-discriminated people was restricted and there was no freedom of movement. Despite the active migration between buraku and non-buraku areas after the abolition of mobility restrictions in 1871, the association between buraku areas and the discriminated people remained.[20] This is presumably because despite the active migration flows, a sizable fraction of formerly discriminated people remained in buraku areas because of their business and attachment to the areas.[21] Consequently, living in a buraku area has remained an informative signal of the former discriminated class. Even more strikingly, many researchers now think that living in a buraku area might not just be a proxy for the former discriminated class but even become the definitive feature of the discriminated class (Okuda 2007; Tabuchi et al. 2012). In other words, the definition of the discriminated class itself might have shifted from the descendants of the former buraku class to those living in the buraku areas, regardless of their ancestors. What is important for our purpose is that under either definition of the buraku class, living in a buraku area increases the risk of experiencing discrimination and we are going to quantify its cost from land prices.

To see the importance of residence in data, we introduce the result of a survey conducted by the Osaka prefecture government in 2005 (Okuda 2007). It asked which information each respondent thought people in society use to determine whether someone belongs to the buraku

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[20] To illustrate the active migration in the prewar period, in one buraku area that had the total population of around 1500 in 1916, Research Center of Kyoto Buraku History (1985) shows that 226 people moved out while 296 people moved in a year. As another example, when a riot for affordable rice (*kome soudou*) took place in a buraku area of Kyoto city in 1918, around 60% of participants came from other places in Kyoto city or even from different prefectures (Research Center of Kyoto Buraku History 1991).

[21] For example, in 1930's buraku areas in Kyoto city, about 8% of household heads had lived in the same area for more than 30 years (Kyoto City Government 1940). Moreover, even in 1993, the share of descendants of formerly discriminated people in buraku areas was higher than 40% (Management and Coordination Agency 1993).

class.[22] The question then listed several potential factors that people might think are important in regarding someone as a buraku person. Multiple choices were allowed. Among eleven items, the most popular answer was "current residence," which 66.6% of the repondents marked as a key factor. Notably, this number is larger than the birthplace (48.4%), parental residence (38.5%), and occupation (25.0%).[23] The relative unpopularity of the occupation is interesting as discrimination against the buraku was historically associated with aversion toward stigmatized jobs, suggesting that occupation no longer plays the central role in sustaining discrimination. The 2005 survey also asked whether the respondents avoid housing in buraku areas when they choose their residence. Of these, 67.6% of respondents stated that they avoid buraku areas.[24] These results are consistently explained if people avoid living in buraku areas because they think doing so increases the risk of getting discriminated against.

Moreover, there are additional reasons not mentioned in the 2005 survey to suppose that current residence is even more strongly associated with experiencing discrimination. First is the availability of information. Most likely, current residence is easier to observe than other popular items such as birthplace and parental residence. Thus, current residence can be used as a handy proxy for other clues by which people identify the buraku class. Second is intergenerational consideration. In particular, even if people born outside buraku areas do not experience discrimination by residing in buraku areas, it makes their children's birthplace a buraku area and the children may be regarded as belonging to the buraku class due to their birthplace (Akisada 1972). As long as parents care about their children's utility, they might avoid living in a buraku area even if it does not cause discrimination against them.

Therefore, living in a buraku area leads to the risk of being regarded as belonging to the buraku class and experiencing discrimination. On the other hand, for people born in a buraku area, moving out of it would, at least partially, help conceal their origin and avoid discrimination thanks to the absence of visible distinctions of buraku people. Of course, given the above survey result, we do not contend that current residence is the only determinant of discrimination status. Those born in a buraku area might get discriminated against even if their current residence is outside of it once their background is revealed (Okuda 2007). Likewise, those who were born outside of a buraku area might avoid discrimination even if they currently reside in a buraku area once they credibly verify their background. Hence, the land price differential between buraku and non-buraku areas reflects the cost of lowering the *probability* of getting discriminated against at various occasions in life, rather than the cost of going from not being discriminated against at all to being fully discriminated against. This implies that our quantification, which captures the cost of facing a higher discrimination risk by living in a buraku area, would probably be conservative for the severeness of discrimination itself.

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[22] The sample size is about 3,500. When we calculate the frequency of answers, we exclude "not sure" or no answer from the denominator. We also note that similar results are obtained in the 2000 and 2010 surveys.

[23] In buraku discrimination, it is generally difficult to infer the buraku class from family names. Indeed, the survey did not even list family names as a potential signal of the buraku class. The question has the alternative "others" that might include family names, but only 1.6% of people marked it.

[24] Available qualitative evidence also confirms aversion toward living in buraku areas (Okuda 2007).

Overall, although current residence may not be the only factor to determine the experience of discrimination, living in a buraku area significantly makes people think that a person is more likely to belong to the buraku class and vice versa. This setting in which affiliation to the discriminated group is mutable through residential location choice allows us to estimate the cost of a higher discrimination risk by looking at land prices. In the next section, we embed such a situation into a spatial equilibrium framework and derive the regression equation relating land prices and the cost of facing a higher discrimination risk.

4 Theoretical framework

We introduce a simple spatial equilibrium model to guide our empirical analysis. Having a formal model gives us several advantages. In particular, the model yields the key regression equation showing that the overall cost of facing a higher discrimination risk is capitalized into the (observable) land prices. The model also paves avenues for additional empirical analyses, such as backing out local average income and counterfactual analyses. In the remainder of this section, we explain the key ingredients of our model and present our main result. A full description of the model and the detailed derivations are provided in Appendix A.

We consider a static spatial model with discrete N locations, where the land supply at each location $n \in \{1, 2, ..., N\}$ is fixed. We incorporate heterogeneity in workers by assuming that worker i is endowed with I_i units of effective labor. Following the canonical Alonso-Muth-Mills monocentric city model (Fujita 1989), we assume that all workers commute to the city center and inelastically provide the labor, the production function is linear, and the output is freely-traded. This implies that the price of the effective unit of labor is 1 after normalization. However, the labor income is still location-dependent because factors such as commuting and discrimination might affect the actual labor supply. We do not distinguish a priori the buraku and non-buraku people by assuming that all people have the same utility function, reflecting the fact that they belong to the same race and have almost no visible distinction. However, living in a particular location (buraku area) might increase the probability of being regarded as belonging to the buraku class. Thus, although all people look ex-ante identical conditional on human capital, after residential choice, those living in buraku areas are deemed as likely coming from the discriminated class and they experience discrimination.[25] Each worker has the outside utility $\tilde{U}_i$ exogenously determined in the outside world. The spatial equilibrium condition across different locations in and outside the city determines the population configuration at each location.

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[25] Given that we do not have data on the inference process of the affiliation to the buraku class, we simply assume that residing in a buraku area is the perfect signal of the affiliation. However, we expect that considering the presence of ex-ante characteristics that might signal the buraku class reduces the importance of residence as a signal and leads to a conservative estimate of the cost of belonging to the buraku class. In an extreme case in which the ex-ante heterogeneity is observable and perfectly determines the affiliation with the buraku class, we would have no effect of buraku areas on land prices, which is empirically not the case.

Discrimination disamenity. V_{in}, the indirect utility of individual i living in location n, is given by the following:

$$V_{in} \propto s_n r_n^{-\gamma} I_i. \tag{1}$$

See Appendix A for the microfoundation of this indirect utility function. The indirect utility is decreasing in the land price r_n due to the higher housing cost, where γ is the spending share for land. The indirect utility is also increasing in the effective units of endowed labor I_i. Importantly, the indirect utility is increasing in the amenity s_n, which captures the overall attractiveness of living in location n.

We now suppose that the amenity in location n, $s_n > 0$, is given by the following equation:

$$\frac{\ln s_n}{\gamma} = D_n + \eta X_n + \epsilon_n, \tag{2}$$

where the division of $\ln s_n$ by γ is only for later notational convenience. X_n represents the exogenous characteristics of location n and η represents the associated coefficients. For example, X_n might include natural conditions at location n and the commuting distance. ϵ_n is an idiosyncratic local characteristic at location n. We assume that ϵ_n is unobservable to econometricians, but its realization is known to workers so that workers make no decision under uncertainty. As discussed in Section 5.1, ϵ_n can be spatially auto-correlated.

D_n in (2) is the key object of interest: "discrimination disamenity." Living in some region n might be unattractive if it induces a higher discrimination risk. This effect is captured in our model as the lower amenity value of location n. The simplest specification of D_n is binary: it takes a low value when location n is outside a buraku area and vice versa. However, a richer spatial configuration of discrimination disamenity is incorporated in our formulation, such as living next to a buraku area might also increase the risk of discrimination. Note that we cannot directly use (2) to estimate D_n because the amenity s_n is unobserved. Our main result shows that in spatial equilibrium, we can estimate D_n using land prices r_n instead of s_n.

We make two remarks on our definition of discrimination before proceeding. First, we have not specified how discrimination affects the indirect utility, but we have introduced D_n, which summarizes the magnitude of bad effects of belonging to the discriminated group. The discrimination might directly reduce the utility in the form of marriage discrimination, bullying, and so on. Discrimination may also reduce the utility by reducing income, which would be caused by discrimination in the labor market. As our discrimination disamenity incorporates all such forms of discrimination in the single index, it can measure the severeness of discrimination as a whole, rather than discrimination in a specific dimension. This is an advantage of our approach because discrimination can take various forms and some of them might be hard to credibly measure or even just observe, such as psychological bullying.

Second, D_n captures all adverse effects for the discriminated group that are not mediated through local characteristics X_n. For example, people might experience lower utility directly by facing difficulties in marriage or being bullied by others, which is included in D_n. However, if the government is discriminating against the buraku, it might choose to invest less in buraku areas, leading to lower-standard infrastructure. Arguably, this should be included as one form of buraku discrimination. However, if X_n includes the local infrastructure level, D_n excludes this channel of discrimination. This implies that our definition of discrimination becomes more conservative as we include in X_n more local characteristics. We thus report regression results using a different set of control variables.

Main result. In the spatial equilibrium, workers are indifferent between living in any location in a city as well as living outside the city. Using this condition, we can obtain the following main result (see Appendix A for the proof).

Proposition 1. *Equilibrium land prices* r_n *satisfy* $\ln r_n = D_n + \eta X_n + \epsilon_n$ *for any location* n*, where* D_n *is the discrimination disamenity,* X_n *is a vector of locational characteristics, and* ϵ_n *is the unobservable idiosyncratic amenity. After parametrizing* D_n*, the OLS consistently estimates it provided that* (D_n, X_n) *is orthogonal to* ϵ_n*.*

Proposition 1 shows that we can back out the discrimination disamenity by regressing land prices on D_n.[26] To illustrate this point, we specify that D_n equals some coefficient β times the dummy indicating whether location n belongs to the buraku area. In other words, β is the impact of locating in a buraku area on land prices relative to a non-buraku area (see Equation (4) in Section 5.1 for a mathematical expression). Then, we can estimate β and η using the OLS and the estimates are consistent if the location of buraku areas and exogenous locational characteristics are orthogonal to the error term ϵ_n.[27]

The intuition behind Proposition 1 is that since the discrimination risk and particular locations are tightly connected, the discrimination risk is implicitly traded through the land market. As such, conditional on other location characteristics X_n, the willingness-to-pay to avoid a higher discrimination risk should be reflected in the land price difference between buraku and non-buraku areas. This is an application of the standard spatial equilibrium logic of Rosen (1979) and Roback (1982) to a novel context of the discrimination risk: the discrimination disamenity D_n is capitalized into land prices since utility is equalized everywhere in equilibrium.[28] Note

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[26] Note that the regression equation in Proposition 1 is equivalent to the semi-parametric hedonic regression of Rossi-Hansberg, Sarte and Owens III (2010) since we have not yet imposed a parametric assumption on D_n.

[27] Note that in Proposition 1, the population and the income level of location n do not appear. Intuitively, a location attracting more people or richer people has more land demand and so a higher land price. On the other hand, the land price must be low enough to keep such a large population or rich people who have decent outside options. These two opposing effects exactly offset each other at the equilibrium (see Appendix A for a more mathematical discussion). This feature is helpful for our regression analysis as we do not need to explicitly consider the potential endogeneity of the population and the income level of each location. Moreover, even if our modelling assumptions are violated so that they enter as omitted variables, focusing on samples around the buraku border would eliminate the bias as long as these variables continuously affect land prices (see Section 5). In Section 6.3, we consider how sensitive our results are to controlling for the neighborhood quality that depends on the local average income.

[28] We note that the main intuition does not rely on our specific model. To see this, consider two nearby land plots A and B. Plot A is in a buraku area while plot B is not. Then, as long as these plots are nearly identical

that D_n includes forms of discrimination that are difficult even just to observe in data, such as psychological bullying. In this sense, Proposition 1 allows us to estimate, in revealed preference, the overall cost of facing a higher risk of being regarded as a discriminated group member.[29]

We discuss the empirical implementation of Proposition 1 in Section 5 and the results are presented in Section 6. In addittion to Proposition 1, the full structure of the model allows us to obtain additional empirical implications, which we discuss in Section 8.

5 Empirical framework

5.1 Empirical strategies

We now describe our empirical strategies to implement Proposition 1 by comparing land plots with similar characteristics but with different levels of the discrimination risk. For this purpose, we use both the OLS regression and the border design. As explained below, we view these two approaches to be complementary to our purpose.

OLS regression. From Proposition 1, our theoretical model justifies estimating the following hedonic equation by OLS to quantify discrimination disamenity:

$$\ln r_n = D_n + \eta X_n + \epsilon_n, \tag{3}$$

where D_n is the strength of discrimination disamenity associated with location n. n corresponds to each land plot. r_n is the land price per m^2 of the land n, and ϵ_n is the error term.[30] We assume throughout that D_n, the amount of discrimination disamenity in each location n, is orthogonal to the error term after controlling for X_n. We also posit that exogenous characteristics X_n are orthogonal to the residual ϵ_n. These assumptions imply that the OLS estimation consistently estimates the effect of buraku areas on land prices. When available, we also report Oster's (2019) bound to show the robustness of our results to unobserved control variables. Moreover, given that unobserved variables might have a spatial correlation, we permit the spatial autocorrelation of the error term using Conley's (1999) standard error.[31]

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because they are close to each other, the price of plot A must be lower at the equilibrium to compensate for the discrimination associated with living in plot A. Qualitatively, this is exactly what we predict in Proposition 1. This argument underlies the border design, which we introduce in Section 5.

[29] We expect that introducing preference heterogeneity and mobility costs does not change our main argument. In the presence of heterogeneous preferences, Proposition 1 would hold for an infra-marginal worker indifferent between buraku and non-buraku areas (Kline and Moretti 2014). In addition, in the presence of the mobility cost, the reduction in the discrimination disamenity of buraku areas would yield smaller decline in the land price penalty but qualitatively the same conclusion holds (Yamagishi 2021).

[30] To facilitate comparison across years despite different price levels, we normalize the log land price by subtracting the mean log land price in the given year so that the mean of the outcome variable is zero in all years. This normalization does not affect regression results except for the constant term.

[31] We calculate Conley's (1999) standard error using *acreg*, the Stata package developed by Colella, Lalive, Sakalli and Thoenig (2020). We assume that the spatial autocorrelation is confined within the circul with $100m$ radius and use the uniform kernel.

For the OLS to be consistent, we need to assume that contemporary shocks to land prices are orthogonal to locations of buraku areas conditional on the control variables. This requires the following. First, the determinants of the location of buraku areas should be orthogonal to the contemporaneous error terms of land prices. This may be plausible in our context because they are determined in the pre-modern period, which is analogous to the widely-used identification strategy based on a long-lagged population in the empirical literature on agglomeration economy (Ciccone and Hall 1996), but this may not perfectly guarantee the orthogonality. For example, a buraku area might be more likely to be located in a place that historically had bad natural amenities such as a high risk of flooding. To address this concern, we include control variables related to transportation access, topography, land use, and geographical coordinates. Second, while certain local conditions, such as infrastructure, might be considered as channels through which discrimination manifests (see the arguments following Equation 2), other local conditions of buraku areas might be considered as confounders. To assess whether and how much our quantification of discrimination disamenity is driven by such local conditions, in our robustness checks, we confirm that our results are robust to controlling for important proxies of the local conditions and neighborhood quality such as urban health amenities (Hanlon and Heblich 2022) and school districts (Black 1999; Bayer et al. 2007). In addition to explicitly controlling for confounders, we also use border design that controls for spatially-continuous unobserved factors. Thus, in the border design, our quantification of discrimination disamenity is contaminated by unobserved factors only if they jump discontinuously at the buraku border.

As explained in discussing the border design, the identification assumption for the OLS is more stringent than what the border design requires as it can control for unobserved factors that are continuous across the space. However, despite the stronger identification assumption, the OLS regression has three advantages. First, the border of buraku areas might be somewhat ambiguous. Although we use a border formally defined by a government, there is no guarantee that citizens use the same border in inferring the class to which people belong. In particular, while a non-systematic mismeasurement of a border would attenuate the buraku effect, and thus, our estimates would be conservative (c.f., Aaronson et al. 2021), we cannot exclude the possibility of a systematic measurement error that leads to overestimation. Since the OLS estimation uses all the observations including ones that are relatively far away from the buraku areas, we expect it to be less sensitive to the measurement error of buraku borders. Second, the statistical power increases significantly by utilizing more observations. Finally, the OLS allows us to flexibly investigate the spatial scope of the buraku effect. Two possibilities are particularly interesting and relevant. First, even outside a buraku area, living close to a buraku area might increase the risk of discrimination as people might not know exactly where buraku areas are located. Second, within a buraku area, living in the "core" of buraku areas increases the risk of discrimination further because people can judge that such a location belongs to a buraku area with little ambiguity. Since we need to focus on samples around the buraku border, such effect may be difficult to estimate based on the border design. Having said this, empirically, this benefit seems minimal in our context because the spatial scope of the buraku effect appears quite narrow and even the border design can allow us to include the relevant scope (see Section 6).

Border design. As discussed above, for the OLS to identify the causal effect, our control variables need to ensure that the remaining variation is orthogonal to the location of buraku areas. However, there might be unobserved factors that induce endogeneity. To address this, we use the *border design* or *spatial discontinuity design* (c.f., Black 1999; Bayer et al. 2007; Dell 2010). We implement this in the same way as our OLS estimation but restrict the sample to the neighborhood of buraku borders. Since the unobserved factors that are spatially continuous are nearly identical within this neighborhood, this approach eliminates the endogeneity stemming from such unobserved factors. In particular, the border design permits identification even if the location of buraku areas is determined by unobserved factors that affect current land prices as long as the exact border of buraku areas can be interpreted as randomly assigned in the neighborhood of the border.

Another key advantage of the border design is its validity in a more general setting. To illustrate this, consider a simple extension of the model in Section 4 that allows for spatial spillovers. Assume that the amenity in each location, given in Equation (2), is modified as $\frac{\ln s_n}{\gamma} = D_n + \eta X_n + h_n(\bar{N}) + \epsilon_n$, where $h_n(\cdot)$ is a location-specific continuous function in location n and $\bar{N}$ denotes the distribution of population density in the city.[32] That is, the amenity of location n now depends on the population because of agglomeration or congestion economy. As a result, the resulting regression equation is $\ln r_n = D_n + \eta X_n + h_n(\bar{N}) + \epsilon_n$. Then, in general, we cannot consistently estimate this equation by OLS because of the endogeneity of $\bar{N}$ with land prices. Still, the border design eliminates the influences of such endogenous variables due to continuity: $h_n(\bar{N})$ takes the same value for arbitrary close two land plots with different discrimination disamenity D_n, allowing us to identify D_n by regression. Similar arguments imply that other forms of spillovers, such as the neighborhood quality determined by the local average income, can also be accommodated as long as they are continuous across the space.

Note that in our context, the effect of the distance to the nearest buraku area is of interest in addition to the discontinuous jump because the discrimination risk might be continuous due to the ambiguity of the border. We thus estimate specifications with and without the continuous effect of the distance to buraku areas. The identification of the discontinuous jump at the border and the continuous effect of distance relies on a different identification assumption. Identifying the discontinuous jump at the border permits the presence of unobserved factors as long as one focuses on a sufficiently small neighborhood of the border and the unobserved factors do not jump at the border. In contrast, the identification of continuous effects of the distance relies on the same assumption as the OLS: conditioning on the control variables should eliminate the endogeneity issue (except that this is now required only within a neighborhood around the border). Therefore, although using only samples around the border, we continue to control for the same set of controls as the OLS estimation.

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[32] An example of continuous $h_n(\cdot)$ is the travel-time weighted sum of local density (Ahlfeldt, Redding, Sturm and Wolf 2015).

Parametric specifications of discrimination disamenity. We parametrize the form of D_n to facilitate interpretation and gain statistical power. We try two specifications of D_n. Let b_n be the distance to the nearest border of buraku areas, which takes a negative value within a buraku area.

Dummy specification. The first is the simple binary specification:

$$D_n = \beta \mathbb{1}(b_n < 0), \tag{4}$$

so that D_n is the size of discrimination disamenity in a buraku area relative to a non-buraku area. Since the outcome variable is in log, β is approximately interpreted as the percentage effect of locating in a buraku area on land prices. However, since the approximation is not accurate as the effect turns out to be large, we also report the implied buraku effect in percentage: a plot in a buraku area is estimated to have $(e^{\beta} - 1) \times 100\%$ lower land prices.[33] Note again that since we are estimating only the discontinuity at the border in (4), the border design can identify β even if there are unobserved factors that are continuous in the space. Note also that this specification would lead to an underestimation of the buraku effect if buraku areas have some negative effects on neighboring non-buraku areas by violating the stable unit treatment value assumption (SUTVA).

Linear specification. The second specification adds the additional effect depending on the distance:

$$D_n = \beta_1 \mathbb{1}(b_n < 0) + \beta_2 b_n + \beta_3 b_n \mathbb{1}(b_n < 0). \tag{5}$$

In addition to the dummy specification (4), (5) also includes the linear effect of distance to the nearest buraku area, whose slope can vary within and outside a buraku area. In this way, the linear specification allows for a continuous effect of distance to the buraku border on land prices. The specification implies that when we compare land plots located x meters within or outside the buraku border, the buraku plot has $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ lower land price.

Since a linear function is locally an approximation of any function, this specification would particularly make sense as long as the samples are confined within a small neighborhood and it is often invoked in the regression discontinuity design (Cattaneo, Idrobo and Titiunik 2019). As discussed above in introducing the border design, the identification of the continuous effect of distance (β_2, β_3) requires no selection on unobservables even under the border design. In this sense, the identification assumption in the linear specification is stronger than in the dummy specification. However, under the additional identification assumption, the linear specification provides important information on the spatial configuration of the buraku effect.

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[33] $\ln(r_n(\mathbb{1}(b_n < 0))) - \ln(r_n(\mathbb{1}(b_n \geq 0))) = \ln(1 + \frac{r_n(\mathbb{1}(b_n<0)) - r_n(\mathbb{1}(b_n \geq 0))}{r_n(\mathbb{1}(b_n \geq 0))}) = \beta$. Taking exponential of this and rearranging, $\frac{r_n(\mathbb{1}(b_n<0)) - r_n(\mathbb{1}(b_n \geq 0))}{r_n(\mathbb{1}(b_n \geq 0))} = e^{\beta} - 1$.

5.2 Data

We use data from Kyoto city to estimate the effect of buraku areas (i.e., discrimination disamenity) on land prices from 1912 to 2018. We focus on Kyoto city for several reasons. First, we have the novel GIS land price data of 1912 Kyoto, which allow us to investigate the evolution of the degree of discrimination over a century. To our knowledge, except for Tokyo, Kyoto is the only Japanese city that has comprehensive digitized land price data preceding WW2.[34] Second, Kyoto city did not experience the US air-raid bombing during WW2, which is exceptional among major Japanese cities (Davis and Weinstein 2002).[35] This is an important advantage of Kyoto over Tokyo for our purpose: the extensive bombing in Tokyo makes it difficult to compare the results of the pre-WW2 and post-WW2 periods as the bombing itself might have had long-lasting impacts (Harada et al. 2020).[36] In contrast, the absence of bombing in Kyoto facilitates the pre-WW2 and post-WW2 comparisons. Third, as discussed in Section 3.1, Kyoto has the longest history of discrimination toward the buraku and relatively a large share of the discriminated population, implying that Kyoto is one of the cities in which the buraku issue is most important. We describe our data in the following sections.

Buraku areas. Buraku areas in Kyoto city are scattered throughout the city, as illustrated in Figure 1a. They constitute only a small fraction of areas in the city as each of them is small. According to our definition of buraku areas that we explain in the next paragraph, in 1912, the total area of five distinct buraku areas is $0.54km^2$, implying the average size of around $0.11km^2$, and the buraku area covers about 1.3% of the areas covered by our land price data. In 2018, the total area of eighteen distinct buraku areas is $2.54km^2$, implying the average size of around $0.14km^2$, and the buraku area covers about 1.5% of the areas covered in our land price data. Note that the number of buraku areas in our data increased from five in 1912 to eighteen in 2018 because Kyoto city expanded over the past century and many buraku areas got engulfed into the city area.

In the main text, we adopt the definition of buraku areas by Kyoto City Government (1975), which was used for implementing policies toward buraku areas, throughout our sample period. Kyoto City Government (1975) lists the names of blocks (*cho cho moku*), which are the smallest administrative units in Japanese cities, constituting each buraku area. Each block in Japan is granular and it tends to be even more so in Kyoto city. According to the 2015 population census, the median area of blocks in Kyoto city is $0.23km^2$ and the median population is 149. Kyoto City Government (1975) accurately identifies buraku areas using such granular geographical units. Because block names in Kyoto have hardly changed over the past half century, we can

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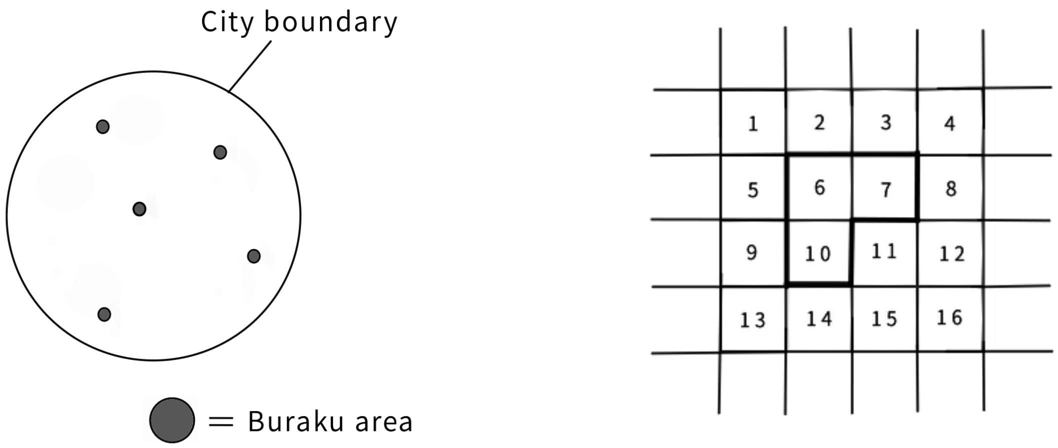
[34] See Yamasaki et al. (2022) for a description of such data in Tokyo.

