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Ex Ante Evaluation of Migration Subsidy: Evidence from Japan*

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Abstract

This study proposes a simple framework for the ex ante evaluation of migration subsidy. Recently, the Japanese government initiated a migration subsidy program to promote urban-to-rural migration for regional revitalization under the economy with a monopolar concentration in Tokyo. The ex ante evaluation framework proposed in this study formulates the payback period of interregional migration as investment behavior. In the model, households compare the sum of the expected benefits available each year after migration with the lump-sum costs of migration, which are estimated with structural estimation using the interregional migration flow data. The migration subsidy leads to an incentive for interregional migration by reducing the payback period. This study finds that households incur different migration costs at each stage of life, implying that a uniformly determined migration subsidy may have different policy effects. Counterfactual simulations provide scientific insight into the potential impact of the migration subsidy program, helping policymakers determine the optimal amount under the budget constraint.

JEL classification: J61, R23, R41
Keywords: migration, real income differences, gravity equation, structural estimation

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1. Introduction

In the face of a declining population in Japan, how to promote regional revitalization has become an important policy issue. The proposal by the Japan Policy Council (2014) released in May 2014 predicted the possible disappearance of municipalities in 2040 due to the excess outflow of population to the Tokyo metropolitan area and the low birthrate. To promote regional revitalization and overcome population decline, the Cabinet established the Headquarters for Overcoming Population Decline and Vitalizing Local Economy in Japan in September 2014, and the policies for regional revitalization have been currently taken over by the Council for the Realization of the Vision for a Digital Garden City Nation from November 2021.[1]

The national government has tackled the "correction of the monopolar concentration in Tokyo," which is the policy axis for regional revitalization. According to the Statistics Bureau of the Ministry of Internal Affairs and Communications (2019), the number of people that moved to Tokyo in 2018 was 79,844. The Tokyo metropolitan area, including Saitama, Chiba, and Kanagawa prefectures, continues to receive a large number of migrants. In line with the proposal of the Japan Policy Council (2014), the national government started a policy intervention in population movement between other regions and the Tokyo metropolitan area.

To achieve the goal of "correction of the monopolar concentration in Tokyo," policies are being implemented from the following two perspectives: (1) preventing the outflow of population from rural areas and (2) promoting the migration of people from Tokyo metropolitan area to rural areas. Specific measures for the former include the regulation of systems related to the movement of people, and those for the latter include subsidies to encourage people to settle down and migrate to rural areas. Regarding the former, it is believed that the outflow of young people from rural areas occurs when they enter university, and the government designated the 23 wards of Tokyo as a special area, and in February 2018, the Cabinet approved regulations to control the increase in university capacity in that area. Regarding the latter, as a measure to support entrepreneurship and employment in rural areas, a project to provide a subsidy of up to 3 million yen for start-up and migration support was started in April 2019 (2 million yen for start-up of social business and 1 million yen for urban-to-rural migration).

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[1] Although the Japanese government has implemented regional revitalization policies in the past, the major difference between the current and previous discussions is that the policy is being discussed from the perspective of the "declining population" of the country as a whole. The national government has set a long-term vision of securing a population of approximately 100 million by 2060 and has formulated policies to achieve this goal in its Comprehensive Strategy. Each local government is required to formulate a Population Vision and Comprehensive Strategy for Local Governments to clarify the current status of the population and the future population projection, and the local governments are in the process of implementing these policies.

This study aims to propose a framework for the ex ante evaluation of urban-to-rural migration subsidy program that began in the 2019 fiscal year. The importance of ex ante policy evaluation has been discussed by Wolpin (2007, 2013). The ex ante evaluation framework proposed in this study considers migration as an investment behavior and enables the calculation of the payback period of interregional migration. Figure 1 illustrates a conceptual framework of the cost-benefit analysis of interregional migration. The payback period is the point in time when the cumulative sum of the benefits accruing in each period after migration exceeds the migration costs, and the net benefits of migration for residents are positive after that point. The migration subsidy increases the incentive to migrate to rural areas by shortening the payback period. With an increasing interest in teleworking in rural areas after the outbreak of the coronavirus disease (COVID-19), this study aims to evaluate the potential effects of the migration subsidy policy when people move to rural areas, which have a low cost of living, while maintaining their income in Tokyo ("migration without job change").

[Figure 1]

In the analysis of migration decisions, it is important not only to look at nominal incomes but also consider how much the cost of living differs across regions. For the same nominal income, real income is higher in a region with a lower cost of living. Higher real income means that more goods and services can be consumed, which corresponds to a higher utility. The urban economics literature has revealed that nominal income and land and housing prices become higher as the city size increases (Combes and Gobillon, 2015; Combes et al., 2019). It has also been demonstrated that as the size of a city increases, the availability of a wider variety of goods increases, which in turn lowers the cost of living (Handbury and Weinstein, 2015). However, as discussed by Glaeser and Maré (2001), the notion that real income is always higher in large cities is not evident. While migration to a metropolitan area raises nominal income, real income declines if the cost of living rises more than nominal income. Conversely, if nominal income declines because of migration to a rural area but the decline in the cost of living is larger, real income will be higher, and people will have the incentive to migrate to the rural area. Therefore, when discussing the migration of people, it is necessary to discuss it from the perspective of regional differences in real income.

Another challenge in the analysis of migration decisions is how to estimate migration costs. Migration decisions cannot be discussed simply by comparing regional differences in real income because migration costs that arise from financial and nonfinancial factors also lead to a decrease in utility.[2] The financial factors

[2] This study is also related to the literature on the economics of switching costs (Klemperer, 1987, 1995; Farrell and Klemperer, 2007). For example, consumer face switching costs between sellers when they switch the services from firm A to firm B. Jones et al. (2002) provide six distinct dimensions of switching costs: lost performance costs, uncertainty cost, pre-switching search

of migration costs include direct costs of migration, such as moving costs, which generally increase as the migration distance increases. Nonfinancial factors include the presence or absence of home ownership, changing jobs, coping with cultural differences, building new social networks in the local community, and changes in the educational environment of children. The costs of migration vary greatly depending on household characteristics and life stage.

This study estimates migration costs with structural estimation. From the perspective of utility maximization, the choice of where people live is an optimal decision for each individual or household. The advantage of the structural estimation method is that migration costs can be estimated retrospectively from the actual migration behavior of people, including unobservable factors. In this study, we estimate migration costs using data on migration flows from the population census of Japan while considering differences in life stages. Rich information on migrants' characteristics, such as age, gender, marital status and education, can reveal heterogeneity in migration costs.

The structural estimation results reveal that migration costs differ significantly between individual and household attributes and by life stage. Unmarried college-educated males have the lowest migration costs. Migration costs tend to increase with age. Migration costs are higher for high school graduates than for university graduates. Migration costs are higher for married than for unmarried individuals, and they are even higher for households with children living with them. The differences in migration costs among individuals and households suggest that a uniformly determined migration subsidy may have different policy effects.

In the counterfactual simulations of migration subsidy policy, the potential effects under "migration without job change" are evaluated a priori. For example, if an unmarried, college-educated, employed male migrates to a rural area 500 km away from his home in Tokyo, where he can save 20% of his living costs, the period of residence required for a return on investment is 8.7 years. The estimated payback period is shortened by one year if a man receives a migration subsidy of 600,000 yen based on the current migration subsidy policy. An advantage of this framework is that it enables us to examine the potential policy effect of an arbitrary amount of migration subsidy. Although it may not be realized because of the government's budget constraint, if 5 million yen of migration subsidy is provided, the effect of shortening the period of residence

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and evaluation costs, post-switching behavioral and cognitive costs, setup costs, and sunk costs. The migration choice can be also viewed as a switching behavior of residence between regions. There are some empirical studies that aim to estimate switching costs based on a random utility model (e.g., Dubé et al., 2009; Nakamura, 2010; Honka, 2014). This study also takes the same approach to estimate interregional migration costs.

required for the return on investment is 8.3 years. Thus, the net benefits become positive immediately after migration, thereby providing a large incentive to promote migration. The effect can be verified for other attributes such as marital status. It is expected that policymakers would be able to evaluate the potential effect of the migration subsidy on the limited government budget by changing the amount of the subsidy in the proposed framework.