[35] Kyoto avoided air raids by a historical coincidence. Kyoto was a primary target of atomic bombing for the US because in the absence of destruction by conventional bombing, it provided “the best lab” to demonstrate the power of the atomic bomb (see http://www.dannen.com/decision/targets.html last accessed on July 16, 2022). Hiroshima also avoided conventional air raids for the same reason and then experienced the atomic bombing on August 6th 1945. In contrast, Kyoto dropped off the list of bombing by the action of Henry Stimson, which might be motivated by personal reasons. See https://www.bbc.com/news/world-asia-33755182 (Last accessed on July 16, 2022).

[36] Moreover, we could not find reliable data that accurately delineate buraku areas in Tokyo.



(a) How buraku areas are located in a city

(b) Defining buraku areas from Kyoto City Government (1975)

Figure 1: Illustrations of buraku areas

use the current digitized map available in the Basic Geospatial Information (*kokudo kihon joho*), Geographical Issue Authority of Japan, to make the shape file of the buraku areas and their outlines. Figure 1b illustrates how we define buraku areas. In Figure 1b, sixteen blocks numbered from 1 to 16 in an illustrative grid city are shown. Now, suppose that blocks 6, 7, and 10 are designated as a buraku area. We combine the area of these three blocks in a map and define it as a buraku area. The buraku border, shown in bold in Figure 1b, is the outline of this buraku area. We focus on observations around the buraku border when implementing the border design (c.f., Black 1999; Bayer et al. 2007; Dell 2010).

We make two remarks on our definition of buraku areas. First, the administrative boundary of buraku areas we use might be different from that envisioned by people. It would lead to an underestimation of the buraku effect if it induces a random classification error of land plots (Aaronson et al. 2021), although we empirically find a statistically significant discontinuity at the border.[37] Second, at some occasions, Kyoto City Government (1975) states that a buraku area includes a part of a particular block (*cho cho moku*) but does not specify which part is included.[38] In such a case, we follow Shima (2016) and classify the whole block as a buraku area, which is sensible because sharing the same block name as the buraku area increases the risk of being identified as the buraku class. Indeed, Okuda (2006) presents survey evidence that homebuyers exhibit a strong aversion toward buying a house sharing the same block name as a buraku area even if the house itself is outside of it, suggesting that just sharing the same block name induces the risk of being regarded as belonging to the buraku class by people who do not know the exact administrative boundary of buraku areas.[39]

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[37] However, we cannot exclude the possibility that a systematic misclassification might spuriously magnify our estimates. To address this concern, we use an alternative definition of buraku borders in Appendix I.5.

[38] Out of 43 blocks mentioned, 13 blocks are partially in a buraku area (Kyoto City Government 1975).

[39] A survey conducted in Mie prefecture in 2004 asked about the homebuying decision when a house is next to

As a robustness check, we also use an alternative definition of buraku areas based on Kyoto City Government (1929). It identifies six major buraku areas as needing special support to improve residential conditions and provides their detailed maps. We digitize them to obtain the shape file of the areas and their outlines. An advantage is that the detailed maps allow us to identify the exact buraku borders even more accurately than the definition of Kyoto City Government (1975), which is based on block boundaries. However, a drawback is that Kyoto City Government (1929) contains only six buraku areas near the city center because Kyoto city at that time was smaller than it is today, which makes it unsuitable especially for contemporary data. Therefore, throughout the main text, we adopt Kyoto City Government (1975) as our definition of buraku areas. Reassuringly, using this alternative definition tends to reinforce our conclusions (see Appendix I.5).

Unfortunately, we cannot present the actual map of buraku areas we constructed in this paper due to our concern that showing such a map might provide easy access to identifying information of the buraku class and catalyze discrimination.[40]

Land price data. We newly compile land price data covering the entire Kyoto city from 1912 to 2018. Throughout, we take a representative point of land plots as our unit of observation. The 1912 land price data are from *Kyoto chiseki-zu*. They cover all land plots in Kyoto city as of 1912 and the comprehensive coverage is essential for our purpose because buraku areas constitute only a small fraction of the entire city. To identify the location of each land plot, we use the GIS version of *Kyoto chiseki-zu* created by geographers at Ritsumeikan University. To our knowledge, ours is the first study in economics to utilize these data (see Salat, Murcio, Yano and Arcaute (2018) for its usage in other fields). For most observations, it contains information on price and lot size. Such information is based on *tochi daicho genbo*, which is the cadaster data that record all land plots and is the basis for ad-valorem land taxes (Kawahara 2009).[41] We compute the land price per square meter and use its log as the outcome variable.[42] Potentially due to nonmarket idiosyncrasies or misrecording at some stage of transcription, some plots apparently have unreasonably extreme unit land prices. We drop observations with the unit land price above the 1st percentile and below the 99th percentile to avoid the influence of such outliers. We use the centroid of each land plot as its representative point.

Our data for land prices in 2006–2018, *kotei shisan-zei rosenka*, also cover the entire Kyoto city. *Kotei shisan-zei rosenka* is the administrative land price data for assessing property

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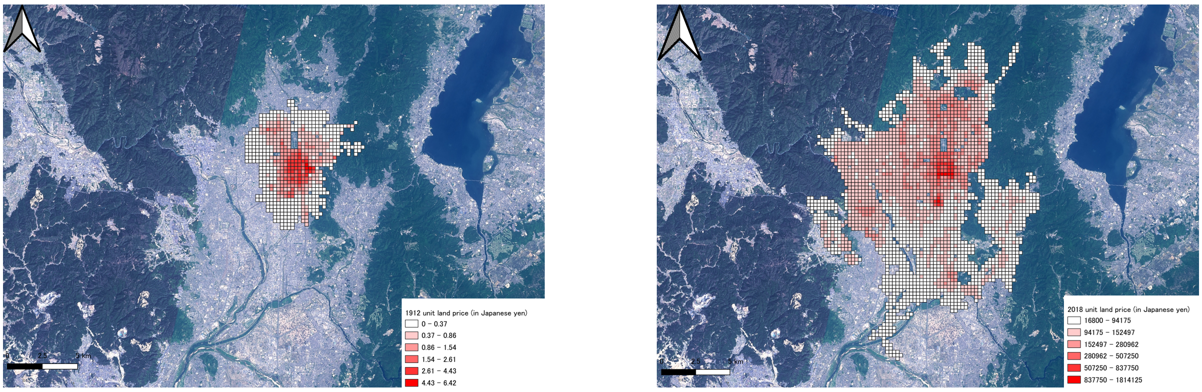
a buraku area in the same block, although the house is not exactly in the buraku area. Out of valid answers, 29.7% of respondents stated that no matter how good the house seems a good deal, they avoid buying it and 31.9% of them stated that they buy the house only if the deal is sufficiently good, implying that the majority of respondents exhibit aversion toward a buraku area in the same block.

[40] Although exceptions apply, many scholarly papers on buraku, especially recent ones, refrain from using the actual names of buraku areas and instead use de-identified names (e.g., buraku area A, B, C, ...).

[41] *Kyoto chiseki-zu* records re-evaluated residential land prices following the act of revision of prices of residential land (*takuchi chika shusei hou*) in 1910. The revision was based on the market rental prices.

[42] To mitigate the influence of outliers, we drop land plots smaller than $4.2m^2$ or larger than $3600m^2$, which roughly corresponds to dropping 0.5% extreme values on each side. However, our results change little if we do not drop such extreme values.



(a) 1912

(b) 2018

Figure 2: Unit land prices in Kyoto in 1912 and 2018

Note: The figure plots the average unit land price within each $250m \times 250m$ grid cell. To avoid the influence of extreme values and misrecording, we exclude land plots with the top and bottom 1% unit land price for 1912 data. A few grids that are made discontinuous from the city due to this trimming are also dropped. As a background map, we use the aerial image of Kyoto from *chiriin chizu* (https://cyberjapandata.gsi.go.jp/), Geospatial Information Authority of Japan. As an aerial photograph in 1912 is unavailable, we use the contemporary one for both 1912 and 2018.

taxation and the same data for different cities are used in several recent urban economic studies (e.g., Miyauchi, Nakajima and Redding 2022; Yamasaki et al. 2022). The assessment aims to capture the "normal transaction price" by referring to actual instances of transactions while ignoring unusual aspects of each transaction (Research Center for Property Assessment System 2018, p4). For this goal, each municipality (Kyoto city government in our case), after dividing streets into many segments, assigns the assessed land price per square meter to each segment by referring to professional land price assessments and other professionally assessed land price data (e.g., *kouji chika*). The assessed price is for the "standard" land plot and the same price per unit applies to all land plots facing the same segment of a street.[43] To identify land plots in a buraku area, we first classify each segment as belonging to a buraku area if and only if the entire segment lies in a buraku area.[44] We then take the centroid of each segment as the representative point of the land plot. Note that since the dataset does not record the prices of all land plots but rather has a price per each road, it has a smaller sample size than the 1912 data that record all land plots. In 2018, the number of observations is about two-thirds of the 1912 data despite the expansion of Kyoto city.

Figure 2 visualizes our land price data for 1912 and 2018. We divide Kyoto city into $250m \times 250m$ grids and plot the average unit land price in each grid. Two points are noteworthy. First, the city area has grown substantially, which reflects the expansion of the boundary of Kyoto city over the past century. Second, despite its growth, Kyoto city has a similar monocentric structure in both 1912 and 2018. Areas around the *kawaramachi* station and the Kyoto station,

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[43] In actually implementing the property taxation, adjustments are made to take into account specific characteristics of each land plot. We ignore such details as we are interested in standardized land prices.

[44] To avoid erroneously classifying non-buraku land plots as buraku plots, we drop exceptional observations in which the entire segment is not contained in a buraku area but the centroid lies within a buraku area.

which are about $2km$ away from each other, have the highest land prices. The land price gradually declines as we move further from this central area. This pattern is consistent with our monocentric city model in Section 4.

For land prices in 1961, 1973, 1982, and 1991, we newly digitize *sozoku-zei rosenka*, which is the administrative land price data for assessing inheritance taxation set by the National Tax Agency. Except that the property valuation is used for inheritance taxes, it is similarly constructed as *kotei shisan-zei rosenka* for property taxation: *sozoku-zei rosenka* is determined by referring to professional land price assessments and other professionally assessed land price data based on transaction prices. In addition to land prices, we also digitize information on land use (i.e., residential, commercial, and industrial areas). We digitize all observations in the 1961 land price data given its importance as the midpoint of 1912 and 2018. For the other years, we digitize only land plots in and around buraku areas.

Throughout, we use the administrative assessment data rather than the transaction data not only because of their availability but also because of the comprehensive coverage. Since land transactions are only infrequent and buraku areas are quite small relative to the entire city, we observe only a few actual transactions in buraku areas even if we pool multiple years of observations. In contrast, our professionally assessed land price data cover every land plot while referring to the actual instances of transactions. Reassuringly, evidence shows that our assessment price is closely related to the transaction price. For 1912, although we, unfortunately, could not find the market rental land price data that our assessment price data is based on, Yamasaki et al. (2022) show a very strong correlation between the two prices in the same data for Tokyo. For the land price data in the 21st century, we show in Appendix C the strong positive correlation between the assessment prices and transaction prices ($\rho \simeq 0.824$), despite that the infrequency of land transactions tends to introduce idiosyncratic noises. Moreover, we estimate that a 1% increase in the assessment price is associated with an approximately 1% increase in the transaction price. These results imply that our buraku effect on the transaction prices can be reasonably approximated by the effect on the assessment prices.

Control variables. We have collected various control variables to ensure that our results are not driven by confounders. Specifically, in our main analysis, we control for transportation access (the distance to the central business district (CBD) and the distance to the nearest train station), topography (proximity to rivers, altitude, ruggedness), contemporary land use pattern, lot size, and geographical coordinates (i.e., latitudes and longitudes). In robustness checks, we also consider proxies of the neighborhood quality (urban health amenities, and school districts) and the floor-to-area regulation. More details and data sources are provided in Appendix D.

We report the summary statistics in Appendix E, separately for buraku and non-buraku areas. In Appendix F, we follow Bayer et al. (2007) and test whether the control variables in our main specification exhibit discontinuity at the buraku border. Overall, we do not find a discontinuity except for a few cases. Moreover, our regression coefficients on these characteristics suggest that the presence of such discontinuity, if any, tends to underestimate the price penalty in buraku areas. Thus, as long as unobserved characteristics work similarly to the observed ones, we expect that our main conclusion is robust to the unobserved confounders.

6 100 years of buraku discrimination: 1912 and 2018

In this section, we present the analysis on land prices in 1912 and 2018 to show a big picture of how the severeness of discrimination against the buraku has changed over the past century. We analyze land price data for 1961–2015 to see the intermediate years in Section 7.

6.1 Descriptive analysis

Before turning to the regression results, we first descriptively analyze how land prices are related to buraku areas. In Figure 3a, we present the mean land price per square meter separately for buraku and non-buraku areas in 1912. As clearly shown, land plots in buraku areas have much lower unit prices than those outside buraku areas: the land price in buraku areas is only around one-fourth of that in non-buraku areas. Figure 3b repeats the same for 2018. It shows that the land price in buraku areas in 2018 is still lower than in non-buraku areas but the price difference is much smaller and it is now around two-thirds of that in non-buraku areas. This simple descriptive evidence suggests large and persistent land price discount, indicating severe and persistent discrimination.

To further investigate the geographic pattern of land prices in relation to buraku areas, we present nonparameteric regression results of log unit land price on the distance to buraku borders in Figures 3c and 3d. Negative distance means within buraku areas and vice versa. Note that since nonparametric regression fits a smooth function, this analysis cannot detect a potential discontinuity at the buraku border by design. Figure 3c shows that the low land prices in 1912 are concentrated within the buraku border and the price quickly goes back to a normal level outside the border. In contrast to the sharp drop at the buraku border, the land price is roughly flat outside the buraku border. This suggests the specialty of buraku areas. Figure 3d shows that the land price in 2018 also has the same pattern as the 1912 data in Figure 3c, although the land price seems to decrease somewhat more gradually when approaching buraku areas than in 1912. In both 1912 and 2018, the price gap disappears for plots more than $150m$ away from the border, implying that the spatial scope of the buraku effect is likely to be spatially concentrated, perhaps within $150m$ from the buraku border. Therefore, when we analyze samples around the buraku border, we focus on land plots within or outside $150m$ from the buraku border both for 1912 and 2018 to ensure comparability while accommodating the relevant spatial scope of buraku effects.[45]

Figure 3e shows the log land prices per unit while restricting the sample to observations

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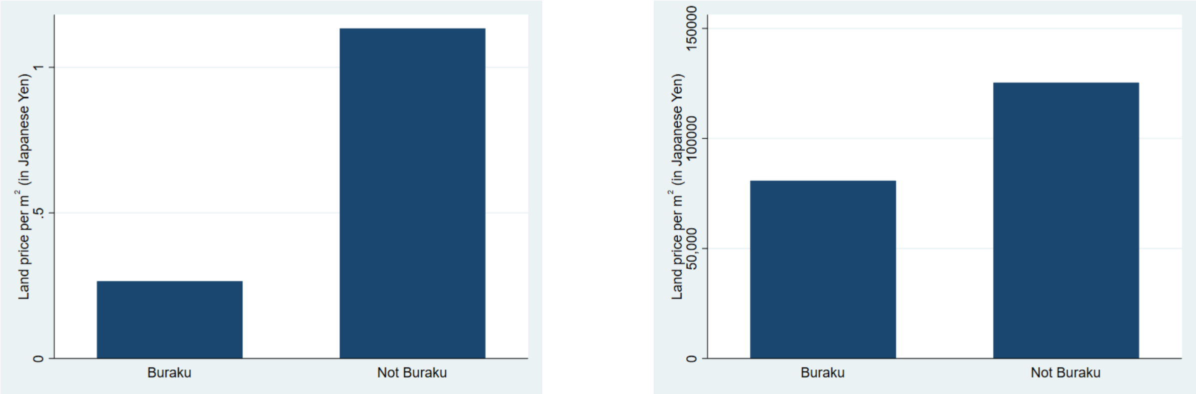
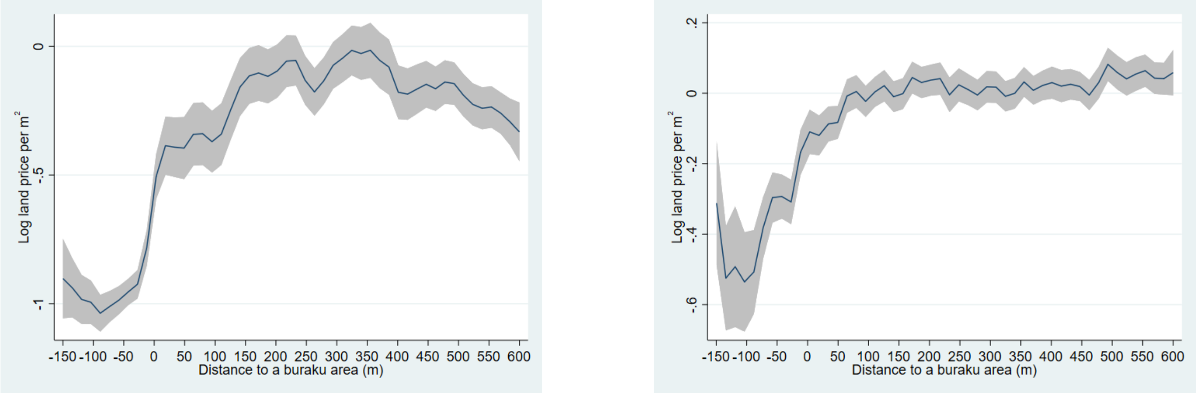
[45] In Appendix I.6, we apply the MSE-optimal bandwidth selection by Cattaneo et al. (2019). We obtain similar results despite the systematic choice of bandwidth separately for 1912 and 2018.



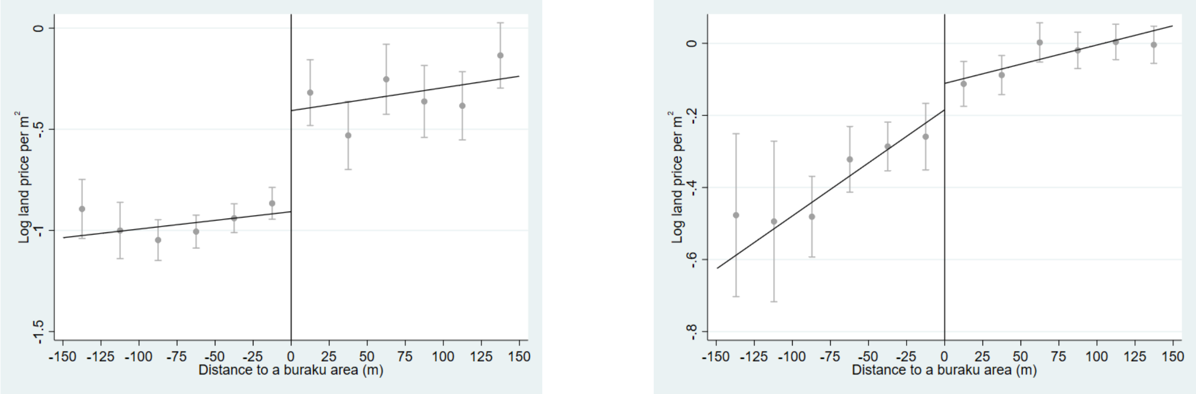
(a) Mean land price in 1912

(b) Mean land price in 2018



(c) Nonparametric regression of log unit land price on distance to a buraku area (1912)

(d) Nonparametric regression of log unit land price on distance to a buraku area (2018)



(e) Log land price around buraku borders in 1912

(f) Log land price around buraku borders in 2018

Figure 3: Description of Kyoto land prices in 1912 and 2018

Note: In figure (a), we plot the mean unit land price in 1912 separately for plots within and outside buraku areas. Figure (b) repeats exactly the same as (a) using 2018 land price data. In figure (c), we present the result of nonparametric regression of log land prices in 1912 on distance to a buraku area. We use the local mean smoothing with the Epanechnikov kernel and the rule-of-thumb bandwidth. The 95% confidence intervals are also shown. Figure (d) repeats the same using 2018 data. In figure (e), we confine the sample to land plots within 150m from buraku borders. The negative distance means that the plot is within a buraku area. We then divide the sample into 25 m bins and plot the mean as well as the 95% confidence interval. The separate local linear equations are fitted for each side of the border using the uniform kernel. Figure (f) repeats the same as figure (e) using 2018 land price data.

within 150*m* from the border of buraku areas. Each dot represents the mean log land price in a bin with a 25*m* width and linear lines are fitted separately for within and outside buraku areas. Thus, unlike Figures 3c and 3d, the specification allows for discontinuity at the boundary. Figure 3e shows a clear discontinuous drop in land prices at the buraku border. The magnitude of the drop is estimated to be 0.50, which corresponds to an approximately 40% drop in land prices. This is consistent with Figure 3a showing that buraku areas have quite low land prices even compared to areas quite close to buraku areas.

Figure 3f shows the log land prices around the buraku border in the same format as Figure 3e. The discontinuity at the buraku border in 2018 is much smaller than in 1912. The estimated size of the jump is now around 0.07, corresponding to an approximately 7% drop in land prices in buraku areas. The discontinuity has substantially decreased from that in 1912 but 7% of land prices is still sizable from an economic point of view. Moreover, in addition to this discontinuity at the border, the land prices in 2018 substantially decrease as we go deeper inside the buraku areas from the border. In contrast, outside buraku areas, being further away from the buraku border increases land prices. Consequently, if we compare buraku and non-buraku land plots that have the same absolute distance from the border, we see a larger land price difference. This pattern explains why we have substantially lower land prices in buraku areas in Figures 3b and 3d despite the relatively small discontinuity at the border.[46]

Overall, our descriptive analysis is indicative of a large negative effect of buraku areas on land prices. The price gap is larger in 1912 than in 2018, although the gap in 2018 seems still substantial. Moreover, the spatial scope of buraku effects appears narrow, most likely within 150*m* from the buraku border.

6.2 Regression results

We now report the regression results. Table 1 presents the regression results for 1912. In Columns 1–3, we use the dummy specification for discrimination disamenity in Equation (4). Column 1 implements simple OLS regression without control variables using the entire sample. The estimate suggests that being in a buraku area lowers the land price by about 62%, which is highly significant from both economic and statistic perspectives. Column 2 adds our control variables. The buraku effect is now larger than Column 1: the penalty is now estimated to be about 71% of land prices. To implement the border design, Column 3 confines the sample to observations within 150*m* from the border as in Figure 3e. The dummy specification of the discrimination disamenity implies that we try to uncover the difference in the mean land prices within and outside buraku areas around buraku borders. The buraku effect is now around 57%,

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[46] A possible explanation for this is that the ambiguity of buraku border in people's minds increased over the past century. Although we are using the same objective definition of buraku borders both for 1912 and 2018, people might have less clear knowledge about the border in 2018 than in 1912 while they clearly know the central location of buraku areas in both periods. The ambiguity of the border is likely to attenuate the discontinuity at the border but the core of buraku areas does not suffer from this attenuation effect.

which is somewhat smaller than Columns 1–2 perhaps because land plots near buraku areas also have relatively low land prices compared to those distant from buraku areas (see Figure 3a) but still substantially higher prices than those within buraku areas. For Columns 2–3, we have also calculated Oster's (2019) bound to see the potential effect of omitted confounders. As seen in Table 1, accounting for them actually magnifies the estimated buraku effects.

Columns 4–6 repeat the same analyses as Columns 1–3 while replacing the specification of discrimination disamenity with the linear specification (5). Thus, we now allow the distance to the nearest buraku border to influence land prices with the potential effect heterogeneity between locations within and outside buraku areas. Since this specification allows for heterogeneous buraku effects, we report four types of buraku effects: buraku effects by comparing two land plots that are just across the buraku border, land plots $25m/50m/100m$ within and outside the buraku border. We note that the comparison right across the border in the linear specification is likely to be an underestimation of the buraku effect because the buraku border might be only ambiguously understood by people in society. In contrast, while the $100m$ comparison would be free of such an underestimation, it is more likely to suffer from unobserved confounding factors by comparing relatively distant land plots. This leads us to take the $25m$ comparison as a conservative estimate of the buraku effect and $100m$ comparison as a high-end estimate of the buraku effect, while the $50m$ comparison is our preferred estimate striking the balance between these two considerations. Our preferred specification is Column 6 because it is least likely to suffer from omitted variables: it includes various control variables and is robust to unobserved continuous confounders thanks to the border design (c.f., Black 1999; Bayer et al. 2007; Dell 2010). From these considerations, our preferred estimate of the buraku price penalty is 53% for 1912.

Table 2 repeats the same analysis as Table 1 but using 2018 data. As suggested by our descriptive analyses, the estimated buraku effects in 2018 are much smaller than in 1912 but still substantial. As in the 1912 analysis, we take 14% from the $50m$ comparison of Column 6 as our preferred estimate. Again, this is largely in line with estimates from other specifications that include control variables, although Column 5 suggests greater buraku effects.

In summary, both in 1912 and in 2018, we find a large buraku effect on land prices that is both economically and statistically significant: The estimated buraku effect in 1912 is 53% and that in 2018 is 14%.[47] In light of our model described in Section 4, this implies that although the cost of facing a higher discrimination risk has greatly diminished over the past century, discrimination persists even 150 years after equality under the law was achieved.