The rest of this paper is organized as follows. Section 2 describes interregional migration data in Japan. Section 3 formulates the decision-making process of interregional migration under utility maximization in the discrete choice model. Section 4 outlines a framework for the ex ante evaluation of the migration subsidy program and presents the counterfactual simulation results. Finally, concluding remarks are presented in Section 5.

2. Data

2.1. Municipality-Level Panel Data

This study uses intermunicipal migration flows, which are taken from the 1980, 1990, 2000, 2010, and 2015 population censuses of Japan. One of the problems in the municipal-level data is that municipal mergers took place during this period. The geographical change in the unit of observation during the period makes it difficult to compare the estimation results for different years, so it is necessary to unify the administrative districts of the municipalities from 1980 to 2015.[3]

In this study, we use the administrative districts of the municipalities as of October 1, 2015. The 23 wards of Tokyo are treated at the ward level. The panel data of the municipalities are compiled from 1980 to 2015 based on the municipality converter developed by Kondo (2019). Creating a municipal panel means that the geographical concordance among municipalities is aligned from 1980 to 2015.

As the number of municipalities was 1,741 as of October 1, 2015, all combinations of migration between municipalities are 3,029,340 ($= (1{,}741 \times 1{,}741) - 1{,}741$. The migration flows used in this analysis are those to the Tokyo metropolitan area. The number of bilateral flows between municipalities, excluding internal migration within the 23 wards of Tokyo, is 39,514 ($= (1{,}741 - 23) \times 23$).[4]

[3] As an exception, Kamikuisshiki Village in Yamanashi Prefecture was divided into two and merged into Kofu City and Fujikawaguchiko Town. For simplicity, Kamikuisshiki Village was merged into Kofu City in the dataset.

[4] In the 2000 Population Census, Miyake Village in Tokyo was missing because of the volcanic eruption, and in the 2015 Population Census, four towns in Fukushima Prefecture were missing due to the earthquake, but they are all treated as zero flows in this study.

2.2. Intermunicipal Migration Flows

This study uses migration flows by individual characteristics, which we compiled originally from the micro data of the 1980–2015 population censuses. The most important advantage of the population census is that it is designed to cover all residents in Japan, which is a crucial aspect for empirical analysis of intermunicipal migration flows, as zero flows also reveal insight into individuals' migration decisions. The population census is conducted every five years. A year whose first digit is 0 denoted an extended survey, and a year whose first digit is 5 denotes a simple survey. In principle, an extended migration survey of the population census is conducted every 10 years. However, as an exception, it was conducted in the 2015 Population Census to investigate the impact of the Great East Japan Earthquake.

Table 1 summarizes the classification of individual attributes in the aggregation of migration flows. Note that educational information is not available in the 2015 population census. The micro data are filtered based on gender, age, marital status, and education to construct intermunicipal migration flows. The reference points for measuring the distance between municipalities are the latitude and longitude of the local government offices of the former and present places of residence. The latitude and longitude of the municipal office are obtained from the GIS software MANDARA, but in some municipalities, the location information is obtained before the municipal merger. Migration distance is measured as the great circle distance from the longitude and latitude of the reference.[5]

Table 2 presents the descriptive statistics for migration flows and distances between all municipalities. The descriptive statistics are based on migration flows, excluding zero flow. First, the data reveal that 1985–1990 was characterized by a particular type of population movement between municipalities, implying that the period of the bubble economy was when many people traveled long distances. The total size of population migration has been gradually decreasing since then. However, the average distance of migration did not change significantly during the research period.

Tables 3 and 4 present the descriptive statistics of migration flows between all municipalities by gender. The difference between men and women is the total number of migrants. In 1980, more than twice as many men as women migrated between municipalities; in 2015, the number of men migrating between municipalities gradually decreased, while the number of women migrating between municipalities did not decrease significantly. The mean values of migration distance reveal that there was no significant change between 1980 and 2015 for both men and women.

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[5] The great-sphere distances were calculated based on Vincenty's formula, using Stata's geodist command (Picard, 2012).

Figure 2 depicts scatter plots of migration flows and distances among all municipalities by gender.[6] As the figure depicts, there is a negative relationship between the number of migrants and migration distance. However, unlike the commuting flows analyzed by Kondo (2020), the migration flows have a structure in which many people travel long distances. A comparison of men and women reveals that women are less likely to be long-distance migrants. These differences are revealed by the estimates of the distance elasticity parameter with the regression analysis of the gravity equation.

Figure 3 depicts a map of the 23 wards of Tokyo, where the black markers represent the locations of offices of the local governments. Our structural estimation distinguishes between the inflow to and outflow from the 23 wards of Tokyo. For comparison, we also estimate the distance decay parameters for migration between all the 1,741 municipalities in Japan (see the Online Appendix).

[Tables 1–4; Figures 2–3]

3. Structural Estimation of Interregional Migration

3.1. Gravity Equation of Migration Flow

In this section, we derive the gravity equation for interregional migration flows using a discrete choice model.[7] An individual residing in region i decides at some point in time to reside in destination j for T periods starting from the next period (time notation is omitted unless otherwise necessary). The utility of an individual who moves from region i to region j is defined as follows:

$$U_{ij} = V_{ij} + \varepsilon_{ij}, \qquad \forall\, i, j, \tag{1}$$

where U_{ij} is the total utility; V_{ij} is the deterministic utility; and ε_{ij} is the stochastic component in the utility that exhibits heterogeneous preferences for each individual. The deterministic utility V_{ij} is constructed using two factors. The relative value of real income between regions i and j and the migration costs κ_{ij} are

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[6] Scatter plots of other individual attributes are depicted in the Online Appendix.

[7] Tabuchi and Thisse (2002) and Murata (2003, 2007) discussed the mechanism of migration decisions and agglomeration among regions by introducing stochastic amenity preferences in the framework of new economic geography. Empirical analyses based on stochastic utility have also been conducted. For example, Nakajima and Tabuchi (2011) indicated that the utility gap between prefectures narrowed through population movements in the 1970s by using migration data based on the Basic Resident Registers between prefectures in Japan. Kondo and Okubo (2015) estimated real wages in the manufacturing industry by prefecture based on the theoretical framework of new economic geography and found that net migration is higher in prefectures with higher real wages. Ramos (2016) summarized previous studies on the gravity equation in migration.

as follows:

$$V_{ij} = \log\left(\frac{\sum_{t=1}^{T} \omega_{jt}}{\sum_{t=1}^{T} \omega_{it}}\right) - \log(\kappa_{ij}), \tag{2}$$

where the real income ω is defined as the ratio of nominal income I and the cost of living P, and κ_{ij} represents migration costs. The first term on the right-hand side expresses the relative value of the sum of real incomes obtained in each region in each period as the deterministic utility component. For simplicity, assuming that an individual expects that real income in each region at the time of the decision to migrate will remain the same for the next T periods, it can be expressed as follows:

$$\frac{\sum_{t=1}^{T} \omega_{jt}}{\sum_{t=1}^{T} \omega_{it}} = \frac{T\omega_{jt}}{T\omega_{it}} = \frac{\omega_j}{\omega_i}. \tag{3}$$

Individuals make a migration choice in each period and incur migration costs κ_{ij} only when they migrate. In this study, we formulate the migration costs from region i to j (κ_{ij}) as follows:

$$\kappa_{ij} = D_{ij}^{\delta}, \tag{4}$$

where D_{ij} is the migration distance, and δ is the distance decay parameter. Migration costs are simply formulated as the monotonic function of migration distance. The option of staying in the same region i (i.e., $j = i$) means $D_{ii}^{\delta} = 1$ and then $V_{ii} = 0$.