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[47] We illustrate the magnitude of this effect size by comparing with Cutler et al. (1999, Table 7) who estimate by how much black people pay lower housing rents. Using Columns 1 and 6 of Table 7 while the interaction terms are evaluated at the mean value reported in the summary statistics tables, their regression results imply that blacks pay about 45% lower housing rents in 1940 and almost the same housing rents in 1990. While caution is needed as the outcome variable is not the land price, this calculation might imply that our estimated land price penalty, especially that of 1912, is quite large.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 1912	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.9744***	-1.2387***	-0.8335***	-0.9824***	-1.1829***	-0.6849***
	(0.1384)	(0.1140)	(0.1431)	(0.1896)	(0.1703)	(0.2416)
Distance to buraku (m)				0.0000	0.0004***	0.0033*
				(0.0001)	(0.0000)	(0.0019)
Distance to buraku (m) × Buraku dummy				-0.0005	-0.0036***	-0.0052***
				(0.0022)	(0.0013)	(0.0019)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect	-62.23***	-71.03***	-56.55***	-62.56***	-69.36***	-49.59***
(Right across the border)	(5.22)	(3.30)	(6.22)	(7.10)	(5.22)	(12.18)
Buraku effect				-62.12***	-67.14***	-51.40***
(25m within vs outside)				(6.25)	(4.83)	(9.40)
Buraku effect				-61.68***	-64.75***	-53.15***
(50m within vs outside)				(5.98)	(4.48)	(7.15)
Buraku effect				-60.79***	-59.46***	-56.45***
(100m within vs outside)				(7.46)	(4.37)	(5.50)
Oster's bound for buraku effect (in percentage points)	N/A	-73.51	-61.60	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	60339	60339	2885	60339	60339	2885
R^2	0.012	0.734	0.724	0.012	0.743	0.733

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1: 1912 regression results on log land prices per m^2

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's (1999) standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50,$ or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's (2019) bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

Outcome: Log land price per m^2 in 2018	Dummy specification			Linear specification		
	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.3570***	-0.2066***	-0.1665***	-0.3573***	-0.2269***	-0.0989**
	(0.0441)	(0.0338)	(0.0297)	(0.0573)	(0.0447)	(0.0451)
Distance to buraku (m)				-0.0001***	-0.0000***	0.0007**
				(0.0000)	(0.0000)	(0.0003)
Distance to buraku (m) ×				0.0023***	0.0005	-0.0003
Buraku dummy				(0.0005)	(0.0005)	(0.0010)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect	-30.03***	-18.66***	-15.34***	-30.04***	-20.30***	-9.42**
(Right across the border)	(3.08)	(2.75)	(2.51)	(4.01)	(3.57)	(4.08)
Buraku effect				-33.58***	-21.14***	-11.64***
(25m within vs outside)				(3.28)	(2.91)	(2.69)
Buraku effect				-36.94***	-21.97***	-13.80***
(50m within vs outside)				(2.73)	(2.56)	(2.56)
Buraku effect				-43.15***	-23.60***	-17.97***
(100m within vs outside)				(2.27)	(3.04)	(5.18)
Oster's bound for buraku effect (in percentage points)	N/A	-14.80	-11.16	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	38832	38832	1892	38832	38832	1892
R^2	0.005	0.559	0.538	0.048	0.562	0.541

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 2: 2018 regression results on log land prices per m^2

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's (1999) standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50$, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's (2019) bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

6.3 Robustness checks

We probe the robustness of our results. First, we investigate whether our land price penalty might be driven by a discontinuous jump in the neighborhood quality (Ambrus, Field and Gonzalez 2020; Hanlon and Heblich 2022). Second, we consider the effect of school districts (Bayer et al. 2007). Third, we consider whether the land price penalty is driven by the discontinuous change in the floor-to-area ratio regulation (Brueckner, Fu, Gu and Zhang 2017). Fourth, we present regression results using an alternative definition of buraku areas. Finally, we check the robustness to the optimal bandwidth selection and bias-correction in the regression discontinuity design (Cattaneo et al. 2019).

Neighborhood quality. Buraku areas might have lower land prices even in the absence of discrimination if they have lower neighborhood quality. Although the border design admits the heterogeneous neighborhood quality as long as it is spatially continuous, the poor might sort into the buraku areas, which may lead to discontinuity in sanitation, school quality, and so on (Bayer et al. 2007; Ambrus et al. 2020). We now consider the extent to which our main results reflect lower neighborhood quality.

However, it is important to note that in our context, controlling for neighborhood quality might induce an over-control problem.[48] To illustrate this point, suppose that all workers are homogeneous and the neighborhood quality is completely characterized by the local average income. The homogeneity implies that no sorting in terms of the unobserved worker characteristic confounds the estimated buraku price penalty. Still, buraku areas may have lower local average income because of the labor market discrimination against residents in buraku areas. Then, worker i in a buraku area suffers not only from direct buraku discrimination against her/him, but also indirectly from buraku discrimination against her/his neighbors $j \neq i$ in the same buraku area by lowering the neighborhood quality. Thus, controlling for neighborhood quality might understate the severeness of buraku discrimination by ignoring such an indirect effect.

To evaluate the potential importance of neighborhood quality in our context, we first investigate the relationship between buraku areas and their income level. Analogously to Heblich et al. (2020), the income data are backed out using the land market clearing condition in our model and additional population density data (see Appendix D for details). We find that buraku areas in 1912 had 74% lower but no longer have lower income today (see Appendix G). The substantial poverty in the past and no income gap today are consistent with several studies on buraku areas in a different setting (e.g., Akisada 1972; Shima 2016). This implies that although the unobserved neighborhood quality would not explain our result in 2018, our results for 1912 might be potentially driven by the lower neighborhood quality.

We assess the role of neighborhood quality in 1912 in two ways. First, we explicitly control for urban health amenities in buraku areas (see Appendix I.1 for details). Poor areas might have

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[48] This approach also has an identification issue that the neighborhood quality is likely an endogenous variable correlated with the error term.

poor sanitary conditions and they are the key determinant of neighborhood quality, especially in historical times in the context of developed countries (Hanlon and Heblich 2022; Ambrus et al. 2020). We control for the best available proxies for them recently digitized by Inoue (2019): the incidence rate of typhoid, the prevalence of tap water usage, and the location of hospitals. We find that controlling for them actually magnifies the estimated land price penalty for buraku areas (see Appendix I.1).[49]

Second, we investigate the land price penalty for non-buraku areas with low income level (see Appendix I.2 for details). If such areas also have a land price penalty as large as that for buraku areas, it indicates that the buraku price penalty is driven by neighborhood quality (measured by average income). In contrast, if the land price penalty for poor non-buraku areas is smaller, then it indicates the special nature of buraku areas, implying the importance of the discrimination disamenity. Specifically, we split the city into $250m \times 250m$ grid cells as shown in Figure 1. After dropping the cells overlapping a buraku area, we define the same number of cells with the lowest average income as the non-buraku poor areas. Repeating the same analysis as in Table 1 (1912 regression results), we find that such areas have 16% lower land prices. This land price penalty is way smaller than the 53% land price penalty for buraku areas. Thus, although we cannot fully rule out that some of the land price penalty for buraku areas is driven by lower neighborhood quality, neighorhood quality alone cannot explain it.[50]

Taken together, we conclude that the low neighborhood quality in buraku areas is not the main factor inducing the low land price in buraku areas. Although buraku areas in 1912 are characterized by poverty, we find little evidence suggesting that it can explain the large part of the land price penalty for buraku areas. Buraku areas in 2018 are no longer characterized by poverty, thus, limiting the importance of neighborhood quality.

School districts. School quality can be an important determinant of neighborhood quality that might change discontinuously at the borders of school districts (e.g., Bayer et al. 2007). While school district boundaries might be endogenous to the presence of buraku areas and thus a consequence of discrimination,[51] some of the school quality differences might not be attributable to discrimination and confound our estimate of the severeness of discrimination. Moreover, being in the school district including a buraku area would discontinuously increase the chances of interactions with residents in buraku areas. Thus, controlling for school districts would also address the concern that people avoid living in buraku areas not to avoid being regarded as buraku, but to avoid frequent interactions with residents in buraku areas.

In Section I.3, we re-estimate the buraku effect while additionally controlling for public

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[49] Indeed, it is not obvious that buraku areas had poorer urban health amenities than neighboring non-buraku areas. More specifically, while buraku areas had significantly lower rate of tap water usage, they also had *lower* incidence rate of typhoid and *more* hospitals.

[50] As we analyze the land price data in 1961 in Section 7 and digitize all land plots in this year, we also conduct the same analysis for 1961 in which buraku areas are also characterized by poverty. Similarly to 1912, we find that the land price penalty of poor non-buraku areas is substantially smaller than that of buraku areas.

[51] For example, Okuda (2006) describes a case in which people opposed redrawing of the school district boundaries, potentially to avoid sharing the same school district as a buraku area.

primary and junior-high school fixed effects. We do this only for 2018 as we do not have accurate data on the boundary of school districts in other years.[52] We find that our estimates hardly change, implying that the above concerns do not seem to affect our results.

Floor-to-area ratio (FAR) regulation. The FAR regulation can affect land prices through the efficiency of land use (Brueckner et al. 2017), implying that our buraku effect might be influenced by the regulation if it discontinuously changes at the buraku border. In Japan, the FAR regulation did not exist in 1912 but was in effect in 2018. The FAR regulation is closely tied with the width of the front road, in which the narrower front road mandates a lower floor-to-area ratio.[53]

In Appendix I.4, we re-estimate the regression for 2018 while additionally controlling for the width of the front road. We find that while the width of the front road is associated with land prices consistently with the actual FAR regulation schedule, it has little impact on our buraku effects. We conclude that the heterogeneous FAR regulation is unlikely to explain our results.

Alternative definition of buraku areas. In Appendix I.5, we repeat the same analysis using the alternative definition of buraku areas by Kyoto City Government (1929). Results are similar for both 1912 and 2018, although the buraku effects tend to be somewhat larger and the discontinuity at the border is more substantial in 2018.

This result mitigates several concerns. First, it ensures that our results are not driven by a specific way of defining buraku areas. Second, since we have clear evidence that the six buraku areas in Kyoto City Government (1929) date back to the pre-modern period (Kyoto City Government 1940), shocks to contemporary land prices are unlikely to be correlated with the locational determinants of these areas (Ciccone and Hall 1996). Finally, since buraku areas in Kyoto City Government (1929) are around the center of Kyoto city, it excludes the possibility that the diminishing buraku effect is spuriously induced by the inclusion of new buraku areas due to the expansion of the city.[54]

Robustness of the border design. In Appendix I.6, we explore the robustness of our border design using the MSE-optimal bandwidth selection and robust bias-correction by Cattaneo et al. (2019). We do not use this as our main result because by focusing on identifying the jump

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[52] However, we expect that the contamination due to the school quality is, if any, moderate in other years. Japanese public schools are generally highly standardized in terms of the curriculum and funding. Indeed, the capitalization of public school quality into land prices appears smaller than other developed countries (e.g., Kuroda 2022). We also have suggestive evidence that school districts did not matter for our results in 1912. Out of five buraku areas, there is a buraku area that almost coincides with the school district (*moto-gakku*), implying that the school quality might jump at the boundary of this buraku area. However, our results change little by dropping this buraku area.

[53] In the main specification, we do not control for this to (i) enhance comparability of results with other years and (ii) road width difference might be a consequence of discrimination potentially through smaller public investments.

[54] To further address this concern, we have also conducted the 2018 analysis focusing only on buraku areas that were present in 1912 while using the original definition of buraku areas (Kyoto City Government 1975). We find similar results.

at the border, this procedure might not allow us to fully estimate the spatial configuration of buraku effects. The approach might also reduce the comparability of the results by choosing different bandwidths for 1912 and 2018. Reassuringly, however, using this alternative method leads to similar results.

7 Time series of buraku land price discount

Having established how the land price discount in buraku areas changed from 1912 to 2018, we now examine the intermediate years to better understand its time-series pattern. The time series allows us to investigate the speed and timing of the mitigation of discrimination. In particular, it would be interesting to know if the mitigation has stopped in the recent period or if it is still ongoing. Moreover, it might also be informative of the effect of various efforts and large place-based policies to eliminate discrimination against the buraku, which were especially active from the late 1960's to 1970's. Despite the limitation that we do not have counterfactual buraku areas that went through no such change, the time series of the severeness of discrimination, measured by land price discount, would indicate their impacts.

We first briefly discuss some important events for the buraku from the late 1960's to the 1970's. In 1969, the special integration policy law (*dowa taisaku jigyo tokubetsu sochi hou*) was implemented following the preceding governmental report that requires policies to eliminate discrimination (Dowa Policy Council, the Prime Minister's Office 1965). The law designates the buraku areas and invests in these areas, implying that it was a place-based policy. The law ended in 2002 and the project had spent 15 trillion yen in total. The law has significantly improved the living conditions of people, such as infrastructure and housing, and today buraku areas receiving such public investment have few disadvantages in these dimensions (Management and Coordination Agency 1993; Uehara 2009). Another important change is in the public education system: Classes emphasizing that buraku discrimination is unjustifiable started around 1970 (Kanegae 1995). Moreover, efforts to eliminate buraku discrimination have made it difficult to identify buraku people by restricting access to key information. First, it became more difficult for employers to know the location of buraku areas. This is due to a scandalous event found out in 1975, called *buraku chimei soukan jiken*, that many firms were found to have purchased a list of buraku areas to reject applicants from buraku areas. These firms were publicly condemned and the list was banned. Although it is possible that firms secretly keep the list to identify buraku areas even after the scandal, the ban is likely to mitigate discrimination in the labor market by increasing the cost of knowing the location of buraku areas. Second, access to the family registry (*koseki*) became restricted more strictly since 1976. Since it records the history of residential addresses, accessing it facilitates identifying who has lived in buraku areas, thereby catalyzing discrimination. Such concern led to a law amendment in 1976 to restrict the access to the records. Taken together, we may reasonably hypothesize that these changes since the late 1960's accelerated the decrease in the severeness of discrimination.

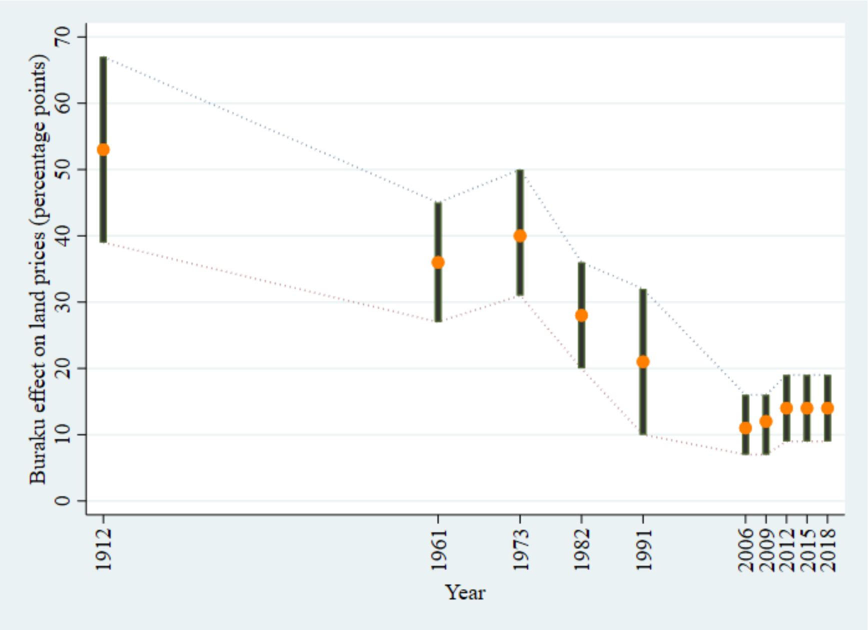

Figure 4: Time series of land price discount in buraku areas

Note: The orange dots represent the point estimates of the buraku price penalty (50m comparison) in Column 6 of Table 1 for 1912 and Tables B.1–B.8 for 1961–2015, and Table 2 for 2018. The vertical bars represent the corresponding 95% confidence intervals. All numbers are rounded to the nearest integers.

We now quantify the land price discount in 1961, 1973, 1982, 1991, and 2006–2015 using the same method as in Section 6. The time series of land price discount is summarized in Figure 4, showing the estimated land price penalty in percentage in each year, with a 95% confidence interval.[55] From 1912 and 1961, we observe a declining trend in land price discount. However, the declining trend seems to no longer exist from 1961 to 1973. This implies that when the above-mentioned policies and efforts were introduced, the mitigation of the discrimination might have faced a standstill. However, the decrease in land price discount appears fast from 1973 to 2006. Although we cannot unambiguously conclude due to the standard errors and the absence of "control" buraku areas that did not go through such policies and efforts, this time-series pattern of the land price penalty supports the hypothesis that the policies and efforts to combat buraku discrimination indeed contributed to mitigating it.

Figure 4 also shows that after 2006, the buraku price penalty seems stable despite the declining trend throughout the 20th century (see Tables B.5–B.8 in Appendix B for regression results). This suggests that the size of discrimination disamenity did not diminish in the 21st century. This result is consistent with the survey evidence on the public opinions about buraku issues (Kambara 2012). The standstill starkly highlights the persistence of buraku discrimination.[56] It also implies that even the large-scale policies and efforts did not eliminating

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[55] Figure 4 is based on our preferred 50m comparison within and outside the border of buraku areas. In Appendix I.7, we present similarly-constructed figures based on 25m and 100m comparisons.

[56] In 2016, the Act on the Promotion of the Elimination of Buraku Discrimination (*buraku sabetsu no kaisyo no suishin ni kansuru houritsu*) came into force with the aim of clarifying the government's responsibility in taking all possible actions in order to eliminate buraku discrimination. The enactment of this new law might imply that

buraku discrimination.

Overall, the time-series pattern is consistent with the interpretation that while the large-scale policies and efforts to combat discrimination indeed contributed to mitigating it, they did not succeed in fully eliminating it. Perhaps interestingly, this pattern is similar to the black-white earnings gap in the US (Boustan 2016; Derenoncourt and Montialoux 2021): It substantially shrank in the civil rights era despite that the gap no longer had a declining pre-trend, but the gap seems to have stopped shrinking after some years. This might imply that eliminating discrimination is fundamentally more difficult than mitigating existing severe discrimination.

8 Additional discussions

Having investigated the effect of buraku areas on land prices, we conduct additional analyses to obtain further insights on buraku discrimination by exploiting various implications from our model. First, we express the cost of having a higher discrimination risk in terms of income rather than land prices, which facilitates comparison with other studies on discrimination. Second, we conduct a simple counterfactual analysis of reducing the discrimination disamenity and compare the counterfactual results with the observed changes from 1912 to 2018. Finally, we quantify how much buraku discrimination decreases the wealth value of landowners. Appendix J provides more details.

Income-equivalent cost of a higher discrimination risk. Based on Proposition 1, we have quantified the overall cost of having a higher discrimination risk by living in a buraku area in units of land prices. While this is the straightforward approach from our model, it is also somewhat inconvenient in comparing our results with those of other studies on discrimination, which often express the severeness of discrimination in terms of income or wages. We exploit the full structure of the model to convert the cost of a higher discrimination risk into income units. We find that in 1912, discrimination is compensated for by giving 11.2% of income while the percentage for 2018 drops to 1.7%. Based on other studies about discrimination and the potential underestimation of the severeness of discrimination in our approach, we argue that the discrimination in 1912 is at least comparable to or even more sever than other types of discrimination such as the contemporaneous racial discrimination in the US and gender discrimination in Japan. However, given the relatively small estimates for 2018, buraku discrimination in 2018 seems more moderate than these cases of discrimination.

Comparing counterfactual prediction and reality. We undertake a simple counterfactual analysis to check the validity of our model. We consider the 1912 economy as our baseline and hypothetically set discrimination disamenities at the 2018 level rather than the 1912 level. We then compare the predicted changes in population and income to the observed ones. We find that the model's prediction is consistent with reality, despite that many other changes that

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the government is indeed aware of the stop in the mitigation of discrimination.

occurred over the century are ignored in this analysis. Thus, our model seems to successfully capture key economic forces.

Wealth loss due to discrimination. Since buraku areas have lower land prices due to discrimination, the owners of the land plots in buraku areas suffer (c.f., Akbar et al. 2019). Our back-of-the-envelope calculation suggests that the aggregate losses in land value amount to 99 billion yen in 1912, 59 billion yen in 1961, and 36 billion yen in 2018. We also calculate that out of the total wealth loss, homeowners living in buraku areas incur a wealth loss of 20 billion yen in 1912, 32 billion yen in 1961, and 20 billion yen in 2018.[57] While we do not have sufficient data to determine how well the wealth loss for homeowners approximates the wealth loss for discriminated people, these numbers suggest that our quantification of the cost of a higher discrimination risk, which does not include the wealth effect by assuming the absentee ownership of land, likely underestimates the true cost of discrimination against the buraku people by ignoring the wealth loss of the buraku people. Our quantification of the severeness of discrimination is thus conservative.

9 Concluding remarks

In this paper, we propose a novel revealed-preference approach for measuring the overall cost of the risk of being identified as a discriminated group member by focusing on *buraku*, a historically discriminated group in Japan. Although the buraku people are very similar to the majority Japanese, discrimination against the buraku exists due to a vestige of the premodern history as in many other contexts such as the caste system in India and the feudal system in Europe. Buraku discrimination is distinctive in that in the absence of visible difference of the buraku people, living in a small historical community area (*buraku area*) in a city serves as a signal that people use to infer whether someone belongs to the buraku class. In this situation, the discrimination risk is traded indirectly through the land market, providing a rare opportunity to measure the cost of the discrimination risk using the revealed-preference approach. We formalize this argument by showing the capitalization of the discrimination risk into land prices of buraku areas in a spatial equilibrium model.

Empirically, we implement our approach using the newly arranged land price data of Kyoto city from 1912 to 2018, which allows us to analyze the evolution of the severeness of discrimination over the past century. Using a border design to exploit a quasi-experimental variation in the discrimination risk, we find that buraku areas had 53% lower land prices in 1912 while they had 14% lower land prices in 2018. This implies that the degree of discrimination has substantially diminished over the past century but discrimination persists even 150 years after achieving equality under the law. Analyzing the intermediate years between 1912 and 2018 using newly digitized data, we find that while large-scale policies and efforts to address buraku

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[57] The wealth loss of buraku residents is larger in 1961 than 1912 because the homeownwership became much more common in Japan after WW2. See the Appendix J.4.

discrimination might have contributed to mitigating it, even they could not fully eliminate discrimination from society. Indeed, the mitigation of discrimination might have stopped in the 21st century. This result highlights the strong persistence of discrimination.

We believe that our results on 100 years of buraku discrimination have implications on other contexts of discrimination, especially in two important ways. First, our setting is distinctively desirable as a laboratory to detect and quantify the severeness of discrimination. In particular, since the discrimination risk is indirectly traded through the land market, we could measure the cost of facing a high risk of being identified as a discriminated group member from a revealed-preference approach, rather than stated-preferences. Moreover, we could exploit a quasi-random variation in the risk of discrimination by comparing similar land plots with different discrimination risks, which is exceptional because the discrimination risk is typically determined by innate characteristics such as skin color (Sen and Wasow 2016). We quantitatively show the severe and persistent buraku discrimination even if such empirical concerns are addressed, implying that the severe and persistent discrimination found in other contexts of discrimination (e.g., Fryer 2011; Boustan 2016) might not be spuriously driven by the above-mentioned empirical concerns.

Second, our results underscore the strong persistence of discrimination even among the same race. This might imply the persistence in other contexts in which the discriminated group has more differences from the majority. We illustrate this point using US racial discrimination. The US still experiences racial discrimination despite that the civil rights movement banned it more than 50 years ago. Currently, we cannot observe the severeness of US racial discrimination 50 years from now (i.e., after about 100 years from the civil rights movement), but our result on buraku discrimination is telling on this issue. The centuries-long persistence of buraku discrimination even among the same race suggests an unfortunate possibility that the remaining racial discrimination in the US might be quite persistent. In particular, our results imply that even the large-scale policies and efforts mitigated discrimination but could not eliminate it, just like the civil rights movements in the US also mitigated discrimination against black people but could not eliminate it measured by the black-white earnings gap (Boustan 2016; Derenoncourt and Montialoux 2021). Thus, our result might suggest the potential difficulty of the “last mile problem” in eliminating discrimination in the context of racial discrimination in the US and other settings.

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Appendix to "Measuring Discrimination in Spatial Equilibrium: 100 Years of *Japan's Invisible Race*" (Not for Publication)

A Full description of the model

We present the full description of our model and the detailed derivation of our proposition. To make the Appendix self-contained, a part of this Appendix reproduces the contents of Section 4.

Consider a static spatial model with N locations, where the land supply at each location $n \in \{1, 2, ..., N\}$ is fixed. The city is populated with an endogenous measure of workers and all of them commute to the CBD for work.[A.1] We incorporate heterogeneity among workers by assuming that worker i is endowed with I_i units of effective labor. However, we let the actual labor supply depend on residence because of commuting and potential discrimination in the labor market. We do not distinguish a priori the buraku and non-buraku people by assuming that all people have the same utility function, reflecting the fact that they belong to the same race and have almost no visible distinction. However, living in a particular location (a buraku area) might increase the probability of being regarded as belonging to the buraku class. Thus, although all people look ex-ante identical conditional on human capital, after residential choice, those living in a buraku area are deemed likely to come from the discriminated class and they experience discrimination.[A.2] Each worker has the outside utility $\tilde{U}_i$ that is exogenously determined in the outside world. On the production side, firms produce a single final good that is costlessly traded within the city as well as between the city and the outside world. The spatial equilibrium condition across different locations in and outside the city determines the population configuration at each location.

Production. Since production is not our focus, we consider a simple production sector following the canonical Alonso-Muth-Mills monocentric city model (Fujita 1989). We assume that all firms are located in the CBD and have the linear technology that uses labor only to produce freely traded composite goods: $f(h) = h$, where h is the effective unit of labor input. By appropriately choosing the units, the coefficient of h can be set to one without loss of generality. Assuming that the market is perfectly competitive, the profit maximization then implies that the output price is $p = w$, where p is the output price and w is the wage rate. Using the final output as our numéraire, $p = w = 1$. The linear technology and perfect competition ensure that firms obtain no profit in equilibrium. Note that production does not require land as an input.

[A.1] The model presented in this section can be easily extended to accommodate multiple workplaces. Empirically, however, Kyoto city has a monocentric structure throughout our sample period (see Figure 2).

[A.2] Given that we do not have data on the inference process of the affiliation to the buraku class, we simply assume that residing in a buraku area is the perfect signal of the affiliation. However, we expect that considering the presence of ex-ante characteristics that might signal the buraku class reduces the importance of residence as a signal. If so, our estimate would be a conservative estimate of the cost of belonging to the buraku class because our approach identifies the effect of the incremental discrimination risk by living in a buraku area. In an extreme case in which the ex-ante heterogeneity is observable and perfectly determines the affiliation with the buraku class, we would have no effect of buraku areas on land prices, which is empirically not the case.