Summarizing the above discussion, we derive the deterministic utility V_{ij} of an individual living in region i migrating to region j as follows:

$$V_{ij} = \log\left(\frac{\omega_j}{\omega_i}\right) - \delta \log(D_{ij}). \tag{5}$$

In this study, we focus on the fact that the distance elasticity parameter δ contains heterogeneous factors of individual preferences for migration distance. If δ differs across individuals, it means that individuals have different utility levels even when migrating the same distance. The heterogeneity of the distance decay parameter δ in preferences can be discussed from two perspectives—first, the direct monetary cost factor arising from migration and, second, the indirect monetary cost factor arising under a given social structure and family environment. The first is the migration costs arising from direct payments and is common to all individuals, while the second is the migration costs that are not directly observable and is heterogeneous across individuals. For example, when comparing single and married individuals, the indirect cost of migration is larger for married individuals because their decision to migrate depends on their spouse and children. Thus, if married individuals' indirect migration costs differ significantly among them, the value of the distance decay parameter will also differ correspondingly.

An empirical problem of estimating the distance decay parameter is that the utility is directly unobservable. We use a structural estimation approach to estimate the distance decay parameter δ in the utility. First, we describe a model of migration behavior using a discrete choice model that treats stochastic utility. In general, the gravity equation for migration flows between regions can be derived by assuming a probability distribution for the amenity factor ε_{ij} in the utility. Type I extreme value distribution (Gumbel distribution) is assumed for the probability distributions of the amenity factor (e.g., Crozet, 2004; Kondo and Okubo, 2015).[8]

The probability density function $g(\varepsilon, \beta)$ and cumulative distribution function $G(\varepsilon, \beta)$ of the Gumbel distribution are expressed as follows:

$$g(\varepsilon, \beta) = \frac{1}{\beta} \exp\left[-\frac{\varepsilon}{\beta} - \exp\left(-\frac{\varepsilon}{\beta}\right)\right] \quad \text{and} \quad G(\varepsilon, \beta) = \exp\left[-\exp\left(-\frac{\varepsilon}{\beta}\right)\right], \tag{6}$$

where $\beta > 0$ is a scale parameter, indicating that the larger the value, the larger the variance of the amenity.[9] Here, the share of amenities in the total stochastic utility is high, so the relative importance of deterministic utility becomes smaller.

If an individual moves from region i to j, among all alternatives, the utility is highest in region j, and the following inequality holds:

$$V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}, \qquad i, k = 1, 2, \ldots, N, \qquad j \neq k. \tag{7}$$

Given the assumption that the stochastic amenity component ε_{ij} in the utility follows a Gumbel distribution, we can derive the probability π_{ij} of migrating from region i to j as follows:

$$\pi_{ij} = \int_{-\infty}^{\infty} \prod_{k \neq j}^{N} G\left(\varepsilon_{ik} < \varepsilon_{ij} + V_{ij} - V_{ik}\right) g\left(\varepsilon_{ij}\right) \mathrm{d}\varepsilon_{ij}, \tag{8}$$

where we perfume a marginalization of the random variable ε_{ij}. Solving this, we express the probability of migration from region i to j as follows:

[8] Models in which stochastic amenities are introduced additively, as in this study, are called additive random utility models. Ahlfeldt et al. (2015), Redding and Rossi-Hansberg (2017), Monte et al. (2018), Heblich et al. (2020), Owens et al. (2020), and Kondo (2020) derived the gravity equation for commuting flows using type II extreme value distribution (Fréchet distribution) to derive the gravity equation for commuting flows. Eaton and Kortum (2002) derived the gravity equation of trade flows from the profit maximization of firms, assuming the Fréchet distribution. The essential results do not change regardless of the extreme value distribution that is assumed, and both distributions correspond to each other by variable transformation.

[9] The location parameter is assumed to be zero.

$$\pi_{ij} = \frac{\exp\left(V_{ij}/\beta\right)}{\sum_{k=1}^{N}\exp\left(V_{ik}/\beta\right)}. \tag{9}$$

Furthermore, by substituting the deterministic utility equation (5), we obtain the following equation:

$$\pi_{ij} = \frac{\omega_j^{1/\beta} D_{ij}^{-\delta/\beta}}{\sum_{k=1}^{N}\omega_k^{1/\beta} D_{ik}^{-\delta/\beta}}. \tag{10}$$

The real income of region i is offset in this equation. This equation means that (i) the higher the real income ω_j of the destination region, the higher the probability of migration to region j; (ii) the higher the real income outside region j, the lower the probability of migration to region j; and (iii) the longer the migration distance D_{ij}, the lower the probability of migration to region j. Although the migration probability of an individual cannot be observed directly, as an aggregate value, the migration flow m_{ij} can be observed. Thus, the condition under which the observed migration flows equal the expected migration flows can be expressed as follows:

$$m_{ij} = \pi_{ij} \times L_i, \tag{11}$$

where L_i denotes the population living in region i. Taking logarithms on both sides, the gravity equation for the migration flows can be expressed as follows:

$$\log m_{ij} = -\frac{\delta}{\beta}\log D_{ij} + \varphi_i + \psi_j, \tag{12}$$

where

$$\varphi_i = \log L_i - \log\left(\sum_{k=1}^{N}\omega_k^{1/\beta} D_{ik}^{-\delta/\beta}\right) \text{ and } \psi_j = \frac{1}{\beta}\log\omega_j. \tag{13}$$

The important point in the gravity equation of the migration flows is that the distance decay parameter δ in the utility can be estimated from the aggregate observed migration flows m_{ij}. The gravity equation above, δ and β, cannot be separately distinguished and are estimated as a single parameter. Therefore, we estimate δ by exogenously providing the scale parameter β of the Gumbel distribution.

3.2. Estimation Method of the Distance Decay Parameter

In this section, we describe a method for estimating the gravity equation of migration flows. The method of empirical analysis of the gravity equation has been greatly developed in the field of international trade theory, and this study uses the method of estimating the gravity equation by Poisson regression proposed by Silva and Tenreyro (2006). As we are interested in estimating the distance decay parameter, we introduce fixed effects of previous and current residence into the Poisson regression. Finally, the Poisson regression model in this study is as follows:

$$\Pr\left(M_{ij} = m_{ij}\right) = \frac{\exp\left(-\lambda_{ij}(\boldsymbol{\theta})\right)\left(\lambda_{ij}(\boldsymbol{\theta})\right)^{m_{ij}}}{m_{ij}!}, \qquad m_{ij} = 0,1,2,\ldots,$$
$$\lambda_{ij}(\boldsymbol{\theta}) \equiv \exp\left(-\nu \log D_{ij} + \varphi_i + \psi_j\right), \tag{14}$$

where $\boldsymbol{\theta}$ is the parameter vector; φ_i is the fixed effect of municipality i; and ψ_j is the fixed effect of municipality j. The individual parameters of the distance elasticity ν cannot be estimated, so they are estimated from the gravity equation as a single parameter $\nu = \delta/\beta$. When we perform counterfactual simulations, we obtain the distance elasticity parameter δ from $\hat{\delta} = \hat{\nu}\beta$ with an arbitrary value for the scale parameter β of the Gumbel distribution.