Workers. The utility function is assumed to be homogeneous across people and Cobb-Douglas:

$$U = s_n^{utility} l^\gamma x^{1-\gamma}, \tag{A.1}$$

where $s_n^{utility} > 0$ is the residential amenity of location n that directly affects utility, including the commuting cost in terms of utility (Ahlfeldt, Redding, Sturm and Wolf 2015). x is the freely-tradable composite goods, which is our numéraire, and l is the land consumption. In Equation (A.1), we implicitly assume that housing structures and utilities (e.g., electricity) have the same price regardless of location in a city and include them in the composite numéraire goods. The amenity $s_n^{utility}$ includes the "discrimination disamenity": living in location n might be associated with discrimination and yields lower utility. We discuss this in more detail below.

Worker i is endowed with I_i units of effective labor, implying that I_i also represents the level of her human capital. However, the actual labor supply is location dependent: $s_n^{labor} I_i$. $s_n^{labor} > 0$ captures the time cost of commuting and the potential labor market discrimination. For example, discriminated people might face a higher risk of layoffs or difficulty in finding a new job, reducing the total labor supply throughout the year. Since the wage rate is $w = 1$ at the equilibrium, this implies that worker i in location n has disposable income $s_n^{labor} I_i$. Workers receive no revenue from land because we assume absentee ownership of land (Fujita 1989).[A.3]

After choosing location n, workers maximize the utility (A.1) subject to the budget constraint $x + r_n l = s_n^{labor} I_i$ where r_n is the unit land price and I_i is the income. This yields the following demand functions:

$$x_{in} = (1-\gamma) s_n^{labor} I_i, \quad l_{in} = \gamma \frac{s_n^{labor} I_i}{r_n}. \tag{A.2}$$

Thus, γ is the spending share on land, which is the feature of Cobb-Douglas utility (A.1).

Consequently, V_{in}, the indirect utility of individual i living in location n, is

$$V_{in} \equiv \gamma^\gamma (1-\gamma)^{1-\gamma} s_n r_n^{-\gamma} I_i, \tag{A.3}$$

where $\ln s_n \equiv \ln s_n^{utility} + \ln s_n^{labor}$. Thus, regardless of whether residential amenities or commuting costs affect utility directly or indirectly through labor market, its total impact on indirect utility is summarized respectively by the single index s_n and κ. Henceforth, we call s_n the (residential) amenity of location n.

We now suppose that the amenity in location n, $s_n > 0$, is given by the following equation:

$$\frac{\ln s_n}{\gamma} = D_n + \eta X_n + \epsilon_n, \tag{A.4}$$

[A.3] Note that we can introduce landlords without changing our results if they are immobile and we remove the land owned by such landlords from the model. However, the welfare implication might change in that owners of plots in a buraku area receive lower land rents due to discrimination disamenity. So long as land of buraku areas tends to be owned by the residents, introducing the land ownership further magnifies the cost of discrimination through the wealth effect, which we ignore in the main analysis by assuming the absentee ownership. We briefly discuss its quantitative impact in Section 8.

where the division of $\ln s_n$ by γ is only for later notational convenience. X_n is the exogenous characteristics of location n and η is the vector of the associated coefficients. ϵ_n is an idiosyncratic local characteristic at location n. We assume that ϵ_n is unobservable to econometricians, but its realization is known so that workers make no decision under uncertainty. As discussed in Section 5.1, ϵ_n can be spatially auto-correlated.

D_n in (A.4) is the key object of interest: "discrimination disamenity." Living in some region n increases the risk of experiencing discrimination. This effect is captured by the lower amenity value of this region. The simplest specification of D_n is binary: it takes a low value when location n is outside a buraku area and vice versa. However, a richer spatial configuration of discrimination disamenity is incorporated in our formulation; for example, living next to a buraku area might also increase the risk of discrimination.

We make two remarks on our definition of discrimination before proceeding. First, we have not specified how discrimination affects the indirect utility, but we have introduced D_n that summarizes the magnitude of bad effects by belonging to the discriminated group. The discrimination might directly reduce the utility in the form of marriage discrimination, bullying, and so on. Discrimination may also reduce the utility by reducing the income, which would be caused by discrimination in the labor market. As our discrimination disamenity incorporates all such forms of discrimination in the single index, it can measure the severeness of discrimination as a whole, rather than discrimination in a specific dimension. This is an advantage of our approach because discrimination can take various forms and some of them might be hard to credibly measure or even just to observe, such as psychological bullying.

Second, D_n captures all adverse effects on the discriminated group that are not mediated through local characteristics X_n. For example, people might experience lower utility directly by facing difficulty in marriage or being bullied by others, which is included in D_n. However, if the government is discriminating against the buraku, it might choose to invest less in buraku areas, leading to poorer infrastructure. Arguably, this effect should be included as one form of buraku discrimination. However, if X_n includes the local infrastructure level, D_n does not include this channel of discrimination. This implies that our definition of discrimination becomes more conservative as we include in X_n more local characteristics. We thus report regression results using a different set of control variables.

Equilibrium conditions. In equilibrium, all workers and firms behave optimally and all markets clear. Specifically, Equation (A.2) should be satisfied so that workers' consumption given residential choice is optimal. Firms' optimality and labor market clearing are trivially satisfied when $p = w = 1$ due to the linear production technology combined with inelastic labor supply. By assuming that the numéraire goods are freely traded with the outside world, the numéraire goods market also always clears.

The two remaining conditions are the land market clearing at each location n and the spatial equilibrium condition (i.e., optimality of location choice). For the land market clearing, let

L_n be the land endowment at location n, which is inelastically supplied.[A.4] The land market clearing condition is, for all n,

$$\sum_{i \in \Phi_n} l_{in} = \frac{\gamma}{r_n} \sum_{i \in \Phi_n} s_n^{labor} I_i = L_n, \tag{A.5}$$

where Φ_n is the set of workers living in location n. Let N_n be the measure of Φ_n, that is, the population of location n. Note that Equation (A.5) implies that

$$\bar{I}_n \equiv \frac{\sum_{i \in \Phi_n} s_n^{labor} I_i}{N_n} = \frac{r_n}{\gamma \bar{N}_n}, \tag{A.6}$$

where $\bar{I}_n$ is the average income at location n and $\bar{N}_n \equiv \frac{N_n}{L_n}$ is the population density. Thus, Equation (A.6) says that the average income at each location can be backed out from land prices, population density, and the spending share for land. Intuitively, the same amount of land demand can follow either by hosting many poor people, each of whom demands only a small amount of land, or many rich people each of whom demands a large amount of land. Although looking at the land price alone cannot distinguish these two cases, observing the population density allows us to separate these two scenarios. Equation (A.6) is important because although we do not have income data at the local level, we can recover it from the land price and population data, analogously to Heblich, Redding and Sturm (2020). We exploit this property to analyze the income level in buraku areas in Section 8. Note that while Equation (A.6) allows us to identify the local average income, it does not allow us to decompose it into the effective units of labor and the effect of the potential labor market discrimination.

We turn to the spatial equilibrium condition. Let $\tilde{U}_i$ be the utility that can be obtained outside the city, which differs across workers because of human capital heterogeneity. Assuming the city is sufficiently small, we treat $\tilde{U}_i$ as exogenously given.[A.5] The spatial equilibrium condition says that the location choice of each worker i is optimal. For those living in the city, the utility of worker i living in region n must be greater than the utility by living in another location n' or the outside world. Formally, for each worker i living in n,

$$V_{in} \equiv \gamma^{\gamma}(1-\gamma)^{1-\gamma} s_n r_n^{-\gamma} I_i \geq \max\{\max_{n' \neq n} V_{in'}, \tilde{U}_i\}. \tag{A.7}$$

For any worker i living outside the city, the maximum utility in the city must be weakly smaller

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[A.4] Note, however, that housing supply can be elastic in our model. To see this, consider x as a housing structure. The demand for housing structure per unit of land ($\frac{x}{l}$) is increasing in r, implying that a worker builds up higher to enjoy more floor space given the same amount of land. Note also that the elastic land supply might be incorporated by endogenizing the number of locations N. However, the inelastic land supply is reasonable in our setting because no leapfrogging development was observed in Kyoto, implying that developers had an incentive to develop all relevant areas, including buraku areas, perhaps due to the high value of land in rapidly growing Kyoto. Therefore, the natural constraint on the total amount of available land seems binding, justifying the inelastic land supply assumption.

[A.5] To exclude the case in which everyone lives in the city, we assume that the mass of population in the entire economy is sufficiently large that in equilibrium, the city does not accommodate all people in the entire economy (i.e., someone chooses to live in the outside economy).

than the outside utility:

$$\tilde{U}_i \geq \max_n V_{in}. \tag{A.8}$$

To simplify the analysis, we impose the following assumption on the outside utility:

Assumption 1. *$\tilde{U}_i = \xi I_i$, where $\xi > 0$ is exogenously given.*

This means that the outside utility is proportional to the human capital I_i. Assumption 1 is naturally satisfied when the outside economy has a similar structure as that of the city under study. Indeed, as discussed in Appendix A, the equilibrium indirect utility within the city (V_{in}) also becomes proportional to I_i and independent of location n. We take ξ as exogenous to the city since we assume the small city that has no general equilibrium effect on the outside economy.

Main result. We now state our main proposition. The proof is found at the end of this section.

Proposition 1. *Equilibrium land prices r_n satisfy $\ln r_n = D_n + \eta X_n + \epsilon_n$ for any location n, where D_n is the discrimination disamenity, X_n is a vector of locational characteristics, and ϵ_n is the unobservable idiosyncratic amenity. After parametrizing D_n, the OLS consistently estimates it provided that (D_n, X_n) are orthogonal to ϵ_n.*

Proposition 1 shows that we can back out the discrimination disamenity D_n by regression.[A.6] To illustrate this point, we specify that D_n equals some coefficient β times the dummy indicating whether location n belongs to the buraku area; that is, β is the impact of locating in a buraku area on land prices relative to a non-buraku area (see Equation (4) in Section 5.1 for a mathematical expression). Then, we can estimate β and η by the OLS and the estimates are consistent if the location of buraku areas and exogenous locational characteristics are orthogonal to the error term ϵ_n.[A.7]

The intuition behind Proposition 1 is that since the discrimination risk and particular locations are tightly connected, the discrimination risk is implicitly traded through the land market. As such, conditional on other location characteristics X_n, the willingness-to-pay to avoid a higher discrimination risk should be reflected in the land price difference between buraku and non-buraku areas. This is an application of the standard spatial equilibrium logic of Rosen (1979) and Roback (1982) to a novel context of the discrimination risk: the discrimination disamenity

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[A.6] Note that Equation (A.10) is equivalent to the semi-parametric hedonic regression of Rossi-Hansberg, Sarte and Owens III (2010) since we have not yet imposed a parametric assumption on D_n.

[A.7] Note that in Proposition 1, the population and the income level of location n do not appear. Intuitively, a location attracting more people or richer people has more land demand and so a higher land price. On the other hand, the land price must be low enough to keep such a large population or rich people who have decent outside options. These two opposing effects exactly offset each other at the equilibrium. This feature is helpful for our regression analysis as we do not need to explicitly consider the potential endogeneity of the population and the income level of each location. Moreover, even if our modelling assumptions are violated so that they enter as omitted variables, focusing on samples around the buraku border would eliminate the bias as long as these variables continuously affect land prices (see Section 5).

D_n is capitalized into land prices since utility is equalized everywhere in equilibrium.[A.8] Note that D_n includes forms of discrimination that are difficult to detect experimentally or even just to observe in data, such as psychological bullying. In this sense, Proposition 1 allows us to estimate, in revealed preference, the overall cost of facing a higher risk of being regarded as a discriminated group member.[A.9]

We discuss the empirical implementation of Proposition 1 in Section 5 and the results are presented in Section 6. On top of Proposition 1, the full structure of the model allows us to obtain additional empirical implications, which we discuss in Section 8.

Proof of Proposition 1. We first prove the following lemma:

Lemma 1. *In the spatial equilibrium,* $\gamma^\gamma(1-\gamma)^{1-\gamma}s_n r_n^{-\gamma}$ *equalizes for all n, implying that* V_{in} *becomes independent of n and proportional to* I_i*. Under Assumption 1,* $\gamma^\gamma(1-\gamma)^{1-\gamma}s_n r_n^{-\gamma}$ *equalizes to* ξ *so that* $V_{in} = \xi I_i$ *for all i and n.*

Proof of Lemma 1. We first show that $\gamma^\gamma(1-\gamma)^{1-\gamma}s_n r_n^{-\gamma}$ equalizes for all n. Suppose $\gamma^\gamma(1-\gamma)^{1-\gamma}s_n r_n^{-\gamma} > \gamma^\gamma(1-\gamma)^{1-\gamma}s_{n'} r_{n'}^{-\gamma}$ for some locations n and n'. Then, for any i, $V_{in} > V_{in'}$ so that any individual i prefers location n to location n'. Thus, the spatial equilibrium condition (A.7) implies that n' is not inhabited. But then the demand for land in n' becomes zero and the equilibrium land price must become zero. This implies $V_{in'} = \infty$, a contradiction to (A.7) because everyone has an incentive to move to n'.

Now let $\tilde{\xi}$ be the common value of $\gamma^\gamma(1-\gamma)^{1-\gamma}s_n r_n^{-\gamma}$. We show that $\tilde{\xi} = \xi$ under Assumption 1. Suppose $\tilde{\xi} > \xi$. Then the spatial equilibrium condition (A.8) is not satisfied, implying that any individual in the outside economy has an incentive to live in the city. Thus, it contradicts that the city has the finite population at the equilibrium.[A.10] Next, suppose $\tilde{\xi} < \xi$, but then, everyone prefers to live in the outside economy. This implies zero land price at every location in the city, again contradicting the spatial equilibrium condition (A.7). ■

In other words, for any worker i, the indirect utility is independent of location n and equals the outside utility given in Assumption 1. Moreover, the first part of Lemma 1 in turn justifies Assumption 1 by showing that the city equilibrium naturally implies the indirect utility proportional to I_i. Note that the first part of Lemma 1 does not use Assumption 1 because it

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[A.8] We note that the main intuition does not rely on our specific model. To see this, consider two nearby land plots A and B. Plot A is in a buraku area while plot B is not. Then, as long as these plots are nearly identical because they are close to each other, the price of plot A must be lower at the equilibrium to compensate for the discrimination associated with living in plot A. Qualitatively, this is exactly what we predict in Proposition 1. This argument underlies the border design, which we introduce in Section 5.

[A.9] We expect that introducing preference heterogeneity and mobility costs does not change our main argument. In the presence of heterogeneous preferences, Proposition 1 would hold for an infra-marginal worker indifferent between buraku and non-buraku areas (Kline and Moretti 2014). In addition, in the presence of the mobility cost, the reduction in the discrimination disamenity of buraku areas would yield smaller decline in the land price penalty but qualitatively the same conclusion holds (Yamagishi 2021).

[A.10] As the city population approaches infinity, the equilibrium utility V_{in} approaches 0 for any i and n as land price r_n goes to infinity. However, this implies that (A.7) is not satisfied for a sufficiently large population given $\tilde{U}_i > 0$ due to our assumption in footnote A.5.

follows from the migration condition between different locations in a city, not from migration condition between the city and the outside economy.

Given Lemma 1, the spatial equilibrium condition (A.7) can be simply rewritten as follows: For any worker i in location n,

$$\gamma^{\gamma}(1-\gamma)^{1-\gamma} s_n r_n^{-\gamma} = \xi. \tag{A.9}$$

Taking the log of (A.9) and rearranging it using the amenity expression (A.4), we obtain the following hedonic regression equation

$$\ln r_n = D_n + \beta X_n + \epsilon_n. \tag{A.10}$$

Equation (A.10) establishes Proposition 1.[A.11] ■

Note that human capital I_i does not enter the spatial equilibrium condition (A.9) because both the indirect utility V_{in} and the outside utility are proportional to I_i. Thus, given any equilibrium vector of locational characteristics (r_n, s_n), any worker i, regardless of her human capital level, is indifferent between any location n in the city. This implies that although we have human capital heterogeneity, no strict sorting incentive arises from the heterogeneity. However, our model can still uncover the sorting observed in the data because the indifference admits weak sorting motives. Since we can observe the realized population level, we can still back out the average income using (A.6) that is consistent with the equilibrium of our model. However, when doing a counterfactual analysis in Section 8, we cannot separately pin down these two in the counterfactual scenario as we do not know what population level realizes in the counterfactual case.[A.12]

[A.11] Strictly speaking, we are slightly abusing the notation in that the constant term included in (A.10) is different by $\frac{1}{\gamma}\ln\gamma^{\gamma}(1-\gamma)^{1-\gamma} - \frac{1}{\gamma}\ln\xi$ from the constant of the term in (A.4). This does not affect our regression results on D_n because X_n includes a constant term.

[A.12] Technically, N land market clearing conditions and N spatial equilibrium conditions determine $2N$ endogenous variables: land price and total local income at each location n. This leads to a continuum of equilibria with different average income and population levels at each location. Using a different but similar model, Gaigné, Koster, Moizeau and Thisse (2022) recently show that homothetic preferences, which our Cobb-Douglas preference belongs to, exhibit such a property. However, since all equilibria have the same total local income, which is the product of the average income and population, observing the population in data allows us to pin down the average wage. We exploit this property to back out the average income in Section 8.

B Omitted tables from the main text (land price results for 1961–2015)

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 1961	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.8218***	-0.7479***	-0.5136***	-0.6500***	-0.5233***	-0.2137*
	(0.0605)	(0.0907)	(0.0747)	(0.1174)	(0.1533)	(0.1171)
Distance to buraku (m)				0.0000	0.0001***	0.0022***
				(0.0000)	(0.0000)	(0.0007)
Distance to buraku (m) ×				0.0020**	0.0023**	0.0001
Buraku dummy				(0.0009)	(0.0010)	(0.0013)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect	-56.04***	-52.67***	-40.16***	-47.79***	-40.75***	-19.24**
(Right across the border)	(2.66)	(4.29)	(4.47)	(6.13)	(9.08)	(9.46)
Buraku effect				-50.42***	-44.24***	-28.00***
(25m within vs outside)				(4.95)	(7.23)	(6.62)
Buraku effect				-52.91***	-47.53***	-35.82***
(50m within vs outside)				(3.98)	(5.61)	(4.71)
Buraku effect				-57.52***	-53.54***	-48.99***
(100m within vs outside)				(2.83)	(3.18)	(3.91)
Oster's bound for buraku effect (in percentage points)	N/A	-51.50	-39.26	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	11099	11099	633	11104	11099	633
R^2	0.022	0.700	0.552	0.023	0.702	0.573

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B.1: 1961 regression results on log land prices per m^2

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's (1999) standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50,$ or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's (2019) bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 1973	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.7174***	-0.8677***	-0.6166***	-0.2403	-0.2540	-0.1018
	(0.1349)	(0.1605)	(0.1032)	(0.1716)	(0.2031)	(0.1292)
Distance to buraku (m)				-0.0000	0.0002***	0.0024***
				(0.0000)	(0.0000)	(0.0006)
Distance to buraku (m) ×				0.0073***	0.0079***	0.0035*
Buraku dummy				(0.0016)	(0.0019)	(0.0020)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect	-51.20***	-58.01***	-46.02***	-21.36	-22.43	-9.68
(Right across the border)	(6.58)	(6.74)	(5.57)	(13.50)	(15.76)	(11.67)
Buraku effect				-34.45***	-36.89***	-26.58***
(25m within vs outside)				(9.18)	(10.51)	(7.43)
Buraku effect				-45.37***	-48.65***	-40.31***
(50m within vs outside)				(6.26)	(7.00)	(4.99)
Buraku effect				-62.05***	-66.00***	-60.56***
(100m within vs outside)				(3.85)	(3.91)	(3.99)
Oster's bound for buraku effect (in percentage points)	N/A	-60.21	-47.80	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	3754	3754	537	3754	3754	537
R^2	0.055	0.485	0.419	0.069	0.516	0.470

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B.2: 1973 regression results on log land prices per m^2

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's (1999) standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50$, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's (2019) bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 1982	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.3701***	-0.4266***	-0.3500***	-0.1872**	-0.1202	-0.0824
	(0.0660)	(0.0825)	(0.0630)	(0.0790)	(0.0914)	(0.0797)
Distance to buraku (m)				-0.0001	0.0001*	0.0008**
				(0.0000)	(0.0000)	(0.0004)
Distance to buraku (m) × Buraku dummy				0.0037***	0.0050***	0.0034***
				(0.0009)	(0.0009)	(0.0013)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect (Right across the border)	-30.94***	-34.73***	-29.53***	-17.07***	-11.33	-7.91
	(4.56)	(5.38)	(4.44)	(6.55)	(8.10)	(7.34)
Buraku effect (25m within vs outside)				-24.25***	-21.92***	-18.52***
				(5.11)	(6.16)	(5.13)
Buraku effect (50m within vs outside)				-30.75***	-31.24***	-27.90***
				(4.28)	(4.95)	(4.18)
Buraku effect (100m within vs outside)				-42.28***	-46.68***	-43.56***
				(4.19)	(4.25)	(4.87)
Oster's bound for buraku effect (in percentage points)	N/A	-35.97	-30.95	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	6558	6558	1057	6561	6558	1057
R^2	0.038	0.463	0.434	0.046	0.477	0.458

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B.3: 1982 regression results on log land prices per m^2

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's (1999) standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50,$ or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's (2019) bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 1991	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.4238***	-0.3194***	-0.2625***	-0.1901**	0.0029	0.0230
	(0.0878)	(0.1156)	(0.0799)	(0.0965)	(0.1212)	(0.0949)
Distance to buraku (m)				-0.0002***	-0.0001*	0.0011**
				(0.0001)	(0.0000)	(0.0005)
Distance to buraku (m) × Buraku dummy				0.0052***	0.0059**	0.0029
				(0.0012)	(0.0024)	(0.0022)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect (Right across the border)	-34.55***	-27.34***	-23.09***	-17.31**	0.29	2.32
	(5.74)	(8.40)	(6.15)	(7.98)	(12.15)	(9.70)
Buraku effect (25m within vs outside)				-26.82***	-13.11*	-9.81*
				(5.82)	(7.08)	(5.83)
Buraku effect (50m within vs outside)				-35.22***	-24.71***	-20.51***
				(4.60)	(5.67)	(5.61)
Buraku effect (100m within vs outside)				-49.26***	-43.48***	-38.25***
				(4.42)	(8.93)	(9.44)
Oster's bound for buraku effect (in percentage points)	N/A	-24.85	-21.14	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	5138	5138	817	5138	5138	817
R^2	0.016	0.586	0.522	0.026	0.594	0.536

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B.4: 1991 regression results on log land prices per m^2

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's (1999) standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50,$ or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's (2019) bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 2006	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.2771***	-0.1618***	-0.1383***	-0.2456***	-0.1856***	-0.0571
	(0.0345)	(0.0307)	(0.0267)	(0.0440)	(0.0398)	(0.0388)
Distance to buraku (m)				-0.0001***	-0.0000***	0.0007***
				(0.0000)	(0.0000)	(0.0003)
Distance to buraku (m) × Buraku dummy				0.0017***	0.0005	-0.0002
				(0.0004)	(0.0005)	(0.0008)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect	-24.20***	-14.94***	-12.92***	-21.77***	-16.94***	-5.55
(Right across the border)	(2.62)	(2.61)	(2.32)	(3.44)	(3.30)	(3.66)
Buraku effect				-24.85***	-17.80***	-8.43***
(25m within vs outside)				(2.83)	(2.68)	(2.51)
Buraku effect				-27.80***	-18.65***	-11.23***
(50m within vs outside)				(2.41)	(2.35)	(2.34)
Buraku effect				-33.36***	-20.32***	-16.56***
(100m within vs outside)				(2.29)	(2.86)	(4.31)
Oster's bound for buraku effect (in percentage points)	N/A	-11.85	-10.35	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	36576	36576	1807	36576	36576	1807
R^2	0.006	0.457	0.427	0.028	0.463	0.433

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B.5: 2006 regression results on log land prices per m^2

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50$, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 2009	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.3298***	-0.1830***	-0.1454***	-0.3135***	-0.2135***	-0.0910**
	(0.0393)	(0.0333)	(0.0270)	(0.0554)	(0.0480)	(0.0445)
Distance to buraku (m)				-0.0001***	-0.0000***	0.0008***
				(0.0000)	(0.0000)	(0.0003)
Distance to buraku (m) × Buraku dummy				0.0019***	0.0004	-0.0009
				(0.0005)	(0.0006)	(0.0007)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect	-28.09***	-16.73***	-13.53***	-26.91***	-19.23***	-8.70**
(Right across the border)	(2.82)	(2.78)	(2.33)	(4.05)	(3.87)	(4.07)
Buraku effect				-30.09***	-19.94***	-10.21***
(25m within vs outside)				(3.25)	(3.08)	(3.03)
Buraku effect				-33.12***	-20.65***	-11.69***
(50m within vs outside)				(2.64)	(2.59)	(2.41)
Buraku effect				-38.81***	-22.05***	-14.59***
(100m within vs outside)				(2.14)	(2.94)	(3.09)
Oster's bound for buraku effect (in percentage points)	N/A	-12.86	-9.78	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	37418	37418	1828	37418	37418	1828
R^2	0.006	0.503	0.477	0.034	0.507	0.482

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B.6: 2009 regression results on log land prices per m^2

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25$, 50, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 2012	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.3457***	-0.2051***	-0.1710***	-0.3372***	-0.2311***	-0.1027**
	(0.0418)	(0.0347)	(0.0298)	(0.0552)	(0.0457)	(0.0447)
Distance to buraku (m)				-0.0001***	-0.0000***	0.0007***
				(0.0000)	(0.0000)	(0.0003)
Distance to buraku (m) × Buraku dummy				0.0020***	0.0005	-0.0005
				(0.0005)	(0.0006)	(0.0009)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect (Right across the border)	-29.23***	-18.54***	-15.71***	-28.62***	-20.64***	-9.76**
	(2.96)	(2.83)	(2.51)	(3.94)	(3.62)	(4.03)
Buraku effect (25m within vs outside)				-31.80***	-21.42***	-11.92***
				(3.24)	(2.95)	(2.79)
Buraku effect (50m within vs outside)				-34.83***	-22.20***	-14.03***
				(2.70)	(2.59)	(2.58)
Buraku effect (100m within vs outside)				-40.50***	-23.74***	-18.09***
				(2.27)	(3.09)	(4.74)
Oster's bound for buraku effect (in percentage points)	N/A	-14.92	-12.01	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	37794	37792	1844	37794	37792	1844
R^2	0.007	0.504	0.490	0.041	0.508	0.494

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B.7: 2012 regression results on log land prices per m^2

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50$, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 2015	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.3575***	-0.2126***	-0.1755***	-0.3484***	-0.2344***	-0.0979**
	(0.0429)	(0.0334)	(0.0294)	(0.0562)	(0.0442)	(0.0447)
Distance to buraku (m)				-0.0001***	-0.0000***	0.0008***
				(0.0000)	(0.0000)	(0.0003)
Distance to buraku (m) × Buraku dummy				0.0022***	0.0005	-0.0004
				(0.0005)	(0.0005)	(0.0009)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect (Right across the border)	-30.06***	-19.15***	-16.10***	-29.42***	-20.89***	-9.32**
	(3.00)	(2.70)	(2.47)	(3.97)	(3.50)	(4.05)
Buraku effect (25m within vs outside)				-32.82***	-21.73***	-11.85***
				(3.25)	(2.83)	(2.73)
Buraku effect (50m within vs outside)				-36.06***	-22.56***	-14.32***
				(2.70)	(2.48)	(2.52)
Buraku effect (100m within vs outside)				-42.07***	-24.20***	-19.03***
				(2.21)	(3.01)	(4.80)
Oster's bound for buraku effect (in percentage points)	N/A	-15.44	-12.24	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	38259	38259	1869	38259	38259	1869
R^2	0.006	0.517	0.495	0.044	0.520	0.500

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B.8: 2015 regression results on log land prices per m^2

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50,$ or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

C Comparing the assessment data and transaction data of land prices

For 2018, our analysis uses land price assessment data for property taxation (*kotei shisan-zei rosenka*). We validate the assessment data using the transaction data from the Land General Information System.[C.1] The transaction data is collected through a voluntary survey and all people who made a real estate transaction receive the questionnaire.[C.2] Since land transactions are not frequent, we pool the transactions from 2005 to the former half of 2021 and then exclude the bottom 1% and the top 1% transaction prices per m^2 to eliminate the extreme idiosyncrasies of each transaction. To identify the location of each transaction, we use the centroid of the recorded geographical unit because the data do not reveal the exact location of the transacted plots. The geographical unit is basically comparable to the block level, but there are observations reported at the less geographical granularity (e.g., *moto-gakku*).[C.3] We then divide Kyoto city into $250m \times 250m$ grids as shown in Figure 2 and compare the average assessment land prices and the average transaction land prices in each grid. Note that since land transactions are not frequent, even averaging within a grid might not always eliminate the idiosyncrasies of each transaction. While we drop grids that contain less than four transactions to mitigate this issue, this limitation of our transaction data should be kept in mind.