3.3. Estimation Results of the Distance Decay Parameter

Figure 4 depicts the estimated distance elasticity parameters using data on outflows from and inflows into the 23 wards of Tokyo. Figures 4(a) and 4(b) depict the results for males and females, respectively. For both men and women, the estimated distance elasticity tends to be larger for outflows than inflows, suggesting that the cost of migration is higher for migrants who return to their original area after an inflow to the 23 wards of Tokyo. The estimated distance elasticity is higher for females than males. The time-series results reveal a gradual downward trend in the estimated values for both men and women.

Figures 5 and 6 depict the estimation results for men and women by individual attributes. Regarding the asymmetry between inflows and outflows, in many cases, the distance elasticities estimated from the inflows to the 23 wards of Tokyo are lower than those estimated from the outflows from the 23 wards of Tokyo. However, the asymmetry is not observed for single men and women with a university degree.

Panels (a)–(d) in Figures 5 and 6 depict that the estimated distance elasticity increases with age. The estimated values tend to be higher for those aged 60 and above, suggesting that migration is very expensive for those aged 60 and above.

Panels (e)–(h) of Figures 5 and 6 depict that the estimated distance elasticity is higher for married persons than for single persons, and the estimated distance elasticity is higher for households with elementary and junior high school students than for infants. In particular, we find that migration costs are larger for women with children of elementary and junior high school age for outflows from the 23 wards of Tokyo than for inflows to the 23 wards of Tokyo.

Panels (i)–(l) of Figures 5 and 6 depict that unmarried college graduates tend to be mobile. As mentioned earlier, there is no difference in the estimated distance elasticity between outflows and inflows for both male and female unmarried university graduates, suggesting that migration costs from the 23 wards of Tokyo to a rural area are at the same level as those to the 23 wards of Tokyo from a rural area. The estimated distance elasticity is larger for high school graduates, indicating that migration costs tend to be higher for high school graduates than for university graduates. The asymmetry between outflows and inflows is also larger.

[Figures 4–6]

4. Ex Ante Evaluation of Urban-to-Rural Migration Subsidy

4.1. Costs and Benefits of Migration

The framework of the ex ante evaluation of migration policy proposed in this study is to consider migration as an investment behavior and calculate the payback period of interregional migration. The potential policy effects are then evaluated in terms of how much the payback period can be shortened by the migration subsidy.

The following is a brief overview of the migration subsidy program (Cabinet Office, 2022). The migration subsidy is limited to residents of the 23 wards of Tokyo or commuters to the 23 wards of Tokyo (there are also some conditions regarding the period of residence). The subsidy is eligible for those who move to prefectures outside the Tokyo metropolitan area (in this case, Saitama, Chiba, Tokyo, and Kanagawa prefectures) or those who move to municipalities in disadvantaged areas of the Tokyo metropolitan area. As of October 2022, the amount of migration subsidy was 600,000 yen for a single person and 1 million yen for a household (additional 300,000 yen for each household member under 18 years of age). Migration to rural areas through teleworking became eligible from the 2021 fiscal year after the outbreak of COVID-19. In addition, the maximum amount of subsidy for those who start-up a social business instead of employment is 2 million yen.

In the counterfactual simulations, we consider a case where an individual living in the 23 wards of Tokyo decides to move to region j (we do not consider the stochastic component ε_{ij}). The migration subsidy obtained by moving to region j is defined as S_j (unit: nominal income).

As the residence period $\bar{T}$, which is the payback period, cannot be obtained in the relative form, we derive it from the difference in utility. The migration decision is conditional on the migration benefits being greater than the migration costs. First, the real migration benefit (RMB) (unit: real income), that is, the cumulative sum of the benefits that accrue every period after migration can be expressed as follows:

$$\mathrm{RMB} = T\left(\omega_j - \omega_{\mathrm{Tokyo}}\right) + \frac{S_j}{P_j}, \tag{15}$$

where the first term on the right-hand side is the cumulative sum of the differential benefits accruing in each period during the residence period T, and the second term on the right-hand side is the benefit from the lump-sum migration subsidy (the units of RMB are measured in terms of real income at destination region j). Next, the real migration cost (RMC) (unit: real income) is expressed as follows:

$$\mathrm{RMC} = \left(D^{\delta}_{\mathrm{Tokyo},j} - D^{\delta}_{\mathrm{Tokyo,Tokyo}}\right)\omega_{\mathrm{Tokyo}}, \tag{16}$$

The right-hand side has real income in the 23 wards of Tokyo, ω_{Tokyo}, because the unit of migration cost is converted from relative real income to real income units in migration destination j. We also assume that $D^{\delta}_{\mathrm{Tokyo,Tokyo}} = 1$ for staying in Tokyo. In the counterfactual simulations, we use the parameter estimates $\hat{\nu}$ in 2005–2010. If the scale parameter of the Gumbel distribution is $\beta = 1/6$, we obtain a distance decay parameter $\hat{\delta} = \hat{\nu}\beta$.

The residence period required to recover the investment $\bar{T}$ is defined as the point in time when $\mathrm{RMB} = \mathrm{RMC}$. Solving this condition in terms of T, we obtain the residence period required to recover investment $\bar{T}$ as follows:

$$\bar{T} = \frac{D^{\delta}_{\mathrm{Tokyo},j} - 1}{\omega_j/\omega_{\mathrm{Tokyo}} - 1} - \frac{\left(S_j/I_{\mathrm{Tokyo}}\right)\left(P_j/P_{\mathrm{Tokyo}}\right)^{-1}}{\omega_j/\omega_{\mathrm{Tokyo}} - 1}, \tag{17}$$

where the first term on the right-hand side indicates how long it takes to repay the migration costs with the benefits derived in each period. The second term on the right-hand side indicates how much the migration subsidy can shorten the residence period required for investment payback.

The decision to migrate is based on a comparison of the number of years that a household intends to live in the destination region and the residence period required for payback $\bar{T}$. The migration decision can be made if the period of residence is longer than the period of residence required for the return on investment. If the time required for the net benefits of migration to be realized is too long, a migration decision is not made.

For migration costs, if $\delta = 0$, the migration cost is zero. Thus, a small regional difference in real incomes will lead to an instantaneous migration decision. However, in reality, the distance decay parameter ($\delta > 0$) is positive, so the residence period for payback $\bar{T}$ is also positive. As the regional difference in real income becomes large, the period of residence required for investment payback becomes shorter.

Although the migration benefits and costs are expressed in real income units, they can also be expressed in nominal income units by multiplying both sides by the cost of living (P_j) at destination j. The nominal migration benefits NMB can be expressed as follows:

$$\mathrm{NMB} = T\left(I_j - I_{\mathrm{Tokyo}}\frac{P_j}{P_{\mathrm{Tokyo}}}\right) + S_j. \tag{18}$$

Similarly, the nominal migration costs NMC can be expressed as follows:

$$\mathrm{NMC} = \left(D^{\delta}_{\mathrm{Tokyo},j} - D^{\delta}_{\mathrm{Tokyo},\mathrm{Tokyo}}\right)I_{\mathrm{Tokyo}}\frac{P_j}{P_{\mathrm{Tokyo}}}. \tag{19}$$

With the variables of nominal income I_{Tokyo} in the 23 wards of Tokyo, nominal income I_j in the destination location j, relative cost of living P_j/P_{Tokyo}, and migration distance $D_{\mathrm{Tokyo},j}$, we can conduct a counterfactual policy evaluation of the effect of the migration subsidy S_j.

4.2. Ex Ante Evaluation of Potential Impact of Migration Subsidy

Tables 5 and 6 present the potential effects of the migration subsidy for males, while Tables 7 and 8 present them for women based on numerical simulations in the case of "migration without job change." As this is "migration without job change," nominal income before and after the migration is assumed to be equal. In the relative real income condition, it is assumed that when an individual moves to a rural area, the cost of living is 20% lower than that in the 23 wards of Tokyo. Here, the relative real income is 1.25 (= 1/0.8). To calculate the migration cost, the migration distance is set as 50 km, 100 km, and 500 km in the simulation.