Figure C.1 presents the scatter-plot of the log assessment prices and the log transaction prices of each grid. A strong positive correlation is apparent: the correlation coefficient is $\rho \simeq 0.824$ despite the noises due to infrequent land transactions. We also plot the linear regression of these two variables. The slope is estimated to be 1.021 (s.e. 0.0239). Importantly, we cannot reject the null that the slope is 1 (p-value = 0.369), implying that a 1% increase in the assessment price is associated with a 1% increase in the transaction price. The unit elasticity is consistent with the well-known anecdote that different appraised land prices in Japan have a proportional relationship with each other. Our land price, *kotei shisanzei rosen-ka*, is said to be about 70% of the *kouji chika*, which is another major data source of assessed land prices in Japan. The *kouji chika*, in turn, is said to be about 10% lower than the transaction price. Taken together, we conclude that our estimated buraku effects in percentage directly translate into effects on transaction prices.

We discuss several additional concerns about the relationship between the two prices. First, we might suspect that the linear projection shown in Figure C.1 might be invalid for areas with very high land prices because they seem to have systematically lower transaction prices than the projected values. However, such high prices are irrelevant for buraku areas. The dashed vertical line is the highest assessment price in buraku areas, implying that the "relevant region"

[C.1] https://www.land.mlit.go.jp/webland/servlet/MainServlet (In Japanese. Last accessed on September 28th, 2021).

[C.2] Using data from Tokyo, Shimizu, Nishimura and Watanabe (2016) show that the housing prices from the voluntary survey closely track the distribution of the actual transaction prices.

[C.3] The smaller spatial resolution prevents us from accurately classifying whether each transaction took place in a buraku area or not.

for buraku areas is below this price. In this region, we observe no indication of systematic deviation from the linear projection.

Second, in the US context, Davis, Larson, Oliner and Shui (2021) point out two potential reasons that might bias tax assessments relative to transaction values. First, tax assessment data may fail to closely follow rapidly-appreciating market land prices. However, this concern seems limited in our context because (i) the land prices in Kyoto have been relatively stable during the 21st century and (ii) our empirical results are similar for all data from 2006–2018 (see Section 7). Second, tax assessment data might be right-censored near the market value to avoid challenges by property owners. In practice, however, the threat of challenges is rather weak in Japan. For instance, in the 2000's, property taxation on land receives challenges in only about 0.01% of all the cases.[C.4] Moreover, the assessment process is standardized with emphasis on transaction prices, leaving little room for systematically departing from transaction prices. Overall, it is reasonable to expect our tax assessment data to closely follow market prices, which we indeed find in this section.

Third, Avenancio-León and Howard (2022) recently show that the minorities in the US face higher property assessment prices relative to the transaction prices because (i) adverse neighborhood conditions are not fully considered in the assessment prices and (ii) appeals are less frequent and successful among the minorities. In our Japanese context, (ii) seems unimportant since appeals are rare, as just discussed above. We also do not think that (i) is essential because Figure C.1 presents the proportional relationship between the assessment and transaction prices, implying that using the log land price as the outcome variable allows us to identify the results using the assessment price as those using the transaction price. Having said this, note that (i) tends to shrink the buraku penalty because the land price differential between non-buraku and buraku areas is understated, implying our estimate would be conservative if (i) holds true. Overall, the issues raised in Avenancio-León and Howard (2022) would not fundamentally affect our conclusions.

Our analysis of the relationship between the assessment and transaction prices is limited to the 21st century due to the availability of transaction data. However, we expect that similar conclusions hold for other years of our data. First, our data during 1961 and 1991 come from *sozoku zei rosenka*, which is constructed very similar to our 21st century data (*kotei shisan-zei rosenka*). This implies that our result for the 21st century data would be applicable to the dataset for the period between 1961 and 1991. Second, for 1912 data, we, unfortunately, cannot find the market rental price data that our assessment price data is based on. However, Yamasaki, Nakajima and Teshima (2022) use the same data for Tokyo and show that the assessment price and the market price show a very strong correlation. We expect that their result naturally extends to Kyoto.

[C.4] According to Research Center for Property Assessment System (2013), property taxation on land received about 3,000 challenges per year, while the total number of taxpayers was around 29 millions.

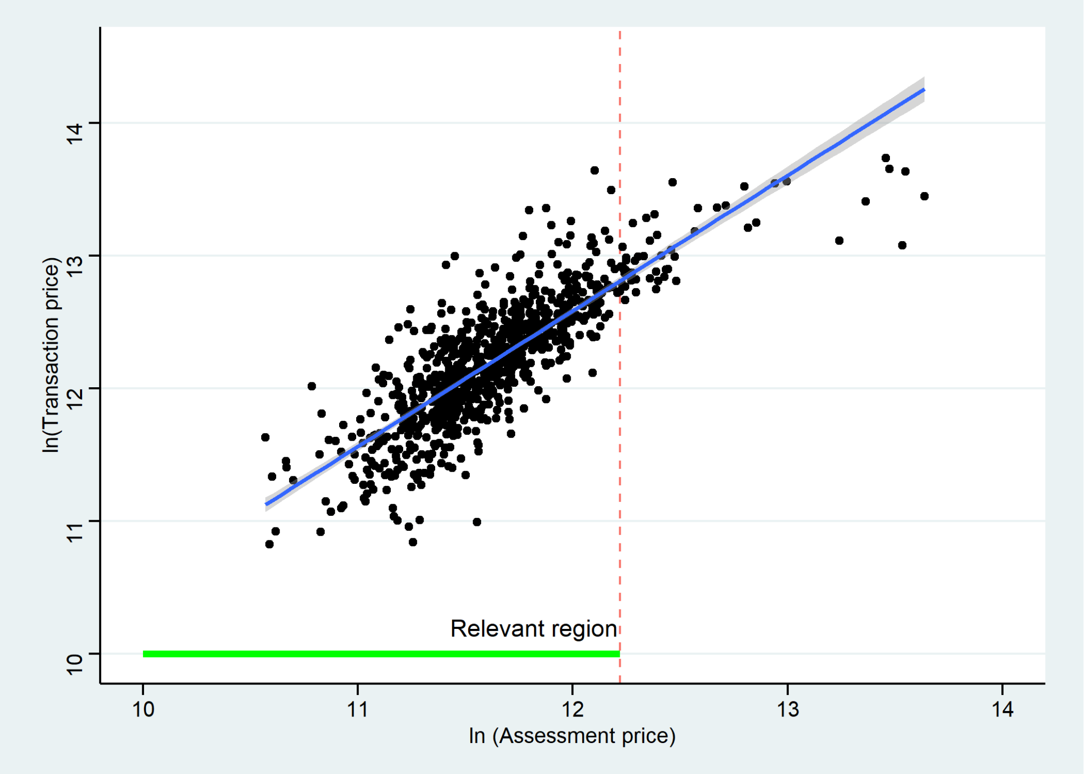

Figure C.1: Comparison between assessed land prices and land transaction prices

Note: The horizon axis is the log transaction land prices and the vertical axis is the log assessed land prices. We plot the average land prices in each 250*m* × 250*m* grid as each dot. The linear least-square relationship is also shown. The vertical dashed red line represents the maximum assessment price in buraku areas. We show regions below this maximum price as the “relevant region” for buraku areas.

D Data construction

Transportation access. As suggested by the model presented in Section 4, transportation access is an important determinant of the attractiveness of each location. Not only commuting trips are important, studies such as Miyauchi, Nakajima and Redding (2021) have highlighted the importance of non-commuting trips in a city. The CBD is not only a place for work, but also a place for consumption, implying that the access to it matters for consumption purposes. At the same time, non-commuting trips are not restricted to the CBD and accessibility to other locations is also an important amenity. Our control variables are expected to capture the transportation access both for commuting and non-commuting purposes.

We proxy for transportation access by calculating the distance to the CBD, measured by the distance to the central train station of Kyoto city, and the distance to the nearest train station. Regarding the CBD, Figure 2 shows that the neighborhoods of Kawaramachi station and Kyoto station, which are just about $2km$ away from each other, have the highest land prices in both 1912 and 2018. We thus measure the distance to the CBD by calculating the minimum distance to one of these two major central stations. We also compute using QGIS the distance (in kilometers) to the nearest train station for each land plot. In calculating both distances, we use the location data of train stations from the Digital National Land Information (*kokudo suchi joho*). In 1912, Kyoto has a different public transportation system than today, such as trams. We obtain the location data of past train stations from the Digital National Land Information (*kokudo suchi joho*). The data has the information on all lines and stations including trams from 1950 in Japan. Regarding years before 1950, although the line opening year is available, the station opening year is not. Hence, we first pick up the lines already available in 1912, and then choose the stations on them that already existed in 1913 by referring to Kyoto maps at that time. Here, we utilize the three maps of Kyoto in January 1913[D.1], March 1913[D.2], and July 1913[D.3], which are made available online by International Research Center for Japanese Studies, Kyoto, Japan. Through such a procedure, we can obtain the information on stations already existed in 1913 and survived at least until 1950, however, we lose the information on stations existed in 1913 but were abolished by 1950. Unfortunately, we cannot pin down the accurate locations of stations abolished by 1950. Although this is the limitation of our analysis in controlling the distance to stations for 1912, we believe it is not so crucial because the abolished stations were abolished because they were inconvenient and not used frequently, implying that our station data still serves as a good proxy for the transportation system at that time. When controlling for these distances, we use the quadratic specification.

Proximity to rivers. Rivers are important in various ways. They might provide a pleasant natural

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[D.1] https://lapis.nichibun.ac.jp/chizu/map_detail.php?id=001910512 (In Japanese, last accessed on October 22, 2021)

[D.2] https://lapis.nichibun.ac.jp/chizu/map_detail.php?id=002812931 (In Japanese, last accessed on October 22, 2021)

[D.3] https://lapis.nichibun.ac.jp/chizu/map_detail.php?id=002754893 (In Japanese, last accessed on October 22, 2021) amenity, or they might increase the risk of flooding. The proximity to rivers might also be an important determinant of buraku areas because leather-crafting and butchering, two major industries in which the discriminated people engaged require water supply (Teraki and Kurokawa 2016). We obtain the locations of rivers from the National Land Information (*kokudo suchi joho*). The data are as of 2008 and we assume that the locations of rivers are approximately constant throughout our sample period. For each land plot, we compute the distance to the nearest river using the $NNjoin$ package in QGIS. We control for a quadratic of the distance to the nearest river.

Altitudes. Altitudes might be correlated with the attractiveness of a land plot by affecting, for example, the landscape, flooding risk, and the comfortableness of the wind. The altitude of each observation point is calculated using the API provided by Geospatial Information Authority of Japan. We assume that altitudes are constant over time so that the API gives the correct altitudes throughout our sample period. We control for a quadratic of altitudes.

Ruggedness. Ruggedness might affect land prices by affecting, for example, construction costs and transportation access. We use a ruggedness measure as of 2011 made available in the Digital National Land Information (*kokudo suchi joho*) by the Ministry of Land, Infrastructure, Transport and Tourism. It first divides the plane into $250m \times 250m$ grids. It then computes the average slope in each grid based on the altitude data calculated at the $50m \times 50m$ grid level. We assign this slope to each land plot within the grid. As in altitudes, we assume that ruggedness is constant so that the contemporary data provide a good approximation to the ruggedness throughout our sample period.

Longitudes and latitudes. Locations with different coordinates might have different attractiveness. For instance, this might capture an aspect of transportation accessibility. As another example, Heblich, Trew and Zylberberg (2021) show that the east side of cities in England was more polluted due to the direction of the wind. Following Yamasaki et al. (2022), we control for the latitude and longitude of each land plot in a quadratic specification. We expect them to account for omitted variables that are spatially continuous throughout the city.

Current land use. The current land use might affect the land price by, for example, affecting the construction and demolition cost of the existing structure. The 1912 data record the current land use of each land plot and we control dummies for each land use.[D.4] Our data for 1961–1991 report the standard use of land in the neighborhood (*chiku kubun*), which is determined by the National Tax Agency based on the current state of neighborhoods, and we include dummies for them. For 2006–2018 data, we include fixed effects of the standard use of land in the neighborhood (*youto chiku*), which is determined by the Kyoto city government based on the

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[D.4] We focus on four land uses: housing, rice fiends (*ta*), non-rice fields (*hatake*), and forest. These land uses account for almost all priced land plots in the data.

current state of neighborhoods and zoning regulations.

Lot size. The size of the land plot might affect prices by affecting possible land use patterns (Yamasaki et al. 2022). Since our land price data for 1912 cover each land plot, each plot varies in size. We include a cubic of the lot size to control for such effect. In contrast, our data from 1961 to 2018 show the land price for a standardized land plot, implying that such adjustment for the lot size is unnecessary.

Urban health amenities. Since buraku areas face both poverty and discrimination, they might have less investment in basic urban infrastructure and poorer health outcomes. For example, the contagion of diseases such as cholera and typhoid was a key determinant of urban mortality but the development of water infrastructure might curb them. Hanlon and Heblich (2022) refer to location-specific determinants of health as "urban health amenities" and they are especially important in a city of a developing country, such as 1912 Kyoto.

As the best available proxies for urban health amenities, we use the dataset constructed by Inoue (2019) that granularly records the incidence rate of typhoid, the proportion of tap water usage rather than water wells, and the locations of hospitals in Kyoto city of the early 1920's.[D.5] These variables would capture the heterogeneous urban health amenities within a city.[D.6]

We do not control for these variables in our main regression specification, but we show how the inclusion of these variables might alter our regression results after showing the main regression results. We do so mainly because buraku areas might have poorer urban health amenities because of discrimination, especially discrimination by policymakers who play the key role in allocating public investment. If so, controlling for urban health amenities induces the over-controlling problem as long as we are also interested in the effect of discrimination against the buraku mediated by urban health amenities (see the discussion right after Equation (A.4)). As discussed in Section 6.3, however, controlling for them actually strengthens our conclusions. Note that in 2018, we have no evidence that buraku areas have inferior infrastructure and sanitation level than other areas thanks to the substantial public investment from the 1960's (Management and Coordination Agency 1993), implying that we know a priori that the difference in urban health amenities today would be little.

School districts. Although exceptions might apply, students wishing to attend a public school are allowed to attend only the one assigned by the school district. Although there are private schools, public schools are by far the most popular option. In Kyoto prefecture, 95.7% of students attend a public elementary school and 86.3% attend a public junior-high school in 2017.

[D.5] As the share of tap water usage is recorded at a somewhat less granular level (*gakku*) than the block level, we improve the measurement for buraku areas by using Kyoto City Government (1929) that records the prevalence of tap water supply in each buraku area. However, not conducting this data augmentation hardly changes our results.

[D.6] Moreover, the construction of sewage system in Kyoto city did not start until 1930 and electricity was used almost at every location within Kyoto city prevalent at least in 1930's (Kyoto City Government 1940; Inoue 2019), implying that the influence of other urban infrastructure as of 1912 would be limited.

In Japan, different public (or equivalently, municipal) school districts are set for elementary schools and junior high schools, which we control for separately. Since the geocoded map of school districts in Kyoto city is not publicized, we purchased one from GEO·K, Inc. (sold on consignment by ESRI Japan, Inc), which collects information on school districts from each municipality and sells its geocoded map.[D.7]

Road width. Road width can be important in modern periods because it is related to the floor-area-ratio (FAR) regulation. We thus flexibly control for the effect of road width by using a functional form that captures the regulation schedule in a robustness check.[D.8] Geospatial data on the road edge line and the road center lines are available in the Basic Geospatial Information (*kokudo kihon joho*), which is a digitized map issued by Geographical Issue Authority of Japan. Using QGIS, we first create points along the road center lines at three-meter intervals, and then compute the road width at each center point by measuring the distance between the center point and the edge of the road. We then allocate the centroid of each *rosenka* segment the road width of the nearest road center point. To mitigate the influence of miscalculated values, we drop samples with road width above the top 1% or below the bottom 1% of the calculated road width distribution in analyses using the road width variables.

Population density. We use the population census data at the level of blocks (*cho cho moku*) to calculate population density around each land plot. In Japan, population census is conducted every five years starting from 1920. We use the 1920 census data to approximate the population density in 1912 and the 1965 census to approximate the population density in 1961. The GIS data of these two population censuses are taken from Kirimura (2011). For 2018, we use the GIS 2015 population census data downloaded from e-Stat (https://www.e-stat.go.jp/en).

To assign population density to each representative point of the land plot, we first create a $10m$ buffer around each land plot point in our data. We then calculate the size of overlap with each block. Assuming that the population is uniformly distributed within each block, we can calculate the number of people living in each overlap. We finally calculate population density around each land plot by dividing the sum of the population of all overlaps by the sum of the area of all overlaps.

Local average income. Importantly, we do not directly observe the local average income data at the block (*cho cho moku*) level throughout our sample period. To overcome this, we exploit the theoretical prediction of the model in Section 4 and Appendix A to back out the income at

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[D.7] https://www.gisdata-store.biz/product/1264/ (In Japanese, last accessed on January 27 2022).

[D.8] The regulation states that if the road width of the front road is less than $12m$, a smaller FAR (a coefficient times the road width in meters) might apply. Moreover, if the width of the frond road is less than $4m$, new buildings cannot be built on some portion of the land for a future enlargement of the road. We thus allow the parameters to be different in ranges [0, 4], [4, 12], and [12, ∞) by including interaction terms and we also include dummy variables for roads narrower than $4m$ and wider than $12m$. Our estimated coefficients of road width exhibit strong statistical and economic significance for roads with less than $4m$ width, which is consistent with the FAR regulation in effect.

the local level.[D.9] More specifically, the land market clearing condition, Equation (A.6), shows that observing land prices, population density, and the spending share for land are sufficient to recover the local average income. We first take each point in our land price data as different location n in the model. We then use Equation (A.6) to obtain the local income level at this point.[D.10] The population density data are described in Appendix H. For the spending share on land, we use the calibrated values summarized in Table J.1. Note that in our model, a buraku area n can have low local income either because of severe labor market discrimination or because workers with low human capital sort into the buraku area. Given the data we have, we cannot distinguish these two possibilities.

A potential concern is the data quality of the local income level backed out from our theoretical model. Reassuringly, we can confirm that our measure of local income level in 2018 is positively correlated with another independent estimate of the local income at the *cho cho moku* level by ZENRIN CO., LTD., which is based on the statistical imputation from the Population Census and the Housing and Land Survey. Although such validation can be done only for 2018, this reinforces the plausibility of our local income variable.

[D.9] This is necessary even for 2018 as Japan does not publicize the local income level at the spatial granularity of *cho cho moku*.

[D.10] See Section 5.2 for how we calculate the population density at each point of the land plot, which is necessary for this calculation.

E Summary statistics

In Figures E.1 and E.2, we present summary statistics for 1912 for buraku areas and non-buraku areas, respectively. Similarly, Tables E.3–E.4 present the same summary statistics tables for 1961, Tables E.5–E.6 for 1973, Tables E.7–E.8 for 1982, Tables E.9–E.10 for 1991, and Tables E.11–E.12 for 2018. We omit summary statistics for 2006–2015 as they are quite similar to 2018. Note that our land price data for 1912, 1961, and 2006–2018 cover all locations in Kyoto city, while our data for 1973, 1982, and 1991 cover only the places in and around the buraku area.

	mean	sd	min	max	count
Land price per m^2 (in Japanese yen)	0.265	0.172	0.004	3.025	1358
Distance to the buraku border (m)	-63.466	41.228	-206.736	-2.579	1358
Plot size (m^2)	206.571	382.137	6.612	3587.113	1358
Distance to the CBD (km)	1.287	1.253	0.174	3.376	1358
Distance to the nearest river (km)	0.110	0.072	0.000	0.351	1358
Distance to the nearest train station (km)	0.473	0.481	0.039	1.680	1358
Altitude (m)	36.780	10.749	23.400	63.200	1358
Slope (ruggedness, degree)	0.450	0.223	0.200	1.900	1358
Currently used for housing (dummy)	0.903	0.296	0.000	1.000	1358
Observations	1358				

Table E.1: Summary statistics (1912, buraku areas)

	mean	sd	min	max	count
Land price per m^2 (in Japanese yen)	1.134	1.383	0.002	8.470	58981
Distance to the buraku border (m)	1212.684	624.402	0.090	3161.686	58981
Plot size (m^2)	327.008	423.288	4.231	3599.013	58981
Distance to the CBD (km)	1.945	1.175	0.008	5.468	58981
Distance to the nearest river (km)	0.418	0.276	0.000	1.413	58981
Distance to the nearest train station (km)	0.442	0.410	0.001	3.330	58981
Altitude (m)	44.584	14.415	19.400	373.300	58981
Slope (ruggedness, degree)	0.962	1.600	0.100	24.800	58981
Currently used for housing (dummy)	0.857	0.350	0.000	1.000	58981
Observations	58981				

Table E.2: Summary statistics (1912, non-buraku areas)

	mean	sd	min	max	count
Land price per m^2 (in Japanese yen)	75.411	48.392	26.000	350.000	207
Distance to the buraku border (m)	-68.378	48.050	-221.360	-0.072	207
Distance to the CBD (km)	2.197	1.783	0.173	6.139	207
Distance to the nearest river (km)	0.138	0.130	0.002	0.706	207
Distance to the nearest train station (km)	0.218	0.173	0.010	1.057	207
Altitude (m)	44.831	23.064	16.300	99.900	207
Slope (ruggedness, degree)	0.752	0.742	0.100	2.800	207
Normal housing area (dummy)	0.923	0.268	0.000	1.000	207
Observations	213				

Table E.3: Summary statistics (1961, buraku areas)

	mean	sd	min	max	count
Land price per m^2 (in 100 Japanese yen)	233.491	435.836	15.000	8560.000	10892
Distance to the buraku border (m)	958.181	477.266	0.010	2367.629	10892
Distance to the CBD (km)	3.004	1.628	0.008	6.486	10892
Distance to the nearest river (km)	0.332	0.258	0.000	1.284	10892
Distance to the nearest train station (km)	0.272	0.228	0.003	1.704	10892
Altitude (m)	45.433	19.961	11.000	118.300	10892
Slope (ruggedness, degree)	1.140	1.407	0.000	17.400	10892
Normal housing area (dummy)	0.778	0.416	0.000	1.000	10892
Observations	11118				

Table E.4: Summary statistics (1961, non-buraku areas)

	mean	sd	min	max	count
Land price per m^2 (in 100 Japanese yen)	30.413	21.205	4.500	100.000	93
Distance to the buraku border (m)	-66.600	50.735	-211.145	-0.138	93
Distance to the CBD (km)	2.534	1.779	0.174	6.094	93
Distance to the nearest river (km)	0.140	0.138	0.003	0.703	93
Distance to the nearest train station (km)	0.213	0.192	0.012	1.020	93
Altitude (m)	45.661	24.379	16.600	102.000	93
Slope (ruggedness, degree)	0.760	0.803	0.100	3.400	93
Normal housing area (dummy)	0.581	0.496	0.000	1.000	93
Observations	93				

Table E.5: Summary statistics (1973, buraku areas)

	mean	sd	min	max	count
Land price per m^2 (in 100 Japanese yen)	54.574	35.970	6.000	440.000	3661
Distance to the buraku border (m)	517.261	320.617	0.063	1651.119	3661
Distance to the CBD (km)	2.931	1.631	0.073	6.428	3661
Distance to the nearest river (km)	0.287	0.211	0.000	1.125	3661
Distance to the nearest train station (km)	0.342	0.279	0.004	1.697	3661
Altitude (m)	44.485	20.548	13.300	120.600	3661
Slope (ruggedness, degree)	1.226	1.596	0.000	18.400	3661
Normal housing area (dummy)	0.698	0.459	0.000	1.000	3661
Observations	3661				