To account for differences in the distance decay parameter δ in the counterfactual simulations, we set up scenarios for men or women, unmarried or married, and high school or college graduates in Tables 5–8. It is assumed that the annual income of unmarried high school graduates in the Tokyo metropolitan area is 2.4 million yen; that of married high school graduates is 4 million yen; that of unmarried university graduates is 3 million; and that of married university graduates is 5 million.

We first discuss the potential effect of the migration subsidy on men based on Figure 7, which visually depicts the effect of the migration subsidy for Columns (3) and (7) of Tables 5 and 6. Unmarried college graduates' duration of residence required for a return on investment is the shortest, which is 8.7 years. The shortest residence period required for a return on investment is 8.7 years for unmarried college-educated males. Next, the average duration of marriage was 14.1 years for married college graduates, 22.3 years for unmarried high school graduates, and 31.3 years for married high school graduates. The potential effect of the migration subsidy policy is to shorten the period of residence required to settle down by about one year.

The effect of migration subsidy on women is discussed based on Figure 8, which visually depicts the simulation results of Columns (3) and (7) of Tables 7 and 8. The shortest residence period required for a return on investment is 11.1 years for unmarried college-educated women. Next, the time required for a return on investment is 12.8 years for married college graduates, 22.8 years for unmarried high school graduates, and

26.6 years for married high school graduates. The migration subsidy is 600,000 yen for a single person and 1 million yen for a household. For men, the potential effect of the policy is to shorten the residence period required to recover the investment by about one year.

In Columns (4) and (8) of Tables 5–8, we assume that the migration subsidy for men and women is 5 million yen, and the results are depicted in Figures 9 and 10, respectively. The potential effect of migration subsidy is large for unmarried college graduates because the residence period required for the return on investment is less than one year. However, for married men and women with a university degree, the shortening effect of migration subsidy is 5 years. The results reveal that the migration costs are large for married high school graduates. Even if 5 million yen is provided as a migration subsidy, the residence period required for a return on investment is more than 20 years.

In Columns (1) and (2) of Tables 5–8, the migration distances are changed to 50 km and 100 km, respectively, implying that migration from the 23 wards of Tokyo to the suburbs is considered. The residence period required for a return on investment is more than half shorter than that in the case of a 500 km migration. The results suggest that the possibility of “migration without job change” does not necessarily promote migration to distant regions as was the case with an increase in the number of people moving to the suburbs of the Tokyo metropolitan area after the outbreak of COVID-19.

In summary, although the impact of the current amount of the migration subsidy is limited, unmarried college graduates are most likely to respond to the migration subsidy policy because their migration costs are relatively small. For married households, although the impact of the migration subsidy is small, the possibility that suburban areas within 100 km of the 23 wards of Tokyo will be selected as a migration destination increases when teleworking becomes possible at the place of employment.

[Tables 5–8; Figures 7–10]

5. Conclusion

This study proposes a simple framework for the ex ante evaluation of migration subsidy policies. We consider interregional migration as an investment behavior and formulate a model in which the lump-sum migration costs incurred at the time of migration are repaid over a period with the benefits that accrue in each period after migration. As the migration costs of each individual cannot be directly observed as data, this study constructs a theoretical model of individuals’ migration decisions and estimates migration costs using structural estimation based on interregional migration flows that are observed.

With an increasing interest in teleworking in rural areas after the outbreak of COVID-19, this study evaluates the potential effect of the migration subsidy policy when the “migration without job change” becomes possible. The results reveal that unmarried men with a university degree have the lowest migration costs and the shortest residence period required for a return on investment. Similarly, unmarried women with a university degree have the second shortest residence period required for a return on investment. The current amount of the migration subsidy has a limited effect of shortening the period of residence required for a return on investment by only one year.

The key policy implication for promoting migration to rural areas is whether real income can be increased in each period before and after migration. The conventional requirement for receiving a migration subsidy was to change jobs at local small and medium-sized companies, but it was uncertain whether real income can be maintained or not. The results reveal that if it becomes possible for people to choose a region with a low cost of living while maintaining nominal income, as in the case of “migration without changing jobs” through telework, which was added as a requirement in 2021, it may promote migration to rural areas even without migration subsidy. However, it is found that the suburbs of the Tokyo area were more likely to be chosen, although they are not eligible for the migration subsidy. The results suggest that the migration subsidy may need to be set up in a way that makes migration to rural areas outside the Tokyo metropolitan area more attractive than migration to suburban areas in the Tokyo metropolitan area.

There are limitations of this study. Migration flows in a society where “migration without job change” is a reality have not yet been observed, and it is necessary to consider the possibility that the values of the distance decay parameter may differ from past values after the implementation of such a policy. In addition, although we simply assumed that migration costs depend only on migration distance, other factors such as the linkage of public transport networks and migration back to the place of origin should be included in the gravity equation. Although this study focuses on the potential impact of migration subsidy on individual migration decisions, whether the promotion of urban-to-rural migration by investing in the migration subsidy increases welfare in Japan as a whole should be examined in a general equilibrium framework. These are the remaining issues to be addressed in the future.

References

Ahlfeldt, Gabriel M., Stephen J. Redding, Daniel M. Sturm, and Nikolaus Wolf (2015) “The economics of density: Evidence from the Berlin Wall,” *Econometrica*, 83(6), pp. 2127–2189. DOI: https://doi.org/10.3982/ECTA10876

Cabinet Office (2022) “Migration Subsidy,” Portal Site for Regional Revitalization. https://www.chisou.go.jp/sousei/ijyu_shienkin.html (accessed on December 1, 2022)

Combes, Pierre-Philippe and Laurent Gobillon (2015) "The empirics of agglomeration economies," in Duranton, Gilles, J. Vernon Henderson, and William C. Strange eds. *Handbook of Regional and Urban Economics*, Vol. 5, Amsterdam: Elsevier, Chap. 5, pp. 247–348.
DOI: https://doi.org/10.1016/B978-0-444-59517-1.00005-2

Combes, Pierre-Philippe, Gilles Duranton, and Laurent Gobillon (2019) "The costs of agglomeration: House and land prices in French cities," *Review of Economic Studies*, 86(4), pp. 1556–1589.
DOI: https://doi.org/10.1093/restud/rdy063

Crozet, Matthieu (2004) "Do migrants follow market potentials? An estimation of a new economic geography model," *Journal of Economic Geography*, 4(4), pp. 439–458.
DOI: https://doi.org/10.1093/jnlecg/lbh029

Dubé, Jean-Pierre, Günter J. Hitsch, and Peter E. Rossi (2009) "Do switching costs make markets less competitive?," *Journal of Marketing Research*, 46(4), pp. 435-445.
DOI: https://doi.org/10.1509/jmkr.46.4.435

Eaton, Jonathan and Samuel Kortum (2002) "Technology, geography, and trade," *Econometrica*, 70(5), pp. 1741–1779. DOI: https://doi.org/10.1111/1468-0262.00352

Farrell, Joseph and Paul Klemperer (2007) "Coordination and lock-in: Competition with switching costs and network effects," in Armstrong, Mark and Robert Porter eds. *Handbook of Industrial Organization*, Vol. 3, Amsterdam: Elsevier, Chap. 31, pp. 1967–2072. DOI: https://doi.org/10.1016/S1573-448X(06)03031-7

Glaeser, Edward L. and David C. Maré (2001) "Cities and skills," *Journal of Labor Economics*, 19(2), pp. 316–342. DOI: https://doi.org/10.1086/319563