Table E.6: Summary statistics (1973, non-buraku areas)

	mean	sd	min	max	count
Land price per m^2 (in 100 Japanese yen)	74.224	31.247	33.000	190.000	255
Distance to the buraku border (m)	-56.444	42.778	-224.436	-0.353	255
Distance to the CBD (km)	3.360	2.024	0.193	6.811	255
Distance to the nearest river (km)	0.215	0.221	0.002	0.813	255
Distance to the nearest train station (km)	0.626	0.586	0.033	1.994	255
Altitude (m)	45.803	24.068	14.800	115.400	255
Slope (ruggedness, degree)	0.998	1.001	0.100	5.500	255
Normal housing area (dummy)	0.769	0.423	0.000	1.000	255
Observations	257				

Table E.7: Summary statistics (1982, buraku areas)

	mean	sd	min	max	count
Land price per m^2 (in 1,000 Japanese yen)	106.001	55.518	8.000	1030.000	6303
Distance to the buraku border (m)	455.537	255.116	0.027	1256.133	6303
Distance to the CBD (km)	3.487	1.888	0.090	7.525	6303
Distance to the nearest river (km)	0.238	0.178	0.000	0.982	6303
Distance to the nearest train station (km)	0.607	0.526	0.008	2.758	6303
Altitude (m)	41.105	22.238	13.300	159.100	6303
Slope (ruggedness, degree)	1.247	1.738	0.000	17.000	6303
Normal housing area (dummy)	0.804	0.397	0.000	1.000	6303
Observations	6342				

Table E.8: Summary statistics (1982, non-buraku areas)

	mean	sd	min	max	count
Land price per m^2 (in 1,000 Japanese yen)	396.414	242.873	119.000	1690.000	162
Distance to the buraku border (m)	-61.157	50.247	-218.106	-0.222	162
Distance to the CBD (km)	4.118	2.540	0.251	9.259	162
Distance to the nearest river (km)	0.201	0.219	0.001	0.819	162
Distance to the nearest train station (km)	0.659	0.613	0.033	2.147	162
Altitude (m)	37.671	23.319	11.000	115.400	162
Slope (ruggedness, degree)	0.833	0.888	0.100	5.500	162
Normal housing area (dummy)	0.790	0.408	0.000	1.000	162
Observations	162				

Table E.9: Summary statistics (1991, buraku areas)

	mean	sd	min	max	count
Land price per m^2 (in 1,000 Japanese yen)	659.643	811.560	70.000	10900	4976
Distance to the buraku border (m)	458.094	256.378	0.038	1255.068	4976
Distance to the CBD (km)	3.540	2.011	0.103	9.905	4976
Distance to the nearest river (km)	0.240	0.180	0.000	0.979	4976
Distance to the nearest train station (km)	0.578	0.495	0.004	2.942	4976
Altitude (m)	38.493	20.988	10.800	159.100	4976
Slope (ruggedness, degree)	1.183	1.659	0.000	22.600	4976
Normal housing area (dummy)	0.775	0.417	0.000	1.000	4976
Observations	4976				

Table E.10: Summary statistics (1991, non-buraku areas)

	mean	sd	min	max	count
Land price per m^2 (in 1,000 Japanese yen)	80785	34181	18000	203000	419
Distance to the buraku border (m)	-63.290	52.443	-260.632	-0.494	419
Distance to the CBD (km)	4.810	2.587	0.173	9.358	419
Distance to the nearest river (km)	0.175	0.183	0.001	0.818	419
Distance to the nearest train station (km)	0.646	0.494	0.001	1.977	419
Altitude (m)	29.693	18.878	10.800	114.300	419
Slope (ruggedness, degree)	0.732	0.775	0.100	5.500	419
Normal housing area (dummy)	0.938	0.242	0.000	1.000	419
Observations	419				

Table E.11: Summary statistics (2018, buraku areas)

	mean	sd	min	max	count
Land price per m^2 (in Japanese yen)	125326	141860	13700	3460000	38413
Distance to the buraku border (m)	1332.403	992.529	0.053	7501.827	38413
Distance to the CBD (km)	4.437	2.154	0.003	11.682	38413
Distance to the nearest river (km)	0.272	0.230	0.000	1.365	38413
Distance to the nearest train station (km)	0.706	0.593	0.000	3.700	38413
Altitude (m)	48.175	30.707	9.500	206.500	38413
Slope (ruggedness, degree)	1.919	2.889	0.000	28.600	38413
Normal housing area (dummy)	0.847	0.360	0.000	1.000	38413
Observations	38413				

Table E.12: Summary statistics (2018, non-buraku areas)

F Testing the discontinuity of characteristics at the buraku border

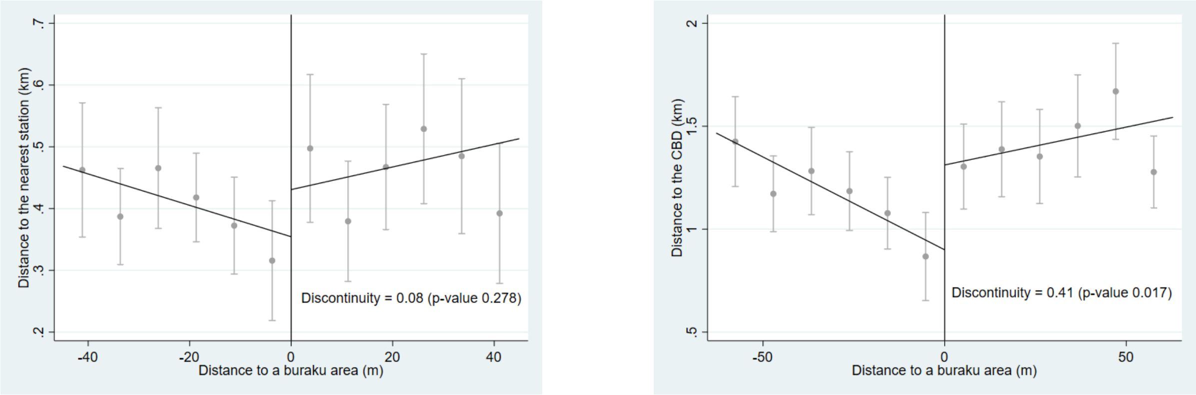
A threat to our identification assumption in border design is that some unobsevable confounding characteristics are discontinuous across the buraku border. Although this assumption itself is not testable, we follow Bayer, Ferreira and McMillan (2007) and investigate the discontinuity in observable characteristics to get a sense of the seriousness of the threat to the identification assumption is.

Figure F.1 graphically represents the estimated discontinuity at the buraku border in 1912 for six characteristics: plot size, distance to the CBD, distance to a river, altitude, ruggedness, and the share of plots currently used for housing. Since we are interested only in the discontinuous change in this analysis, we use the MSE-optimal bandwidth and report the point estimate as well as the p-value that takes bias into account (Cattaneo, Idrobo and Titiunik 2019). We find that the discontinuity is insignificant at the 1% level for all characteristics but the distance to the CBD, the distance to the nearest station, and the altitude exhibit statistical significance at the 5% level. However, we argue that these discontinuities do not imply that our buraku effects on land prices are spuriously driven by unobserved confounders. Regarding the distances to the CBD and the nearest station, they are actually closer for buraku areas, implying that buraku areas are located in an *advantageous* position. Second, in our regression in Table 1, the coefficients of altitude are insignificant in the border design and altitudes are negatively associated with land prices in the full sample (not reported). Thus, if any, buraku areas are again at advantageous locations. Thus, our negative effect on land prices cannot be explained by such discontinuity.

Figure F.2 repeats the same analysis using 2018 data. No characteristic exhibits statistically significant discontinuity at the 5% level. The slope exhibits some discontinuity at the 10% level, but in the regression of Table 2, the estimated regression coefficients of altitudes on land prices are insignificant in border design.[F.1]

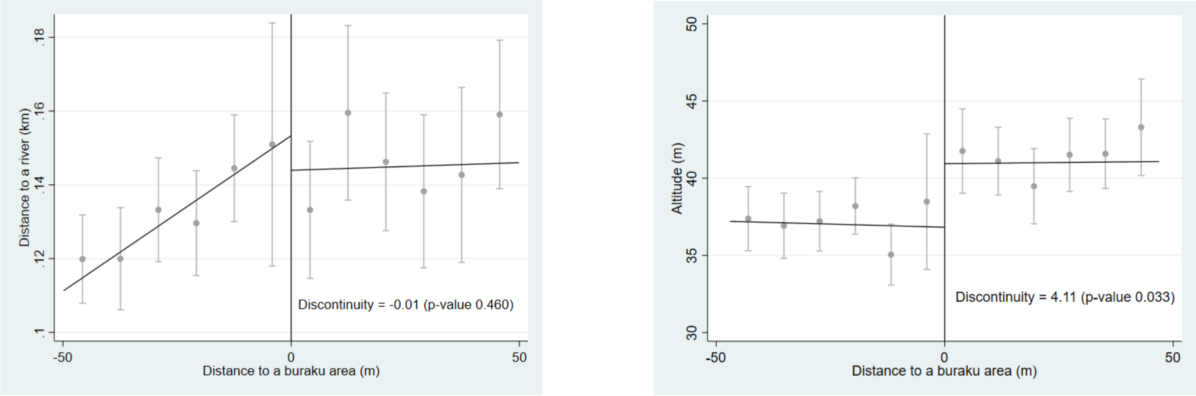
Overall, we do not find significant discontinuity of characteristics around the buraku border that might explain the lower land prices in buraku areas, for both 1912 and 2018. Thus, there is no indication that our estimated negative buraku effect on land prices is driven by unobserved characteristics that are discontinuous at the buraku border.

[F.1] Although when it is significant in the full sample, the coefficient is negative and buraku areas are predicted to have higher land prices since they are located in a flatter place.



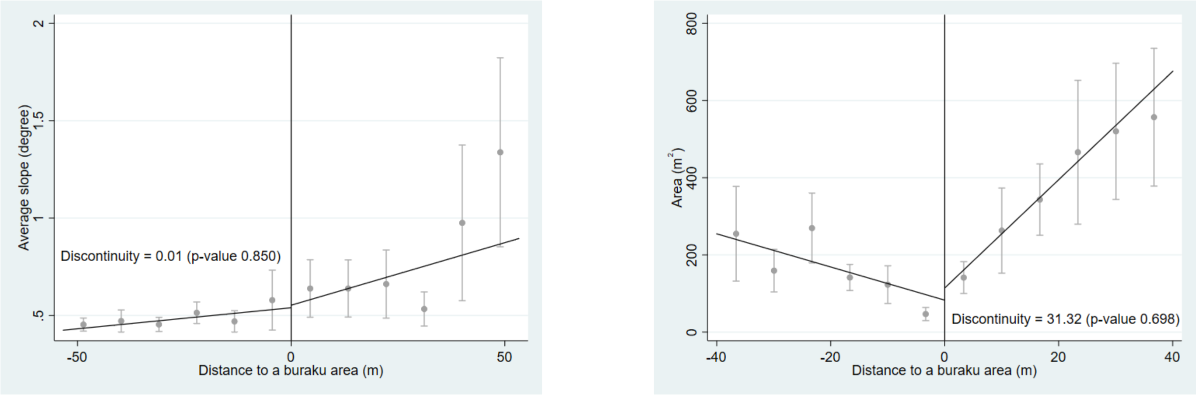
(a) Distance to the nearest station in 1912

(b) Distance to the CBD in 1912



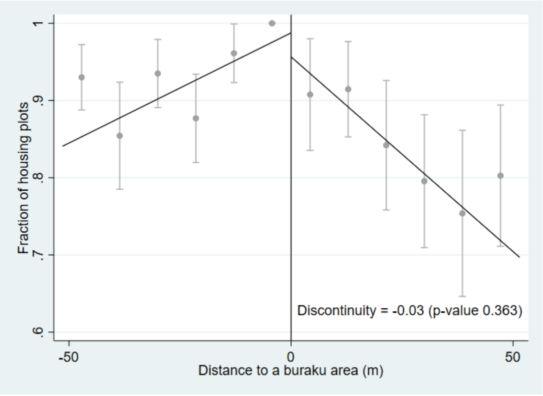
(c) Distance to a river in 1912

(d) Altitudes in 1912



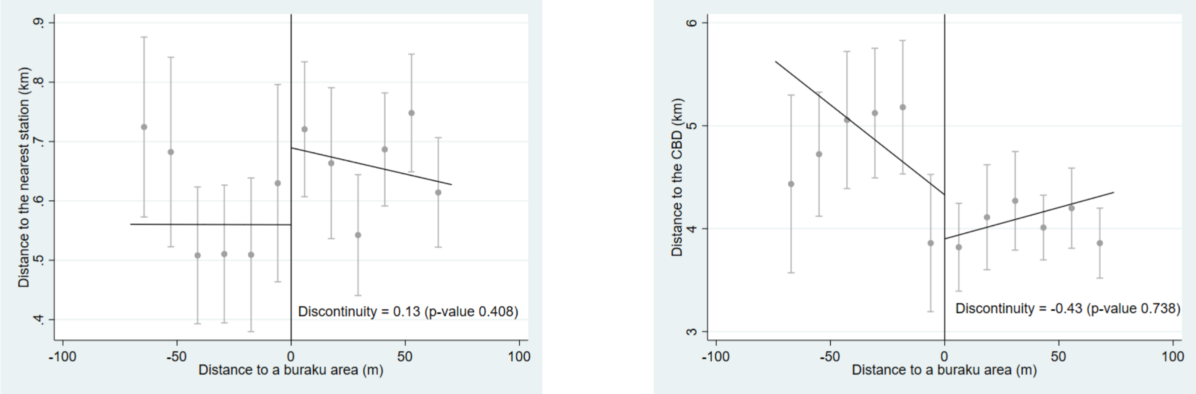
(e) Slope (ruggedness) in 1912

(f) Area (plot size) in 1912



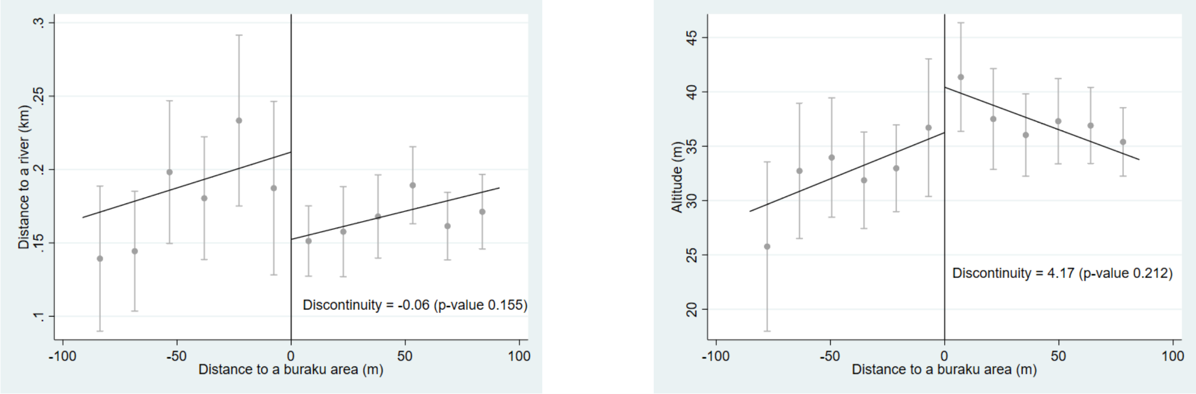
(g) Share of housing plots in 1912

Figure F.1: Discontinuity of characteristics around the buraku border (1912) (See Figure F.2 for the detailed caption)



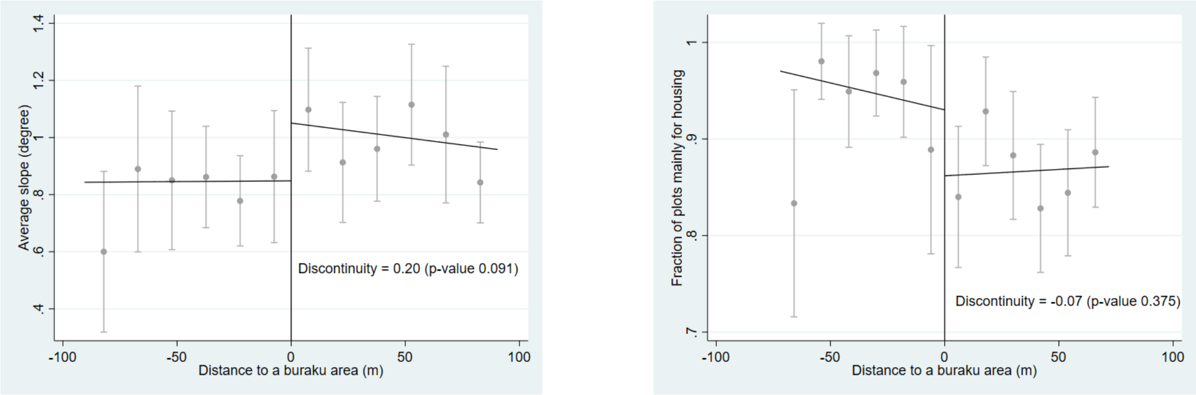
(a) Distance to the nearest station in 2018

(b) Distance to the CBD in 2018



(c) Distance to a river in 2018

(d) Altitudes in 2018



(e) Slope (ruggedness) in 2018

(f) Share of housing plots in 2018

Figure F.2: Discontinuity of characteristics around the buraku border (2018).

Note: In Figures F.1 and F.2, we show the discontinuity of characteristics at the buraku border. On each side of the border, we fit the local linear equation using the triangular kernel. We also plot the mean and the 95% confidence interval for observations in a bin. The bandwidth is selected using the MSE-optimal criterion and we use the bias-corrected standard error to calculate p-values (Cattaneo et al. 2019).

G Income level in buraku areas

We have seen that land prices in buraku areas are lower than those in non-buraku areas. In this section, we investigate whether buraku areas are "slums" in the sense that they have a lower average income than other areas. Sociological and historical literature has suggested that residents in buraku areas had low income in the past. Regarding Kyoto city in the late 1930's, Akisada (1972) shows that 21% of the residents in buraku areas live in poverty while the corresponding number was 2% for the entire Kyoto city. Other studies have also qualitatively documented the poor socioeconomic status of buraku areas in Kyoto city (e.g., Sasaki and De Vos 1966 on the early 1960's). In more recent years, however, the income level of buraku areas seems to have substantially improved. For example, Shima (2016) argues that buraku areas in Osaka city do not seem particularly poor compared with other comparable areas. We investigate whether the poor cluster in the buraku areas of Kyoto city in 1912, 1961, and 2018.

We repeat the same regression analysis as in Tables 1 and 2, but now using the local average income as the outcome variable. Tables G.1 and G.3 in the Appendix provide the results. For 1912, we find that buraku areas have 74% lower average income than non-buraku areas.[G.1] This is even larger than our estimated buraku effect on land prices, which reflects the fact that buraku areas tend to have high population density, reflecting the small per capita land consumption indicative of low income. In contrast, for 2018, we find little evidence that buraku areas have a lower local average income. Some specifications even suggest that buraku areas have a higher average income, although the estimates are noisy and we do not use them as evidence of higher income in buraku areas.[G.2]

We have also repeated the same analysis for 1961, which roughly corresponds to the midpoint of 1912 and 2018. While we have found some evidence that the poverty might have improved, the $50m$ comparison suggests 53% lower income in buraku areas in 1961. This implies that poverty has improved mainly over the last 60 years, which might be attributed to the large-scale policies and efforts starting from the 1960's.

Overall, our results indicate that buraku areas had substantially lower income in 1912, suggesting the presence of either labor market discrimination or sorting of the poor into buraku areas, or both. However, the income gap decreased over time. The decrease was especially substantial over the last 60 years and today the income gap is no longer apparent. This result has two implications. First, we provide new quantitative evidence on the dynamics of the income level in buraku areas. Second, it also reinforces the plausibility of our model since the substantial improvement of the income level over the century is consistent with the available evidence in the sociological and historical literature.

[G.1] As in the main analysis on land prices, we use the second largest and smallest estimate as our estimated buraku effect from specifications with control variables.

[G.2] Another limitation about the 2018 result is that population density in our data is affected by public housing. To be precise, we need the population density data that exclude land plots used for public housing and the residents of them. Unfortunately, we do not have sufficient data to calculate it. In 1912 and 1961, public housing was less prevalent than today and this issue would be of relatively minor importance.

	Dummy specification			Linear specification		
Outcome: Log local average income in 1912	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-1.3283***	-1.5037***	-1.4879***	-1.9278***	-1.8686***	-1.1898***
	(0.2068)	(0.2636)	(0.2042)	(0.2491)	(0.3420)	(0.3025)
Distance to buraku (m)				-0.0002***	0.0001	0.0063**
				(0.0000)	(0.0001)	(0.0026)
Distance to buraku (m) × Buraku dummy				-0.0047*	-0.0068**	-0.0094***
				(0.0026)	(0.0028)	(0.0026)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect	-73.51***	-77.77***	-77.42***	-85.45***	-84.57***	-69.57***
(Right across the border)	(5.48)	(5.86)	(4.61)	(3.62)	(5.28)	(9.21)
Buraku effect				-83.44***	-81.81***	-71.95***
(25m within vs outside)				(3.59)	(5.36)	(6.80)
Buraku effect				-81.15***	-78.56***	-74.14***
(50m within vs outside)				(3.78)	(5.53)	(5.09)
Buraku effect				-75.58***	-70.21***	-78.02***
(100m within vs outside)				(5.51)	(7.09)	(4.20)
Oster's bound for buraku effect (in percentage points)	N/A	-79.18	-84.75	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	56603	56603	2621	56603	56603	2621
R^2	0.035	0.349	0.483	0.055	0.352	0.516

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table G.1: 1912 regression results on average income

Note: The outcome variable is the log of the local average income constructed from the Equation (A.6). The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1)\times$ 100% for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25$, 50, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log local average income in 1961	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-1.0578***	-0.9155***	-0.9068***	-0.6562***	-0.4786***	-0.2685*
	(0.1197)	(0.1203)	(0.1424)	(0.1478)	(0.1463)	(0.1623)
Distance to buraku (m)				0.0000	0.0001*	0.0038***
				(0.0001)	(0.0000)	(0.0013)
Distance to buraku (m) × Buraku dummy				0.0056***	0.0056***	0.0021
				(0.0015)	(0.0013)	(0.0017)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect (Right across the border)	-65.28***	-59.97***	-59.62***	-48.12***	-38.04***	-23.55*
	(4.15)	(4.82)	(5.75)	(7.67)	(9.06)	(12.41)
Buraku effect (25m within vs outside)				-54.94***	-46.40***	-40.13***
				(5.66)	(6.65)	(8.21)
Buraku effect (50m within vs outside)				-60.88***	-53.63***	-53.12***
				(4.37)	(5.00)	(5.91)
Buraku effect (100m within vs outside)				-70.49***	-65.29***	-71.25***
				(3.56)	(3.61)	(4.44)
Oster's bound for buraku effect (in percentage points)	N/A	-58.07	-60.18	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	10829	10829	557	10834	10829	557
R^2	0.016	0.326	0.440	0.017	0.328	0.474

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table G.2: 1961 regression results on average income

Note: The outcome variable is the log of the local average income constructed from Equation (A.6). The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1)\times$ 100% for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25$, 50, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log local average income in 2018	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.2869**	0.0194	0.1040	-0.3359**	-0.0222	0.0532
	(0.1206)	(0.0827)	(0.0879)	(0.1526)	(0.1177)	(0.1153)
Distance to buraku (m)				-0.0002***	0.0000	0.0012
				(0.0000)	(0.0000)	(0.0008)
Distance to buraku (m) × Buraku dummy				0.0028	-0.0008	-0.0041**
				(0.0023)	(0.0010)	(0.0018)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect (Right across the border)	-24.94***	1.96	10.96	-28.53***	-2.20	5.46
	(9.05)	(8.44)	(9.75)	(10.91)	(11.51)	(12.16)
Buraku effect (25m within vs outside)				-32.81***	-0.21	10.06
				(8.14)	(10.11)	(10.44)
Buraku effect (50m within vs outside)				-36.83***	1.81	14.87
				(7.16)	(9.05)	(10.17)
Buraku effect (100m within vs outside)				-44.17***	5.98	25.12
				(9.61)	(8.79)	(15.32)
Oster's bound for buraku effect (in percentage points)	N/A	11.98	21.99	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	37905	37905	1875	37905	37905	1875
R^2	0.001	0.299	0.409	0.022	0.299	0.413

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table G.3: 2018 regression results on average income

Note: The outcome variable is the log of the local average income constructed from Equation (A.6). The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1)\times$ 100% for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25$, 50, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

H Population density of buraku areas

We report regression results from the same specifications as Tables 1, B.1, and 2 using population density at each location n as the dependent variable. As discussed in the main text, population density at each plot is calculated as follows. We first create a $10m$ buffer around each land plot point in our data.[H.1] We then calculate the size of the overlap with each block. Assuming that the population is uniformly distributed within each block, we can calculate the number of people living in each overlap. We finally calculate the population density around each land plot by dividing the sum of the population of all overlaps by the sum of the area of all overlaps.

Tables H.1, H.2, and H.3 show that the population density of buraku areas in 1912 was about 99% higher than that of non-buraku areas, 54% higher in 1961, and 22% *lower* in 2018 (all numbers are from $50m$ comparisons). The population density was substantially higher in the past but is decreasing over time. In 2018, buraku areas now have lower population density, although the result is statistically significant only for the core of buraku areas.

[H.1] Since we treat each land plot as a distinct location (i.e., n in the model), we implicitly ignore the possibility that the $10m$ neighborhoods might overlap with each other. When overlap exists, the land price and population density in the $10m$ neighborhood is interpreted as an approximation to non-overlapping division of areas represented by each land plot (e.g., Voronoi diagram). Note also that since some land plots in our main data were not formally in the city boundary of Kyoto city, some $10m$ neighborhoods do not have an overlap. We drop such observations in analyses requiring population density data.