Handbury, Jessie and David E. Weinstein (2015) "Goods prices and availability in cities," *Review of Economic Studies*, 82(1), pp. 258–296. DOI: https://doi.org/10.1093/restud/rdu033

Heblich, Stephan, Stephen J. Redding, and Daniel M. Sturm (2020) "The making of the modern metropolis: Evidence from London." *Quarterly Journal of Economics*, 135(4), pp. 2059–2133.
DOI: https://doi.org/10.1093/qje/qjaa014

Honka, Elisabeth (2014) "Quantifying search and switching costs in the US auto insurance industry," *RAND Journal of Economics*, 45(4), pp. 847-884. DOI: https://doi.org/10.1111/1756-2171.12073

Japan Policy Council (2014) "Proposal: Stop a decline in the number of children and regional revitalization strategy," May 8, 2014.
http://www.policycouncil.jp/pdf/prop03/prop03.pdf (accessed on February 18, 2019)

Jones, Michael A., David L. Mothersbaugh, and Sharon E. Beatty (2002) "Why customers stay: measuring the underlying dimensions of services switching costs and managing their differential strategic outcomes," *Journal of Business Research*, 55(6), pp. 441–450. DOI: https://doi.org/10.1016/S0148-2963(00)00168-5

Klemperer, Paul (1987) “Markets with consumer switching costs,” *Quarterly Journal of Economics*, 102(2), pp. 375–394. DOI: https://doi.org/10.2307/1885068

Klemperer, Paul (1995) “Competition when consumers have switching costs: An overview with applications to industrial organization, macroeconomics, and international trade,” *Review of Economic Studies*, 62(4), pp. 515–539. DOI: https://doi.org/10.2307/2298075

Kondo, Keisuke (2019) “Municipality-level panel data and municipal mergers in Japan,” RIETI Technical Paper No. 19-T-001.

Kondo, Keisuke (2020) “A structural estimation of the disutility of commuting,” RIETI Discussion Paper No. 20-E-031.

Kondo, Keisuke and Toshihiro Okubo (2015) “Interregional labour migration and real wage disparities: Evidence from Japan,” *Papers in Regional Science*, 94(1), pp. 67–87. DOI: https://doi.org/10.1111/pirs.12055

Monte, Ferdinando, Stephen J. Redding, and Esteban Rossi-Hansberg (2018) “Commuting, migration, and local employment elasticities,” *American Economic Review*, 108(12), pp. 3855–3890. DOI: https://doi.org/10.1257/aer.20151507

Murata, Yasusada (2003) “Product diversity, taste heterogeneity, and geographic distribution of economic activities: Market vs. non-market interactions,” *Journal of Urban Economics*, 53(1), pp. 126–144. DOI: https://doi.org/10.1016/S0094-1190(02)00507-7

Murata, Yasusada (2007) “Taste heterogeneity and the scale of production: Fragmentation, unification, and segmentation,” *Journal of Urban Economics*, 62(1), pp. 135–160. DOI: https://doi.org/10.1016/j.jue.2006.11.005

Nakajima, Kentaro and Takatoshi Tabuchi (2011) “Estimating interregional utility differentials,” *Journal of Regional Science*, 51(1), pp. 31–46. DOI: https://doi.org/10.1111/j.1467-9787.2010.00698.x

Nakamura, Akihiro, (2010) “Estimating switching costs involved in changing mobile phone carriers in Japan: Evaluation of lock-in factors related to Japan’s SIM card locks,” Telecommunications Policy, 34(11), pp. 736–746. https://doi.org/10.1016/j.telpol.2010.10.003

Owens, Raymond III, Esteban Rossi-Hansberg, and Pierre-Daniel Sarte (2020) “Rethinking Detroit,” *American Economic Journal: Economic Policy*, 12 (2), pp. 258-305. DOI: https://doi.org/10.1257/pol.20180651

Picard, Robert (2012) “GEODIST: Stata module to compute geodetic distances.” Statistical Software Components S457147, Boston College Department of Economics.

Ramos, Raul (2016) “Gravity models: A tool for migration analysis,” IZA World of Labor 239.

Redding, Stephen J. and Esteban Rossi-Hansberg (2017) “Quantitative spatial economics,” *Annual Review of Economics*, 9, pp. 21–58. DOI: https://doi.org/10.1146/annurev-economics-063016-103713

Silva, J. M. C. Santos and Silvana Tenreyro (2006) “The log of gravity,” *Review of Economics and Statistics*, 88(4), pp. 641–658. DOI: https://doi.org/10.1162/rest.88.4.641

Statistics Bureau of Ministry of Internal Affairs and Communications (2019), “Annual report on internal migration in Japan derived from the basic resident registration: 2018 Results,” January 2019. https://www.stat.go.jp/data/idou/2018np/kihon/pdf/gaiyou.pdf (accessed on February 18, 2019).

Tabuchi, Takatoshi and Jacques-François Thisse (2002) “Taste heterogeneity, labor mobility and economic geography,” *Journal of Development Economics*, 69(1), pp. 155–177. DOI: https://doi.org/10.1016/S0304-3878(02)00057-3

Wolpin, I. Kenneth (2007) “Ex ante policy evaluation, structural estimation and model selection,” *American Economic Review*, 97(2), pp. 48-52. DOI: https://doi.org/10.1257/aer.97.2.48

Wolpin, I. Kenneth (2013) *The Limits of Inference without Theory*, Cambridge, MA: MIT Press.

Table 1 Classification of Migrants' Characteristics

Type	Content of Classification
All	Full samle
Gender	Male
	Female
Age	Male: (i) Age 15–29, (ii) Age 30–44, (iii) Age 45–59, (iv) Age 60 and above
	Female: (i) Age 15–29, (ii) Age 30–44, (iii) Age 45–59, (iv) Age 60 and above
Marriage	Male: (i) Single, (ii) Married without children, (iii) Married with children (age 0–5), (iv) Married with children (age 6–15)
	Female: (i) Single, (ii) Married without children, (iii) Married with children (age 0–5), (iv) Married with children (age 6–15)
Education	Male: (i) Single high-school graduates, (ii) Married high-school graduates, (iii) Single university graduates, (iv) Married university graduates
	Female: (i) Single high-school graduates, (ii) Married high-school graduates, (iii) Single university graduates, (iv) Married university graduates

Note: Migration was surveyed in in 1980, 1990, 2000, 2010, and 2015 Population Censuses. Educational information is not available in 2015 Population Censuses.

Table 2 Descriptive Statistics of Full Sample

Variable		1980	1990	2000	2010	2015
Migration flows	Average	16.393	15.480	15.976	14.074	13.647
(Unit: Persons)	S.D.	139.239	116.497	125.758	102.689	97.259
	1 Percentile	1	1	1	1	1
	10 Percentile	1	1	1	1	1
	25 Percentile	1	1	1	1	1
	50 Percentile	2	2	2	2	2
	75 Percentile	6	6	6	5	5
	90 Percentile	19	19	19	17	17
	99 Percentile	258	240	253	228	226
	Total Migrants	8,258,626	8,457,805	8,624,937	7,082,409	6,693,052
Migration distance	Average	371.941	388.015	375.901	372.778	373.836
(Unit: km)	S.D.	341.888	352.951	350.255	354.964	357.068
	1 Percentile	10	11	11	11	10
	10 Percentile	45	48	47	45	44
	25 Percentile	103	109	106	101	101
	50 Percentile	263	276	263	257	258
	75 Percentile	552	574	549	543	544
	90 Percentile	875	892	883	883	884
	99 Percentile	1,527	1,547	1,546	1,555	1,560
Inter-municipal Flows	Non-zero Flows	503,791	546,359	539,873	503,235	490,435
	All Flows	3,029,340	3,029,340	3,029,340	3,029,340	3,029,340
	Share of Non-Zero Flows (%)	16.63	18.04	17.82	16.61	16.19

Note: Descriptive statistics are calculated without zero flows. Descriptive statistics of commuting flows and distance are aggregated at the municipality level as of October 1, 2015. Inter-municipal distance is based on the centroid of each municipality.