	Dummy specification			Linear specification		
Outcome: Log land population density per km^2 in 1912	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	0.3158	0.3439**	0.7446***	0.8405***	0.6933***	0.6154***
	(0.2662)	(0.1344)	(0.1189)	(0.2735)	(0.1502)	(0.1572)
Distance to buraku (m)				0.0002***	0.0002***	-0.0025**
				(0.0000)	(0.0000)	(0.0011)
Distance to buraku (m) × Buraku dummy				0.0043	0.0028*	0.0035***
				(0.0036)	(0.0017)	(0.0013)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect	37.13	41.05**	110.57***	131.75**	100.03***	85.04***
(Right across the border)	(36.50)	(18.96)	(25.03)	(63.39)	(30.04)	(29.09)
Buraku effect				106.19**	84.12***	91.76***
(25m within vs outside)				(49.65)	(24.00)	(25.79)
Buraku effect				83.45**	69.47***	98.71***
(50m within vs outside)				(44.07)	(20.76)	(23.45)
Buraku effect				45.22	43.57**	113.39***
(100m within vs outside)				(47.47)	(21.18)	(24.31)
Oster's bound for buraku effect (in percentage points)	N/A	42.40	128.06	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	56612	56612	2481	56612	56612	2481
R^2	0.003	0.534	0.805	0.026	0.543	0.812

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table H.1: 1912 regression results on population density

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 150m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50$ or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log land population density per km^2 in 1961	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	0.3909***	0.3684***	0.5018***	0.1297	0.2003*	0.2042
	(0.1018)	(0.0885)	(0.1163)	(0.1227)	(0.1119)	(0.1359)
Distance to buraku (m)				-0.0000	-0.0000	-0.0018*
				(0.0000)	(0.0000)	(0.0010)
Distance to buraku (m) × Buraku dummy				-0.0038***	-0.0025***	-0.0009
				(0.0011)	(0.0010)	(0.0014)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect (Right across the border)	47.83***	44.54***	65.16***	13.84	22.18	22.66
	(15.06)	(12.80)	(19.21)	(13.97)	(13.67)	(16.67)
Buraku effect (25m within vs outside)				25.31*	30.07**	37.43**
				(13.33)	(12.68)	(16.24)
Buraku effect (50m within vs outside)				37.97**	38.48***	53.98***
				(13.20)	(12.07)	(16.87)
Buraku effect (100m within vs outside)				67.13	56.96***	72.53***
				(16.28)	(13.30)	(19.35)
Oster's bound for buraku effect (in percentage points)	N/A	43.53	69.70	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	10829	10829	557	10834	10829	557
R^2	0.003	0.244	0.489	0.004	0.244	0.500

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table H.2: 1961 regression results on population density

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 150m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50$, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log land population density per km^2 in 2018	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	0.0193	-0.1365	-0.1796**	0.1525	-0.0830	0.0109
	(0.1124)	(0.0857)	(0.0820)	(0.1315)	(0.1009)	(0.0951)
Distance to buraku (m)				0.0001***	-0.0001***	-0.0009
				(0.0000)	(0.0000)	(0.0009)
Distance to buraku (m) × Buraku dummy				0.0006	0.0025**	0.0070***
				(0.0022)	(0.0011)	(0.0019)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect	1.95	-12.76*	-16.44**	16.47	-7.96	1.10
(Right across the border)	(11.45)	(7.47)	(6.85)	(15.32)	(9.28)	(9.61)
Buraku effect				14.39	-13.21*	-11.41
(25m within vs outside)				(12.27)	(7.74)	(7.08)
Buraku effect				12.34	-18.15***	-22.38***
(50m within vs outside)				(12.27)	(6.95)	(6.72)
Buraku effect				8.36	-27.22***	-40.40***
(100m within vs outside)				(19.18)	(8.83)	(8.63)
Oster's bound for buraku effect (in percentage points)	N/A	-16.83	-20.32	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	37999	37999	1591	37999	37999	1591
R^2	0.000	0.179	0.352	0.006	0.181	0.364

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table H.3: 2018 regression results on population density

Note: The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 150m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1) \times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50$, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

I Robustness checks for the land price regression

I.1 Urban health amenities

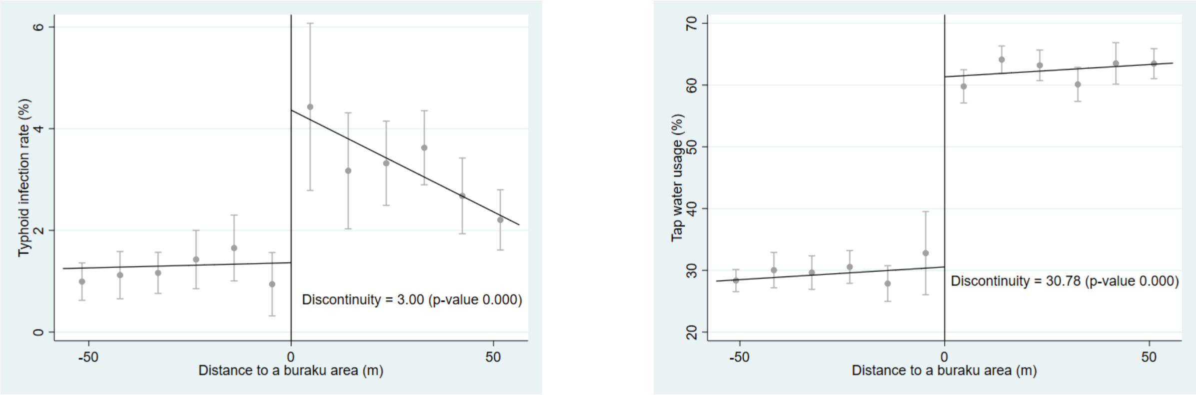
In this section, we investigate how controlling for urban health amenities might change our estimated buraku effects in 1912. In Figure I.1, we investigate the discontinuity of the infection rate of typhoid, the share of tap water usage, and the presence of hospitals. These variables are taken from Inoue (2019).

Perhaps surprisingly, buraku areas do not necessarily have poorer urban health amenities. More specifically, compared with surrounding non-buraku areas, buraku areas have a lower share of tap water usage but have a *lower* infection rate of typhoid and *more* hospitals.[I.1] While the possibility that buraku areas have better urban health amenities in some dimensions might be surprising, the lower infection rate of typhoid is consistent with Research Center of Kyoto Buraku History (1991). To reduce diseases, a community leader of a buraku area encouraged bathing and other measures to improve sanitation. Perhaps as a consequence, the infection rate of cholera in the 1890 boom was lower in this buraku area than in other non-buraku areas.

Table I.1 repeats the regression analysis in Table 1 but controlling for the above three variables.[I.2] Using the same procedures as those used in Section 6, the buraku effect is estimated to be around 70% of land prices, which is larger than 53% in our main analysis. This suggests that while our variables indeed capture urban health amenities, buraku areas tend to have somewhat better urban health amenities (conditional on our other control variables). Overall, we find little evidence that urban health amenities drive our buraku effects.

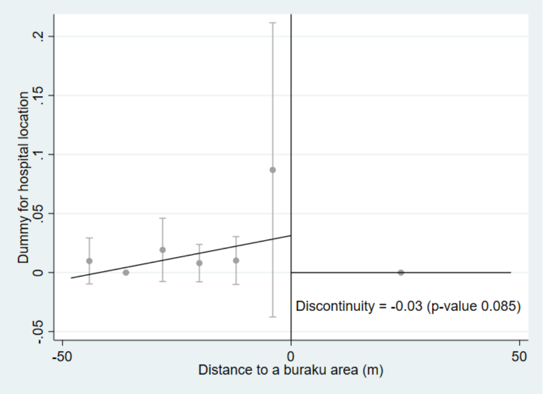
[I.1] Note that the low tap water usage might be a *consequence* of discrimination, rather than a confounding factor. For example, the government might determine who to discriminated based on residence and invest less in buraku areas. In this case, the tap water usage is just one manifestation of discrimination and should not be used as a control variable, which is precisely why we do not control for urban health amenities in our main specifications. Moreover, the implausibility of urban health amenities as control variables implies that detecting the discontinuity at the border does not invalidate the regression discontinuity design as they cannot be considered as predetermined (Cattaneo et al. 2019).

[I.2] We control for the quadratic of the infection rate of typhoid and the share of tap water usage. We also control for dummies of the hospital location and the zero incidence of typhoid.



(a) Infection rate of typhoid in 1912

(b) Share of tap water usage in 1912



(c) The presence of hospitals in 1912

Figure I.1: Discontinuity of infrastructure and sanitation conditions at the buraku border in 1912

Note: We show the discontinuity of the infection rate of typhoid, share of tap water usage, and the presence of hospitals at the buraku border in Kyoto in the early 1920's. The data are taken from Inoue (2019) but the share of tap water usage in buraku areas is augmented by Kyoto City Government (1929). On each side of the border, we fit the local linear equation using the triangular kernel. We also plot the mean and the 95% confidence interval for observations in a bin. The bandwidth is selected by the MSE-optimal criterion and we use the bias-corrected standard error to calculate p-values (Cattaneo et al. 2019).

Outcome: Log land price per m^2 in 1912	Dummy specification			Linear specification		
	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
buraku	-0.9744***	-1.2906***	-1.3223***	-0.9824***	-1.2308***	-1.0779**
	(0.1384)	(0.1823)	(0.3634)	(0.1896)	(0.2156)	(0.4247)
bdist				0.0000	0.0004***	0.0036*
				(0.0001)	(0.0001)	(0.0020)
buraku_bdist				-0.0005	-0.0034***	-0.0042**
				(0.0022)	(0.0012)	(0.0021)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect	-62.26***	-72.49***	-73.35***	-62.56***	-70.79***	-65.97***
(Right across the border)	(5.22)	(5.02)	(9.68)	(7.10)	(6.30)	(14.45)
Buraku effect				-62.12***	-68.81***	-68.37***
(25m within vs outside)				(6.25)	(6.22)	(12.53)
Buraku effect				-61.68***	-66.69***	-70.60***
(50m within vs outside)				(5.98)	(6.22)	(11.04)
Buraku effect				-60.79***	-62.02***	-74.61***
(100m within vs outside)				(7.46)	(6.65)	(9.23)
Oster's bound for buraku effect (in percentage points)	N/A	-83.23	-100	N/A	N/A	N/A
Controls (including infrastructure and sanitation variables)	No	Yes	Yes	No	Yes	Yes
N	60339	59819	2862	60339	59819	2862
R^2	0.012	0.732	0.730	0.012	0.741	0.739

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table I.1: 1912 regression results on log land prices per m^2 (with controls for urban health amenities)

Note: The Table presents the same regression results as those in Table 1 except that we additionally control for the infection rate of typhoid, the share of tap water usage, and the location of hospitals (Inoue 2019). The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1)\times$ 100% for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25$, 50, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

I.2 Land price penalty of non-buraku poor areas

As discussed in Section 6.3, a potential concern for our land price penalty estimate is that it reflects the poor neighborhood quality of buraku areas that is not attributable to discrimination (Ambrus, Field and Gonzalez 2020). In Appendix G, we find that buraku areas had substantially lower average income in 1912 and 1961, although no such income gap is observed today.

To address this concern, we estimate the land price penalty of poor non-buraku areas. If such areas also have a land price penalty as large as that of buraku areas, it indicates that the buraku price penalty is driven by neighborhood quality (measured by the average income). In contrast, if the land price penalty of poor non-buraku areas is smaller, then it indicates the special nature of buraku areas, implying the importance of the discrimination disamenity. We conduct this analysis for 1912 and 1961 given the lower income of buraku areas identified in these years.

We identify the poor non-buraku areas in the following procedure. First, we divide the Kyoto city into $250m \times 250m$ grid cells as shown in Figure 1. To focus on non-buraku areas, we drop the cells including a buraku area.[I.3] Then, we rank all the remaining cells according to the average income within the cell and define the same number of cells with the lowest average income as the non-buraku poor areas. We then repeat the analysis as in our main text to estimate the land price penalty, now treating the poor non-buraku areas like buraku areas. These poor non-buraku areas have lower income than that of buraku areas in both 1912 and 1961, implying that their neighborhood quality can be poorer than that of buraku areas. This might imply that the land price penalty of the poor non-buraku areas reveals an upper-bound of the effect of neighborhood quality.

Tables I.2 reports the result for 1912. From Columns 1 and 4, the poor non-buraku areas have substantially low land prices, which is partially by construction because our income measure is backed out from land prices and other information (see Appendix G). However, Columns 2 and 5 show that including the control variables substantially reduces the land price penalty, which is not the case in analyzing buraku areas (Table 1). This would imply that the role of the unobserved neighborhood quality is more limited than what is suggested by the raw numbers in Columns 1 and 4. Finally, adopting the border design further reduces the land price penalty and the poor non-buraku areas have 16% lower land prices compared to nearby areas. This land price penalty is way smaller than the 53% land price penalty of buraku areas. Overall, although we cannot fully rule out that some of the land price penalty of buraku areas is driven by the lower neighborhood quality, neighborhood quality alone does not seem sufficient to explain it.

Table I.3 repeats the same analysis for 1961 and finds a similar pattern. In particular, in Column 6, we find that the non-buraku poor areas have 11% lower land prices, which is substantially smaller than the land price penalty of buraku areas (36%). This again implies that the neighborhood quality can, if any, only partially explain the buraku price penalty.

[I.3] We drop 28 cells in 1912 and 51 cells in 1961.

Outcome: Log land price per m^2 in 1912	Dummy specification			Linear specification		
	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Poor non-buraku dummy	-1.8162***	-0.4290***	-0.1682***	-0.8320***	-0.3235***	-0.1857**
	(0.1391)	(0.0652)	(0.0508)	(0.2017)	(0.0803)	(0.0816)
Distance to poor non-buraku (m)				0.0010***	0.0002***	-0.0003
				(0.0001)	(0.0001)	(0.0006)
Distance to poor non-buraku (m) × Poor non-buraku dummy				-0.0002	-0.0003	0.0005
				(0.0022)	(0.0008)	(0.0010)
Panel B: Effect of poor non-buraku areas calculated from regression coefficients (in percentage points)						
Poor non-buraku effect (Right across the border)	-83.74***	-34.89***	-15.49***	-56.48***	-27.64***	-16.95**
	(2.26)	(4.25)	(4.30)	(8.78)	(5.81)	(6.78)
Poor non-buraku effect (25m within vs outside)				-58.48***	-28.00***	-16.66***
				(6.98)	(5.02)	(5.56)
Poor non-buraku effect (50m within vs outside)				-60.38***	-28.36***	-16.38***
				(5.84)	(4.56)	(4.65)
Poor non-buraku effect (100m within vs outside)				-63.93***	-29.08***	-15.80***
				(5.81)	(4.89)	(4.63)
Oster's bound for poor non-buraku effect (in percentage points)	N/A	1.64	-8.88	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	60409	60409	3364	60409	60409	3364
R^2	0.022	0.718	0.770	0.159	0.721	0.770

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table I.2: 1912 regression results on log land prices per m^2 (poor non-buraku areas)

Note: The table repeats the same analysis as that in Table 1 but replacing buraku areas with poor non-buraku areas. The border sample includes only observations within 150m from the nearest borders of the poor non-buraku areas. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating the poor non-buraku effects, we calculate the percentage effect of being in a poor non-buraku area (with the designated distance from the border) compared to the corresponding location outside of the poor non-buraku area by the formula $(e^{\beta} - 1)\times$ 100% for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50,$ or 100 for linear specification. This formula provides the percentage penalty on poor non-buraku land prices. We calculate Oster's bound for the poor non-buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 1961	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Poor non-buraku dummy	-0.6228***	-0.2261***	-0.1337***	-0.3271***	-0.0942***	-0.0543*
	(0.0346)	(0.0285)	(0.0240)	(0.0413)	(0.0304)	(0.0298)
Distance to poor non-buraku (m)				0.0003***	0.0002***	0.0008***
				(0.0000)	(0.0000)	(0.0003)
Distance to poor non-buraku (m) × Poor non-buraku dummy				0.0008*	0.0010**	-0.0004
				(0.0004)	(0.0005)	(0.0005)
Panel B: Effect of poor non-buraku areas calculated from regression coefficients (in percentage points)						
Poor non-buraku effect (Right across the border)	-46.36***	-20.24***	-12.52***	-27.90***	-8.99***	-5.28*
	(1.86)	(2.28)	(2.10)	(2.98)	(2.76)	(2.82)
Poor non-buraku effect (25m within vs outside)				-30.18***	-11.89***	-8.05***
				(2.57)	(2.32)	(2.17)
Poor non-buraku effect (50m within vs outside)				-32.39***	-14.71***	-10.74***
				(2.36)	(2.29)	(2.04)
Poor non-buraku effect (100m within vs outside)				-36.60***	-20.06***	-15.88***
				(2.50)	(3.15)	(3.06)
Oster's bound for poor non-buraku effect (in percentage points)	N/A	-8.32	-9.09	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	11143	11143	2003	11143	11143	2003
R^2	0.045	0.687	0.593	0.107	0.698	0.596

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table I.3: 1961 regression results on log land prices per m^2 (poor non-buraku areas)

Note: The table repeats the same analysis as that in Table B.1 but replacing buraku areas with poor non-buraku areas. The border sample includes only observations within 150m from the borders of the nearest poor non-buraku areas. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating poor non-buraku effects, we calculate the percentage effect of being in a poor non-buraku area (with the designated distance from the border) compared to the corresponding location outside of the poor non-buraku area by the formula $(e^{\beta} - 1)\times$ 100% for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25,$ 50, or 100 for linear specification. This formula provides the percentage penalty on the poor non-buraku land prices. We calculate Oster's bound for the poor non-buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

I.3 School districts

If the school district boundary coincides with the buraku border, our results might attribute school quality effects to discrimination (Black 1999; Bayer et al. 2007). School districts might also serve as a proxy for the neighborhood quality and the shape of the social network. We thus present buraku effects in 2018 after additionally controlling for the fixed effects of public primary and junior high school districts.[I.4]

Table I.4 presents 2018 regression results after controlling for primary and junior high school districts. The estimated buraku effects change little, implying that our buraku effects are not driven by school quality and factors that are closely correlated with it.

[I.4] Unfortunately, we do not have an accurate school district data in the 20th century. However, Japanese public schools are generally highly standardized in terms of the curriculum and funding. Indeed, the capitalization of public school quality into land prices appears smaller than other developed countries (e.g., Kuroda 2022). In this sense, even if school district boundaries coincide buraku borders in prior years, we would expect little effect on buraku effects, which is consistent with the 2018 regression result in this section.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 2018	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.3571***	-0.2035***	-0.1471***	-0.3573***	-0.1513***	-0.0979***
	(0.0441)	(0.0305)	(0.0251)	(0.0573)	(0.0386)	(0.0359)
Distance to buraku (m)				-0.0001***	-0.0000***	0.0006***
				(0.0000)	(0.0000)	(0.0002)
Distance to buraku (m) × Buraku dummy				0.0023***	0.0011**	-0.0004
				(0.0005)	(0.0005)	(0.0008)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect	-30.03***	-18.41***	-13.68***	-30.04***	-14.04***	-9.33***
(Right across the border)	(3.08)	(2.49)	(2.17)	(4.01)	(3.32)	(3.26)
Buraku effect				-33.58***	-16.25***	-11.01***
(25m within vs outside)				(3.28)	(2.67)	(2.18)
Buraku effect				-36.94***	-18.40***	-12.65***
(50m within vs outside)				(2.73)	(2.38)	(2.30)
Buraku effect				-43.15***	-22.56***	-15.85***
(100m within vs outside)				(2.27)	(2.95)	(4.80)
Oster's bound for buraku effect (in percentage points)	N/A	-15.04	- 8.80	N/A	N/A	N/A
Controls (including school-district fixed effect)	No	Yes	Yes	No	Yes	Yes
N	38828	38828	1892	38828	38828	1892
R^2	0.005	0.697	0.660	0.048	0.698	0.662

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table I.4: 2018 regression results on log land prices per m^2 (with controls for school-district fixed effects)

Note: The table presents the same regression results as those in Table 2 except that we additionally control for the primary and junior-high school district fixed effects. The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1)\times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25$, 50, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

I.4 Floor-to-area ratio regulation

In this Appendix, we consider the potential road of the floor-to-area ratio (FAR) regulation that was in effect in 2018. The regulation restricts how much floor space one can build for a given land area. Crucially, this ratio is closely related to the width of the front road (LaPoint 2020). If the front road is narrow, the building must be narrow to secure sunlight, prepare for future road expansion, and other reasons. We thus calculate the width of the front road and flexibly control for it.

Table I.5 presents the results after controlling the width of the front road. The results are quite similar to our main specification in Table 2, suggesting that heterogeneity in the FAR regulation does not seem to drive our results. We have also checked that road width has significant explanatory power, especially for road width below $4m$.[I.5] This suggests that our calculated road width reasonably captures the actual regulation pattern.

[I.5] If the front road is narrower than $4m$, one must "set back" from the road to secure the $4m$ width in the future expansion of the road. This means that if the width of the front road is less than $4m$, a significant portion of the land plot cannot support any structure.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 2018	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.3539***	-0.2021***	-0.1514***	-0.3504***	-0.2059***	-0.0750*
	(0.0452)	(0.0364)	(0.0299)	(0.0584)	(0.0471)	(0.0445)
Distance to buraku (m)				-0.0001***	-0.0000***	0.0007***
				(0.0000)	(0.0000)	(0.0002)
Distance to buraku (m) × Buraku dummy				0.0023***	0.0007	-0.0004
				(0.0005)	(0.0007)	(0.0010)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect (Right across the border)	-29.80***	-18.30***	-14.05***	-29.56***	-18.61***	-7.23*
	(3.17)	(2.97)	(2.57)	(4.12)	(3.83)	(4.13)
Buraku effect (25m within vs outside)				-33.18***	-19.79***	-9.81***
				(3.38)	(3.02)	(2.63)
Buraku effect (50m within vs outside)				-36.60***	-20.95***	-12.32***
				(2.81)	(2.69)	(2.62)
Buraku effect (100m within vs outside)				-42.94***	-23.22***	-17.13***
				(2.31)	(3.63)	(5.58)
Oster's bound for buraku effect (in percentage points)	N/A	-14.38	- 9.57	N/A	N/A	N/A
Controls (including width of the front road)	No	Yes	Yes	No	Yes	Yes
N	38227	38227	1862	38227	38227	1862
R^2	0.005	0.594	0.595	0.048	0.596	0.599

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table I.5: 2018 regression results on log land prices per m^2 (with controls for the width of the frond road)

Note: The table presents the same regression results as those in Table 2 except that we additionally control for the width of the front road, which significantly affects the FAR regulation. The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1)\times$ 100% for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25$, 50, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

I.5 Alternative definition of buraku areas

Tables I.6–I.8 repeat the same analysis as in Sections 6 and 7 but using an alternative definition of buraku areas based on Kyoto City Government (1929). As shown in Tables I.6–I.8, the results are qualitatively similar but the buraku effect might seem larger, especially around the border of buraku areas. In 1912, buraku areas have lower land prices by 62%. The corresponding number is 39% for 1961, and 19%-22% for 2018.

Note that buraku areas described in Kyoto City Government (1929) are around the city center and the buraku areas included in the analysis are almost the same for 1912 and 2018.[I.6] Thus, Tables I.6–I.8 also mitigate the concern that the dynamic evolution of buraku effects is spuriously induced by the expansion of the city. Moreover, since we have clear evidence in the history and sociology literature that the six buraku areas in Kyoto City Government (1929) date back to the pre-modern period (Kyoto City Government 1940), shocks to contemporary land prices are unlikely to be correlated with the locational determinants of these areas (Ciccone and Hall 1996).