Table 3 Descriptive Statistics of Male Sample

Variable		1980	1990	2000	2010	2015
Migration Flows (Unit: Persons)	Average	12.976	12.059	12.256	10.549	10.051
	S.D.	104.475	84.424	87.872	69.191	63.692
	1 Percentile	1	1	1	1	1
	10 Percentile	1	1	1	1	1
	25 Percentile	1	1	1	1	1
	50 Percentile	2	2	2	2	2
	75 Percentile	5	5	5	4	4
	90 Percentile	16	16	16	14	13
	99 Percentile	202	183	191	166	161
	Total Migrants	5,741,290	5,885,126	5,782,945	4,564,186	4,208,893
Migration Distance (Unit: km)	Average	363.426	382.689	367.238	361.943	363.399
	S.D.	339.044	352.219	346.335	347.798	351.085
	1 Percentile	10	10	10	10	10
	10 Percentile	42	45	44	42	41
	25 Percentile	98	105	100	96	95
	50 Percentile	255	271	256	248	249
	75 Percentile	540	567	537	528	528
	90 Percentile	868	888	875	872	874
	99 Percentile	1,522	1,546	1,541	1,544	1,552
Inter-municipal Flows	Non-zero Flows	442,448	488,038	471,852	432,669	418,744
	All Flows	3,031,081	3,031,081	3,031,081	3,031,081	3,031,081
	Share of Non-Zero Flows (%)	14.60	16.10	15.57	14.27	13.82

Note: Descriptive statistics are calculated without zero flows. Descriptive statistics of commuting flows and distance are aggregated at the municipality level as of October 1, 2015. Inter-municipal distance is based on the centroid of each municipality.

Table 4 Descriptive Statistics of Female Sample

Variable		1980	1990	2000	2010	2015
Migration Flows (Unit: Persons)	Average	8.728	8.556	9.249	8.649	8.597
	S.D.	55.815	50.434	58.553	51.112	50.414
	1 Percentile	1	1	1	1	1
	10 Percentile	1	1	1	1	1
	25 Percentile	1	1	1	1	1
	50 Percentile	1	2	1	1	1
	75 Percentile	4	4	4	4	4
	90 Percentile	11	12	12	11	11
	99 Percentile	140	133	150	142	142
	Total Migrants	2,517,336	2,572,679	2,841,992	2,518,223	2,484,159
Migration Distance (Unit: km)	Average	329.191	337.274	327.200	329.553	332.003
	S.D.	327.697	335.682	336.998	349.102	350.487
	1 Percentile	8	8	8	8	8
	10 Percentile	32	34	33	32	32
	25 Percentile	76	79	77	74	74
	50 Percentile	212	219	205	202	204
	75 Percentile	502	510	473	470	476
	90 Percentile	829	846	840	850	855
	99 Percentile	1,498	1,528	1,533	1,552	1,554
Inter-municipal Flows	Non-zero Flows	288,417	300,700	307,274	291,172	288,942
	All Flows	3,031,081	3,031,081	3,031,081	3,031,081	3,031,081
	Share of Non-Zero Flows (%)	9.52	9.92	10.14	9.61	9.53

Note: Descriptive statistics are calculated without zero flows. Descriptive statistics of commuting flows and distance are aggregated at the municipality level as of October 1, 2015. Inter-municipal distance is based on the centroid of each municipality.

Table 5 Ex Ante Evaluation of Migration Subsidy for Males with High School Degree and Below

区分	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Single				Married			
Counterfactual Simulation Settings								
Annual Nominal Income in Tokyo (Unit: 10,000 Yen): I_{Tokyo}	240	240	240	240	400	400	400	400
Migration Subsidy (Unit: 10,000 Yen): $S_{\text{Tokyo},j}$	60	60	60	500	100	100	100	500
Migration Costs (Unit: Relative Real Income): $D^{\hat{\delta}}_{\text{Tokyo},j}$	3.271	4.035	6.571	6.571	3.937	5.019	8.82	8.82
Migration Distance (Unit: km): $D_{\text{Tokyo},j}$	50 km	100 km	500 km	500 km	50 km	100 km	500 km	500 km
Distance Decay Parameter: $\hat{\delta}(=\hat{\nu}\beta)$	0.303	0.303	0.303	0.303	0.35	0.35	0.35	0.35
Relative Real Income: $\omega_j/\omega_{\text{Tokyo}}$	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Relative Nominal Income: I_j/I_{Tokyo}	1	1	1	1	1	1	1	1
Relative Cost of Living: P_j/P_{Tokyo}	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Counterfactual Simulation Results								
Payout Period without Migration Subsidy (Unit: Years)	9.1	12.1	22.3	22.3	11.7	16.1	31.3	31.3
Payout Period with Migration Subsidy (Unit: Number of Years)	7.8	10.9	21.0	11.9	10.5	14.8	30.0	25.0
Policy Effect of Migration Subsidy (Unit: Number of Years)	1.3	1.3	1.3	10.4	1.3	1.3	1.3	6.3
Nominal Migration Benefits in Each Year (Unit: 10,000 Yen)	48.0	48.0	48.0	48.0	80.0	80.0	80.0	80.0
Nominal Migration Costs (Unit: 10,000 Yen)	436	583	1070	1070	940	1286	2502	2502

Note: Author's calculation based on the estimated distance decay parameters in 2010.

Table 6 Ex Ante Evaluation of Migration Subsidy for Males with University Degree and Above

区分	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Single				Married			
Counterfactual Simulation Settings								
Annual Nominal Income in Tokyo (Unit: 10,000 Yen): I_{Tokyo}	300	300	300	300	500	500	500	500
Migration Subsidy (Unit: 10,000 Yen): $S_{\text{Tokyo},j}$	60	60	60	500	100	100	100	500
Migration Costs (Unit: Relative Real Income): $D^{\hat{\delta}}_{\text{Tokyo},j}$	2.069	2.354	3.175	3.175	2.587	3.061	4.526	4.526
Migration Distance (Unit: km): $D_{\text{Tokyo},j}$	50 km	100 km	500 km	500 km	50 km	100 km	500 km	500 km
Distance Decay Parameter: $\hat{\delta}(=\hat{\nu}\beta)$	0.186	0.186	0.186	0.186	0.243	0.243	0.243	0.243
Relative Real Income: $\omega_j/\omega_{\text{Tokyo}}$	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Relative Nominal Income: I_j/I_{Tokyo}	1	1	1	1	1	1	1	1
Relative Cost of Living: P_j/P_{Tokyo}	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Counterfactual Simulation Results								
Payout Period without Migration Subsidy (Unit: Years)	4.3	5.4	8.7	8.7	6.3	8.2	14.1	14.1
Payout Period with Migration Subsidy (Unit: Number of Years)	3.3	4.4	7.7	0.4	5.3	7.2	13.1	9.1
Policy Effect of Migration Subsidy (Unit: Number of Years)	1.0	1.0	1.0	8.3	1.0	1.0	1.0	5.0
Nominal Migration Benefits in Each Year (Unit: 10,000 Yen)	60.0	60.0	60.0	60.0	100.0	100.0	100.0	100.0
Nominal Migration Costs (Unit: 10,000 Yen)	257	325	522	522	635	825	1410	1410

Note: Author's calculation based on the estimated distance decay parameters in 2010.