[I.6] Kyoto City Government (1929) describes six buraku areas. In 1912, five out of the six areas are covered by our land price data. The 2018 data cover all the six buraku areas.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 1912	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.8523***	-1.3026***	-1.0258***	-1.0354***	-1.2132***	-0.9523***
	(0.1362)	(0.1034)	(0.1360)	(0.2233)	(0.1416)	(0.2216)
Distance to buraku (m)				-0.0000	0.0003***	0.0020
				(0.0001)	(0.0000)	(0.0018)
Distance to buraku (m) × Buraku dummy				-0.0021	-0.0025*	-0.0038
				(0.0022)	(0.0014)	(0.0024)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect (Right across the border)	-57.36***	-72.81***	-64.15***	-64.49***	-70.28***	-61.41***
	(5.81)	(2.81)	(4.87)	(7.93)	(4.21)	(8.55)
Buraku effect (25m within vs outside)				-62.50***	-68.85***	-61.73***
				(7.03)	(3.86)	(6.79)
Buraku effect (50m within vs outside)				-60.41***	-67.35***	-62.04***
				(6.42)	(3.74)	(5.65)
Buraku effect (100m within vs outside)				-55.85***	-64.14***	-62.65***
				(7.16)	(4.53)	(6.29)
Oster's bound for buraku effect (in percentage points)	N/A	-76.67	-68.66	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	60314	60314	2898	60314	60314	2898
R^2	0.009	0.736	0.752	0.010	0.743	0.756

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses (Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table I.6: 1912 regression results on log land prices per m^2 (Alternative definition of buraku areas)

Note: The table presents the same regression results as those in Table 1 except for using the alternative definition of buraku areas from Kyoto City Government (1929). The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1)\times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25, 50$, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 1961	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.8182***	-0.8433***	-0.5310***	-0.9788***	-0.6607***	-0.4773***
	(0.0675)	(0.0944)	(0.0803)	(0.1154)	(0.1516)	(0.1294)
Distance to buraku (m)				-0.0002***	0.0001***	0.0016*
				(0.0000)	(0.0000)	(0.0008)
Distance to buraku (m) × Buraku dummy				0.0018*	0.0012	-0.0028*
				(0.0009)	(0.0011)	(0.0015)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect (Right across the border)	-55.87***	-56.97***	-41.20**	-62.42***	-48.35***	-37.96***
	(2.97)	(4.06)	(4.72)	(4.34)	(7.83)	(8.03)
Buraku effect (25m within vs outside)				-63.74***	-50.24***	-38.48***
				(3.49)	(6.33)	(6.30)
Buraku effect (50m within vs outside)				-65.04***	-52.07***	-39.00***
				(2.77)	(4.98)	(4.84)
Buraku effect (100m within vs outside)				-67.43***	-55.51***	-40.02***
				(1.99)	(2.96)	(3.91)
Oster's bound for buraku effect (in percentage points)	N/A	-57.33	-34.22	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	11116	11116	461	11121	11116	461
R^2	0.018	0.700	0.632	0.095	0.707	0.640

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses(Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table I.7: 1961 regression results on log land prices per m^2 (Alternative definition of buraku areas)

Note: The table presents the same regression results as those in Table B.1 except for using the alternative definition of buraku areas from Kyoto City Government (1929). The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1)\times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25$, 50, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

	Dummy specification			Linear specification		
Outcome: Log land price per m^2 in 2018	Full sample		Border sample	Full sample		Border sample
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Estimated regression coefficients						
Buraku dummy	-0.2593***	-0.3186***	-0.2566***	-0.2876**	-0.3251***	-0.2574**
	(0.0920)	(0.0772)	(0.0840)	(0.1260)	(0.1206)	(0.1234)
Distance to buraku (m)				-0.0001***	-0.0000***	0.0007**
				(0.0000)	(0.0000)	(0.0003)
Distance to buraku (m) × Buraku dummy				0.0015	0.0003	-0.0018
				(0.0010)	(0.0010)	(0.0017)
Panel B: Effect of buraku areas calculated from regression coefficients (in percentage points)						
Buraku effect (Right across the border)	-22.84***	-27.28***	-22.64***	-25.00***	-27.76***	-22.70**
	(7.10)	(5.62)	(6.50)	(9.45)	(8.71)	(9.54)
Buraku effect (25m within vs outside)				-27.39***	-28.23***	-21.90***
				(7.87)	(7.31)	(7.57)
Buraku effect (50m within vs outside)				-29.71***	-28.71***	-21.11***
				(6.61)	(6.12)	(6.67)
Buraku effect (100m within vs outside)				-34.13***	-29.65***	-19.49***
				(5.39)	(4.88)	(9.32)
Oster's bound for buraku effect (in percentage points)	N/A	-28.59	-26.18	N/A	N/A	N/A
Controls	No	Yes	Yes	No	Yes	Yes
N	38905	38905	1966	38905	38905	1966
R^2	0.001	0.558	0.532	0.038	0.560	0.536

Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors in parentheses(Conley 1999).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

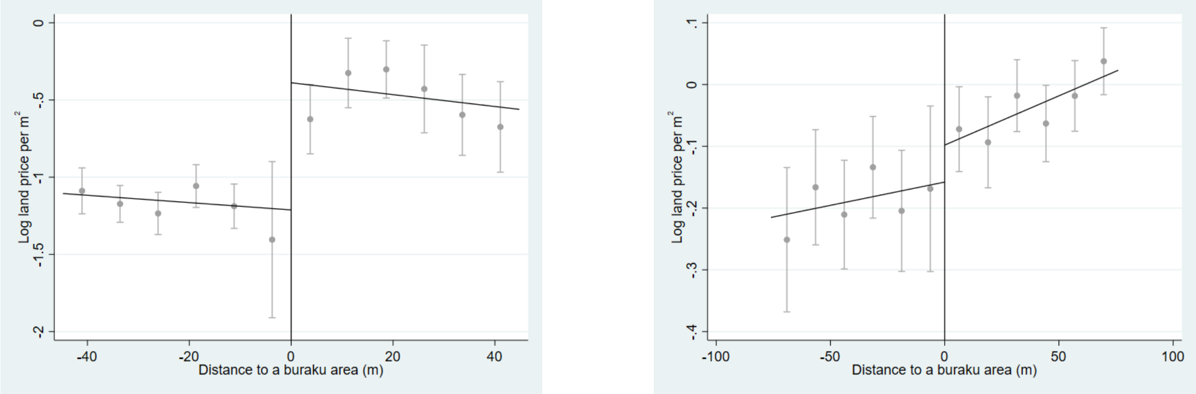
Table I.8: 2018 regression results on log land prices per m^2 (Alternative definition of buraku areas)

Note: The table presents the same regression results as those in Table 2 except for using the alternative definition of buraku areas from Kyoto City Government (1929). The border sample includes only observations within 150m from the nearest buraku border. We report Conley's standard error that allows for the spatial autocorrelation of errors within 100m neighborhood. Control variables are specified in the text. When calculating buraku effects, we calculate the percentage effect of being in a buraku area (with the designated distance from the border) compared to the corresponding location outside of the buraku area using the formula $(e^{\beta} - 1)\times 100\%$ for dummy specification and $(e^{\beta_1 - 2\beta_2 x - \beta_3 x} - 1) \times 100\%$ with $x = 0, 25,$ 50, or 100 for linear specification. This formula provides the percentage penalty on buraku land prices. We calculate Oster's bound for the buraku effect right across the border. We set the maximal R^2 to 1.3 times the R^2 of each regression. Due to its availability, we do not report it for specifications with no controls or with treatment effect heterogeneity.

I.6 Automated bandwidth selection and bias correction for the border design

Figure I.2 presents the discontinuity of land prices at the border in 1912 and 2018. To account for the effect of the observed characteristics, we first regress log unit land price (its mean is normalized to zero) on our control variables and obtain the residual. We then estimate the discontinuity of this residual by applying the MSE-optimal bandwidth selection and the bias-corrected standard error (Cattaneo et al. 2019), implying that the bandwidth is now different for 1912 and 2018. Note that this estimation procedure is designed for identifying the discontinuity at the border and not for detecting the continuous effect of distance to a buraku border, which we are also interested in.

Despite accounting for the control variables and using the different bandwidth, the general pattern in Figure I.2 is similar to what we have obtained in Column 6 of Tables 1 and 2 using the conventional OLS method. There is a large price discontinuity in 1912 at the buraku border. The discontinuity in 2018 is much smaller than that in 1912, but we still obtain a large price gap once we compare land plots that are within and outside the buraku border. This reinforces the robustness of our main regression results in Tables 1 and 2.



(a) (Residualized) log unit land price in 1912

(b) (Residualized) log unit land price in 2018

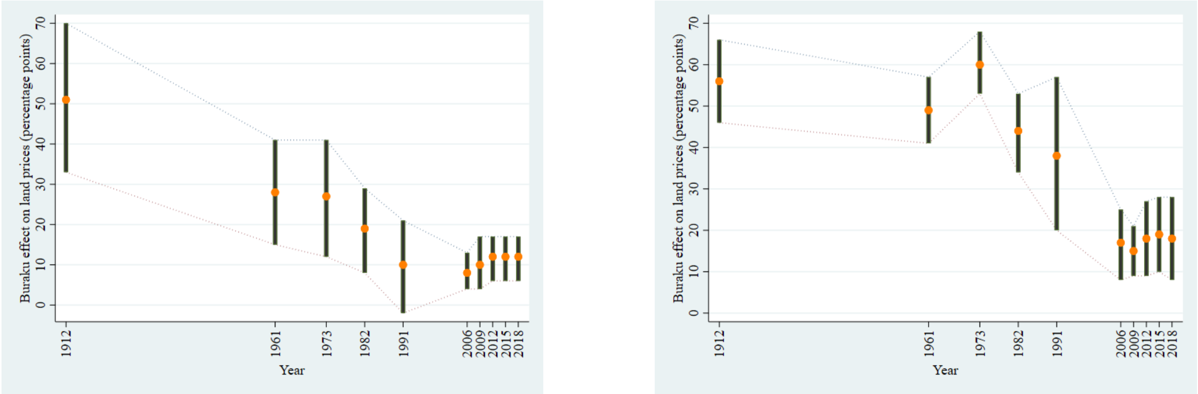
Figure I.2: Residualized log unit land price in 1912 and 2018: optimal bandwidth selection

Note: The figures show the residualized unit prices around the buraku border in 1912 (a) and 2018 (b). We first regress log unit land prices on our control variables and obtain the residual. On each side of the border, we fit the local linear equation using the uniform kernel. We also plot the mean and the 95% confidence interval for observations in a bin. We estimate the discontinuity of this residual by applying the MSE-optimal bandwidth selection and the bias-corrected standard error (Cattaneo et al. 2019), implying that the bandwidth is now different for 1912 and 2018.

I.7 Alternative estimates of the time-series of buraku land price discount

We have presented in Figure 4 of Section 7 the time-series of the land price discount of buraku areas. This is based on our preferred estimate comparing land plots 50*m* within and outside the border of buraku areas. However, we also report throughout this paper the 25*m* comparison that would be closer to the pure spatial discontinuity design but might suffer from the ambiguity of the buraku borders, as well as the 100*m* comparison that would be free of the ambiguity of the borders but might suffer from unobserved confounders to some extent.

Figure I.3 presents the alternative time-series patterns of the buraku land price discount based on 25*m* and 100*m* comparisons. While there are some quantitative differences, both figures point to the same qualitative conclusion as our main result in Figure I.3. First, there was a decline in the land price discount from 1912 to 1961. Second, while there was little decline, or even some increase, from 1961 to 1973, the land price discount again started declining from 1973 to 2006. Finally, there was no decline in the land price discount from 2006 to 2018. These results suggest that the qualitative pattern of the time-series is robust to alternative ways to measure the buraku land price penalty.



(a) 25*m* comparison

(b) 100*m* comparison

Figure I.3: Time-series of the buraku land price discount (alternative measures)

Note: The orange dots represent the point estimate of the buraku price penalty (25m comparison for Panel (a) and 100m comparison for Panel (b)) in Column 6 of Table 1 for 1912, Table B.1 for 1961, Table B.2 for 1973, Table B.3 for 1982, Table B.4 for 1991, Tables B.5–B.8 for 2006–2015, and Table 2 for 2018. The vertical bars represent the corresponding 95% confidence intervals. All numbers are rounded to the nearest integers.

J Additional discussions

Having investigated the effect of buraku areas on land prices, we conduct additional analyses to obtain further insights on discrimination against the buraku. First, we express the cost of a higher discrimination risk in terms of income compensation rather than land prices, which facilitates interpretation and comparison with other studies on discrimination. Second, we investigate whether buraku areas have lower average income than other areas. Third, we conduct a simple counterfactual analysis of reducing the discrimination disamenity and compare it with the observed changes from 1912 to 2018. Finally, we derive the wealth losses of buraku residents in Kyoto. Throughout the analyses in this section, we exploit various implications from the theoretical model presented in Section 4.

J.1 The income-equivalent cost of discrimination

The land price penalty of buraku areas measures the cost of a higher discrimination risk as the land price discount needed for exactly compensating the utility loss from discrimination, conditional on the same income level and location. However, measurements by unit of land prices might be inconvenient for comparison. First, since the relative importance of land in household consumption differs over time, implying that our results for 1912 and 2018 are, strictly speaking, not directly comparable. Second, other studies such as wage gap literature often quantify discrimination in income units. To address these difficulties, we use an alternative expression measuring how much additional income is needed to compensate for discrimination disamenity instead of having lower land prices. We can calculate this alternative measure of the cost of discrimination by invoking the model presented in Section 4.

More formally, we calculate the income-equivalent cost of a higher discrimination risk as follows. Suppose that location n in a buraku area has a land price of $\beta_n r_n$, while the price is r_n if the land price does not reflect that location n belongs to a buraku area. In other words, $1 - \beta_n$ is the price penalty on buraku areas and $\beta_n < 1$ because the lower land price in buraku areas compensates for discrimination disamenity at the spatial equilibrium. If $\beta_n = 1$ hypothetically holds while discrimination amenity remains the same, the indirect utility (A.3) suggests that the human capital I must equal $\beta_n^{-\gamma} I$ to compensate for discrimination disamenity. That is, if the land prices are independent of discrimination and do not compensate for discrimination, those living in a buraku area need to earn $(\beta_n^{-\gamma} - 1) \times 100\%$ higher income to be compensated. In light of this, we calculate $(\beta_n^{-\gamma} - 1) \times 100\%$ as a measurement of the cost of a higher discrimination risk.

Since $1 - \beta_n$ is the buraku effect identified in the previous section, it is sufficient to know γ, the spending share on land, for calculating the utility cost in terms of the income compensation. We calibrate this parameter as follows. Our starting point is the spending share for housing 0.25, which has been used for contemporaneous Japan (Miyauchi et al. 2021) and other countries including the US (Davis and Ortalo-Magné 2011). However, adjustments must be made because our parameter γ is the spending share for land, not housing that also includes payment for housing

	1912	2018
Price penalty on land prices of buraku areas	53%	14%
Spending share on land	$\frac{9}{64}$ ($\simeq 0.14$)	$\frac{1}{9}$ ($\simeq 0.11$)
Estimated cost of discrimination risk (Required compensation as a fraction of income)	11.2%	1.7%

Table J.1: The estimated severeness of discrimination (expressed as required compensation of income given the same location and land price) and two inputs used for the calculation.

structures and utility costs. For 1912, we calibrate $\gamma = \frac{9}{64} \simeq 0.14$ based on available housing and household survey data in pre-war Japan. For 2018, we calibrate $\gamma = \frac{1}{9} \simeq 0.11$ based on data on the values of property tax and the spending share for utilities. The decline in the spending share for land is sensible because due to the advancement of construction technology, the same amount of floor space can be consumed while consuming less land. The details of calibration are described in Appendix J.3.

Table J.1 presents the income-equivalent severeness of discrimination in both 1912 and 2018 and the two inputs used for its calculation, the buraku effect on land prices and the spending share on land. We estimate that the cost of a higher discrimination risk by living in a buraku area in 1912 is compensated for by providing 11.2% of the income. Compared to 1912, the estimated income-equivalent of the cost of discrimination in 2018 is more moderate and estimated to be 1.7%. Recall that discrimination in our model includes a wage penalty due to belonging to a buraku area in addition to other forms of discrimination. Thus, these numbers are interpreted as the sum of the wage gap and discrimination in non-labor market settings.

To assess the magnitude of discrimination, we provide several benchmark numbers from today's racial and gender discrimination. First, Fryer (2011) estimates that in the National Longitudinal Survey of Youth 1997 data, black men in the US have about 10.9% lower wages than white men and black women earn 4.4% less than white women. Fryer (2011) also reports that the corresponding number for Hispanic men is 4.4% and that for Hispanic women is -3.5% (i.e., they earn *more* than white women). Second, regarding the gender wage gap in contemporary Japan, Hara (2018) estimates that women at the median wage face a slightly larger than 10% wage gap after controlling for human capital and establishment. Thus, discrimination against the buraku in 1912 seems severe even compared with these instances of discrimination.

We make three additional remarks. First, in our buraku context, residence is only a partial determinant of buraku status (Okuda 2007), implying that we might understate the impact of perfectly changing the discrimination status. In contrast, racial and gender discrimination are concerned with much more clearly visible characteristics and such underestimation does not arise in estimating the wage gap. Second, since our model assumes absentee landownership, our estimates in Table J.1 abstracts from the wealth effect of buraku areas (see Appendix J.4). If plots of buraku areas tend to be occupied by residents, the lower land price reduces the value of their wealth. Accounting for this negative wealth effect would further magnify the severeness of discrimination than Table J.1. Finally, despite careful econometric considerations, the wage gap literature might still erroneously attribute the influence of unobserved factors that are associated with discrimination status to the wage gap, thereby overestimating the degree of discrimination (Fryer 2011). Our result shows that at least when we also consider non-labor market discrimination, buraku discrimination exists in both 1912 and 2018 and its income-equivalent cost in 1912 is perhaps larger than what the wage gap literature has suggested in today's racial and gender discrimination. Overall, given the potential underestimation discussed above, the buraku discrimination in 1912 seems at least as severe as, or perhaps severer than, discrimination in various other contexts.

The severeness of buraku discrimination in 2018 might be smaller than the wage gap in these examples of discrimination, which might be consistent with quantitative evidence that buraku areas in Osaka no longer have lower income than other areas (Shima 2016) and qualitative evidence that the major remaining discrimination against the buraku seems to be marriage discrimination while a young generation often does not recognize labor market discrimination (Uehara 2009).

J.2 Comparison between the predicted and observed changes in population density and the average income in buraku areas

In this section, we explore what the model predicts to happen to buraku areas once discrimination disamenities substantially diminish. We consider a counterfactual in which we take the 1912 economy as our baseline and hypothetically set discrimination disamenities at the 2018 level rather than the 1912 level. We then compare the prediction to the observed changes from 1912 to 2018. We note upfront an important caveat that many other changes that occurred over the century are ignored in this analysis.

Let $\hat{x} \equiv \frac{x'}{x}$, where x' is the value of x in a counterfactual economy. Using (A.6) for the observed and counterfactual equilibria, we obtain the exact-hat expression often used in the trade literature (Dekle, Eaton and Kortum 2007):

$$\hat{r}_n = \hat{\bar{N}}_n \hat{\bar{I}}_n, \tag{J.1}$$

that is, the relative change in land price is the product of population density and local average income. Alternatively, this can be interpreted as the change in the total income of residents per unit of land, which is proportional to the demand for land under our Cobb-Douglas utility function.[J.1] However, our model does not allow us to separately identify $\hat{\bar{N}}_n$ and $\hat{\bar{I}}_n$ in the counterfactual scenario because the equilibrium sorting pattern with respect to human capital is indeterminate (see the discussion right after Equation A.9 and footnote A.12).

$\hat{r}_n$ is directly obtained from our model-implied regression Equation (A.10), implying that the left-hand-side of (J.1) is straightforward to obtain. Using the specification in Column 3

[J.1] Note that $N_n \bar{I}_n$ is the total income of residents at location n. Dividing this by the size of land plot L_n yields $\bar{N}_n \bar{I}_n$. Note that $\frac{\bar{N}'_n \bar{I}'_n}{\bar{N}_n \bar{I}_n} = \hat{\bar{N}}_n \hat{\bar{I}}_n$, implying that the relative change of $\bar{N}_n \bar{I}_n$ equals $\hat{r}_n$.

of Table 1 and 2, we estimate that $\hat{r}_n = 1.94$ for a plot n in a buraku area by moving the discrimination disamenity level in 1912 to that in 2018.[J.2] Equation (J.1) implies that the total income in buraku areas also increases by 94% if we reduce the discrimination disamenities to the 2018 level.

Now, we compare this prediction with the observed changes in buraku areas from 1912 to 2018. Throughout, we take numbers from $25m$ and $100m$ comparisons to obtain low-end and high-end estimates of each object. Note first that the income gap analysis in Appendix G suggests that buraku areas had 72%–78% lower income in 1912 while no income gap is observed in 2018, implying that around 300%–400% increase in the average income level over the century (relative to non-buraku areas). In contrast, the population density in buraku areas was 92%–113% higher in 1912 but is 11%-40% lower in 2018 (see Appendix H for regression results on population density. This implies that the population density of buraku areas declined by around 50%–75% relative to non-buraku areas. Based on these results, if we measure the population density and the average income of buraku areas relative to non-buraku areas (i.e., normalizing the observation of buraku areas relative to non-buraku areas in the same year for comparison across different years) , we posit that $\hat{\bar{I}}_n$ is roughly from 4 to 5 based on the 300%-400% increase in the average income and $\hat{\bar{N}}_n$ is from 0.25 to 0.5 based on the 50%-75% decrease in the population. Then, $\hat{\bar{N}}_n \hat{\bar{I}}_n$ is from 1 to 2.5, which includes 1.94 that we predict from Equation (J.1).

Our result suggests that although we ignore many other changes over the century, the observed significant improvement in the average income and the lower population density of buraku areas are quantitatively consistent with what Equation (A.9) from our model predicts in response to the substantial reduction in discrimination disamenities.

J.3 Calibrating the spending share for land (γ)

Calibration for 1912. According to The Ministry of Welfare (1940), the rental housing price per m^2 was about 90% of the rental price of land per m^2 Japan in the 1930's, which we extrapolate to Kyoto in 1912. Since The Ministry of Welfare (1940) also shows that both single-story and two-story houses were equally prevalent in Japan at that time and buildings with more than three stories were rare, we also assume that the floor space of $1.5m^2$ can be obtained from the land with a size of $1m^2$. These numbers imply that roughly speaking, 75% of housing rent is for renting land and the remaining 25% is for renting the housing structure. While this value is higher than the estimates of land cost share in construction in contemporary US and Europe (Epple, Gordon and Sieg 2010; Ahlfeldt et al. 2015; Combes, Duranton and Gobillon 2021; Davis et al. 2021), Henderson, Regan and Venables (2021) estimate that land cost account for 75% of total housing costs in the slums of modern Nairobi. We think it is a reasonable value for 1912 Japan as construction technology at this time limited the development of high-rise buildings and woods, by far the most popular construction material in 1912 Japan, are relatively

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[J.2] Given that buraku effect is 56.45% in 1912 and 15.34% in 2018, we have $0.8466/0.4355 \simeq 1.94$. Note that Equation (A.10) predicts no change in the price of a plot outside buraku areas.

cheaper than more durable materials used in the modern formal sector. Indeed, this description of the construction technology in 1912 Japan might be comparable to that of the informal sector (slums) today. In terms of utility costs, Tokyo City Government (1928) shows that the spending share of housing rents and utilities was roughly 3:1 in Tokyo at that time, which we extrapolate to 1912 Kyoto. These numbers imply that $\frac{9}{16}$ of the housing costs (defined as the sum of land cost, housing structure cost, and utilities) go to land. Multiplying this by 0.25, we get $\frac{9}{64}$.

Calibration for 2018. The property tax in Kyoto city, which has the same tax rate for both land and housing structures, collects roughly the same revenue from land and housing structures (https://www.soumu.go.jp/main_sosiki/jichi_zeisei/czaisei/czaisei_seido/ichiran10_19.html. In Japanese. Last accessed on July 26 2021). We thus assume that half of the housing rents is the rental price for land and the remaining half is for the structures. Although this is smaller than the land share in construction costs used for other countries today (Epple et al. 2010; Ahlfeldt et al. 2015; Combes et al. 2021), this is broadly consistent with the land share in Paris from Combes et al. (2021) and expensive counties in the US (Davis et al. 2021). We think this relatively high land cost share is reasonable in our context because Kyoto is densely-populated and the land supply of of Kyoto is constrained by the presence of mountains (see Figure 2). In addition, the spending side of Kyoto prefectural GDP statistics suggests that the spending for utilities is approximately one eighth of that for housing rents (http://www.pref.kyoto.jp/tokei/yearly/tokeisyo/ts2010/tokeisyo201003.html. In Japanese. Last accessed on July 26 2021.). They imply that out of the total housing costs, $\frac{4}{9}$ goes to land. Multiplying this by 0.25, we get $\frac{1}{9}$.

Calibration for 1961. Unfortunately, we have not found a good resource on the spending share for land in 1961. Thus, we use 0.125, which is the mean of 0.14 in 1912 and 0.11 in 2018.

J.4 Losses in wealth from discrimination

Although the land price penalty on buraku areas decreases their asset value, our quantification of discrimination abstracts from the wealth effect by assuming that all land is owned by absentee landlords. In this section, we illustrate the quantitative importance of the overall wealth effect falling onto landlords.

In order to grab the overall burdens for buraku residents in Kyoto city, we compute the losses in their wealth due to discrimination.We first derive the aggregate losses in land values by multiplying the mean land price in the neighborhood (0-50m away from a buraku area) of buraku areas, the size of buraku areas (in m^2), and the buraku effect. They represent the potential gains if land in buraku areas were evaluated equally to that just outside the buraku areas. Moreover, to facilitate comparison across years, we adjust the price levels so that the aggregate losses are represented in the 2018 price level. We use the mean land price in Kyoto city and multiply the estimated aggregate losses by the rate of increase in the mean land price between each year and 2018.[J.3] The aggregate losses amount to 99 billion yen for 1912, 59 billion yen for 1961, and 36 billion yen for 2018.

In practice, some of the land plots in buraku areas are owned by the buraku residents and the low land price of buraku areas might reduce the asset value of their land plots. While this is a burden on landowners, we might regard part of such a wealth effect as another channel through which buraku discrimination reduces the welfare of the buraku people. To provide a crude sense of its quantitative importance, we now calculate how much landowners in buraku areas gain due to the land value appreciation if the discrimination disappears.

Although information on the locations of landowners of housing for rent is not available, information on the home (including land) ownership rate is often available. By multiplying it and the aggregate losses, we can obtain suggestive estimates of the losses in the wealth of buraku residents. Before WW2, home-ownership was relatively prevalent and the home-ownership rate in Kyoto city was 19.9% in 1941. After WW2, it has become more prevalent and the home-ownership rate in Kyoto city reached 53.3% in 1983 (Hinokidani and Sumita 1988). It remained at the similar level until 2018. (Housing and Land Survey, Statistics Bureau of Japan).[J.4] The buraku areas have had a slightly higher home-ownership rate than that on the average (Kyoto Prefectural Government 1953, Management and Coordination Agency 1993), making us employ 20% as a rough estimate of the home-ownership rate within buraku areas for the pre-WW2 periods, and 55% for the post-WW2 periods. From these figures, we obtain

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[J.3] Alternatively, we can use the consumer price index to adjust price levels. However, the increase in the consumer price index between 1912 and 2018 was quite smaller than that in land prices. For instance, if we use the consumer price index published by the Ministry of Internal Affairs and Communication for 1965-2018 (see https://www.e-stat.go.jp/stat-search/files?page=1&toukei=00200573&tstat=000001150147, Last accessed on December 20 2021), and the consumer price index avaiable at the Long-Term Economic Statistics Database, Hitotsubashi University, for 1912-1965 (see https://webltes.ier.hit-u.ac.jp/repo/repository/LTES/?lang=1, Last accessed on December 20 2021), the consumer price in 2018 is 2.8 thousand times higher than that in 1912 whereas the mean land price in Kyoto city in 2018 is 110 thousand times higher that in 1912. We use the mean land price given that our analysis is concerned only with land and the construction of long-run CPI faces limitations.

[J.4] https://www2.city.kyoto.lg.jp/sogo/toukei/Others/HouseLand/, last accessed on December 20 2021.

the modest estimates of the wealth losses of buraku residents in Kyoto city as 20 billion yen for 1912, 32 billion yen for 1961, and 20 billion yen for 2018.

However, it should be noted that it is ambiguous how well the loss of landowners in buraku areas approximates the wealth losses incurred by buraku people. For example, suppose all land plots in buraku areas are initially owned by absentee landlords and land prices are determined only by fundamentals (i.e., the discounted sum of the stream of land rents). Now, suppose that every worker owns the land only for one year, and then moves out by selling the land. This transaction is equivalent to renting the plot for one year. The residents get discriminated against and the cost of discrimination is reflected in the low land rent, but the negative wealth effect does not harm the residents despite the positive homeownership rate. Instead, the original absentee landowners, who are not regarded as buraku because they do not live in the buraku area, carry all the wealth effects. Unfortunately, we do not have enough data to calculate the true incidence of the wealth effect on buraku people. Thus, we prefer not to include the wealth effect as the cost of discrimination in our main estimates, although the omission may lead to an underestimation of the true severeness of discrimination. Having said this, these numbers might provide some guidance about the magnitude of the additional welfare loss incurred by buraku people through the wealth loss.

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