Table 7 Ex Ante Evaluation of Migration Subsidy for Females with High School Degree and Below

区分	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Single				Married			
Counterfactual Simulation Settings								
Annual Nominal Income in Tokyo (Unit: 10,000 Yen): I_{Tokyo}	240	240	240	240	400	400	400	400
Migration Subsidy (Unit: 10,000 Yen): $S_{\text{Tokyo},j}$	60	60	60	500	100	100	100	500
Migration Costs (Unit: Relative Real Income): $D^{\hat{\delta}}_{\text{Tokyo},j}$	3.313	4.097	6.706	6.706	3.603	4.521	7.661	7.661
Migration Distance (Unit: km): $D_{\text{Tokyo},j}$	50 km	100 km	500 km	500 km	50 km	100 km	500 km	500 km
Distance Decay Parameter: $\hat{\delta}(=\hat{\nu}\beta)$	0.306	0.306	0.306	0.306	0.328	0.328	0.328	0.328
Relative Real Income: $\omega_j/\omega_{\text{Tokyo}}$	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Relative Nominal Income: I_j/I_{Tokyo}	1	1	1	1	1	1	1	1
Relative Cost of Living: P_j/P_{Tokyo}	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Counterfactual Simulation Results								
Payout Period without Migration Subsidy (Unit: Years)	9.3	12.4	22.8	22.8	10.4	14.1	26.6	26.6
Payout Period with Migration Subsidy (Unit: Number of Years)	8.0	11.1	21.6	12.4	9.2	12.8	25.4	20.4
Policy Effect of Migration Subsidy (Unit: Number of Years)	1.3	1.3	1.3	10.4	1.3	1.3	1.3	6.3
Nominal Migration Benefits in Each Year (Unit: 10,000 Yen)	48.0	48.0	48.0	48.0	80.0	80.0	80.0	80.0
Nominal Migration Costs (Unit: 10,000 Yen)	444	595	1096	1096	833	1127	2132	2132

Note: Author's calculation based on the estimated distance decay parameters in 2010.

Table 8 Ex Ante Evaluation of Migration Subsidy for Females with University Degree and Above

区分	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Single				Married			
Counterfactual Simulation Settings								
Annual Nominal Income in Tokyo (Unit: 10,000 Yen): I_{Tokyo}	300	300	300	300	500	500	500	500
Migration Subsidy (Unit: 10,000 Yen): $S_{\text{Tokyo},j}$	60	60	60	500	100	100	100	500
Migration Costs (Unit: Relative Real Income): $D^{\hat{\delta}}_{\text{Tokyo},j}$	2.307	2.675	3.772	3.772	2.467	2.894	4.196	4.196
Migration Distance (Unit: km): $D_{\text{Tokyo},j}$	50 km	100 km	500 km	500 km	50 km	100 km	500 km	500 km
Distance Decay Parameter: $\hat{\delta}(=\hat{\nu}\beta)$	0.214	0.214	0.214	0.214	0.231	0.231	0.231	0.231
Relative Real Income: $\omega_j/\omega_{\text{Tokyo}}$	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Relative Nominal Income: I_j/I_{Tokyo}	1	1	1	1	1	1	1	1
Relative Cost of Living: P_j/P_{Tokyo}	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Counterfactual Simulation Results								
Payout Period without Migration Subsidy (Unit: Years)	5.2	6.7	11.1	11.1	5.9	7.6	12.8	12.8
Payout Period with Migration Subsidy (Unit: Number of Years)	4.2	5.7	10.1	2.8	4.9	6.6	11.8	7.8
Policy Effect of Migration Subsidy (Unit: Number of Years)	1.0	1.0	1.0	8.3	1.0	1.0	1.0	5.0
Nominal Migration Benefits in Each Year (Unit: 10,000 Yen)	60.0	60.0	60.0	60.0	100.0	100.0	100.0	100.0
Nominal Migration Costs (Unit: 10,000 Yen)	314	402	665	665	587	758	1279	1279

Note: Author's calculation based on the estimated distance decay parameters in 2010.

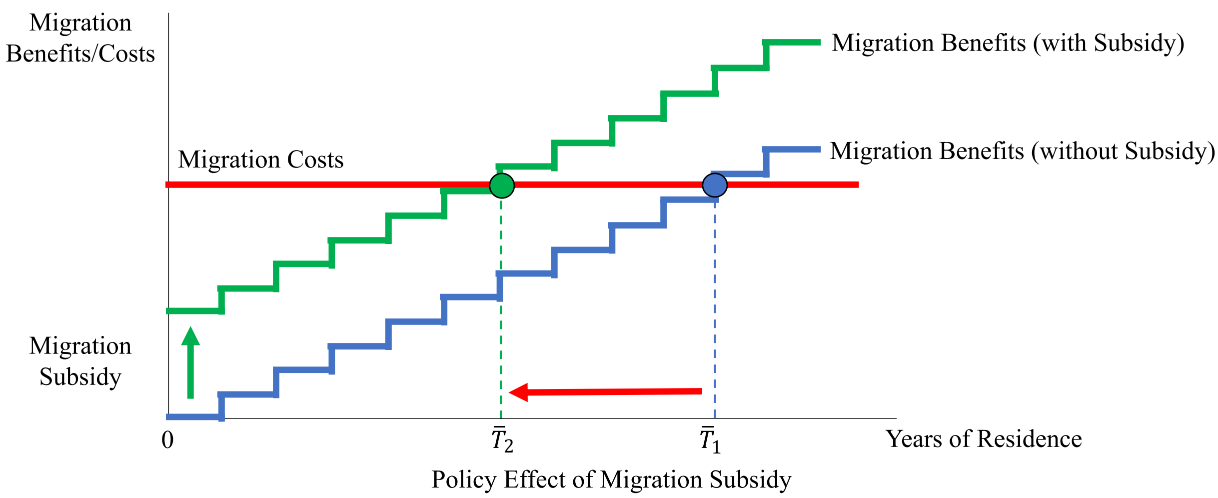
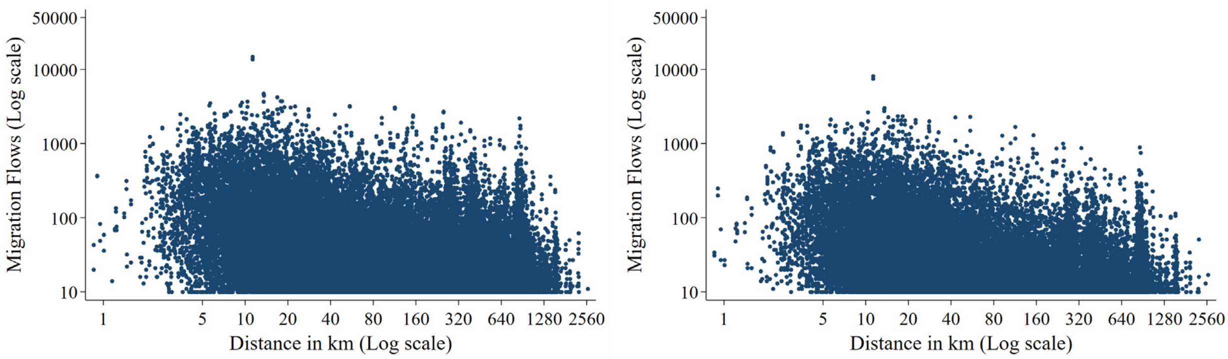


Figure 1 Payback Period of Interregional Migration and Policy Effect of Migration Subsidy

Note: Author's creation. Red solid line represents migration costs. Blue solid line represents migration benefits without migration subsidy. Green sold line represents migration benefits with migration subsidy. The point at the intersection of migration benefits and costs $\bar{T}$ represents the payback period of interregional migration.



(a) Male **(b)** Female

Figure 2 Migration Flow and Distance of All Inter-municipal Migration Flows in 2005-2010

Note: Author's creation based on 2010 Population Census (MIC). Migration flows less than 10 persons are not shown.

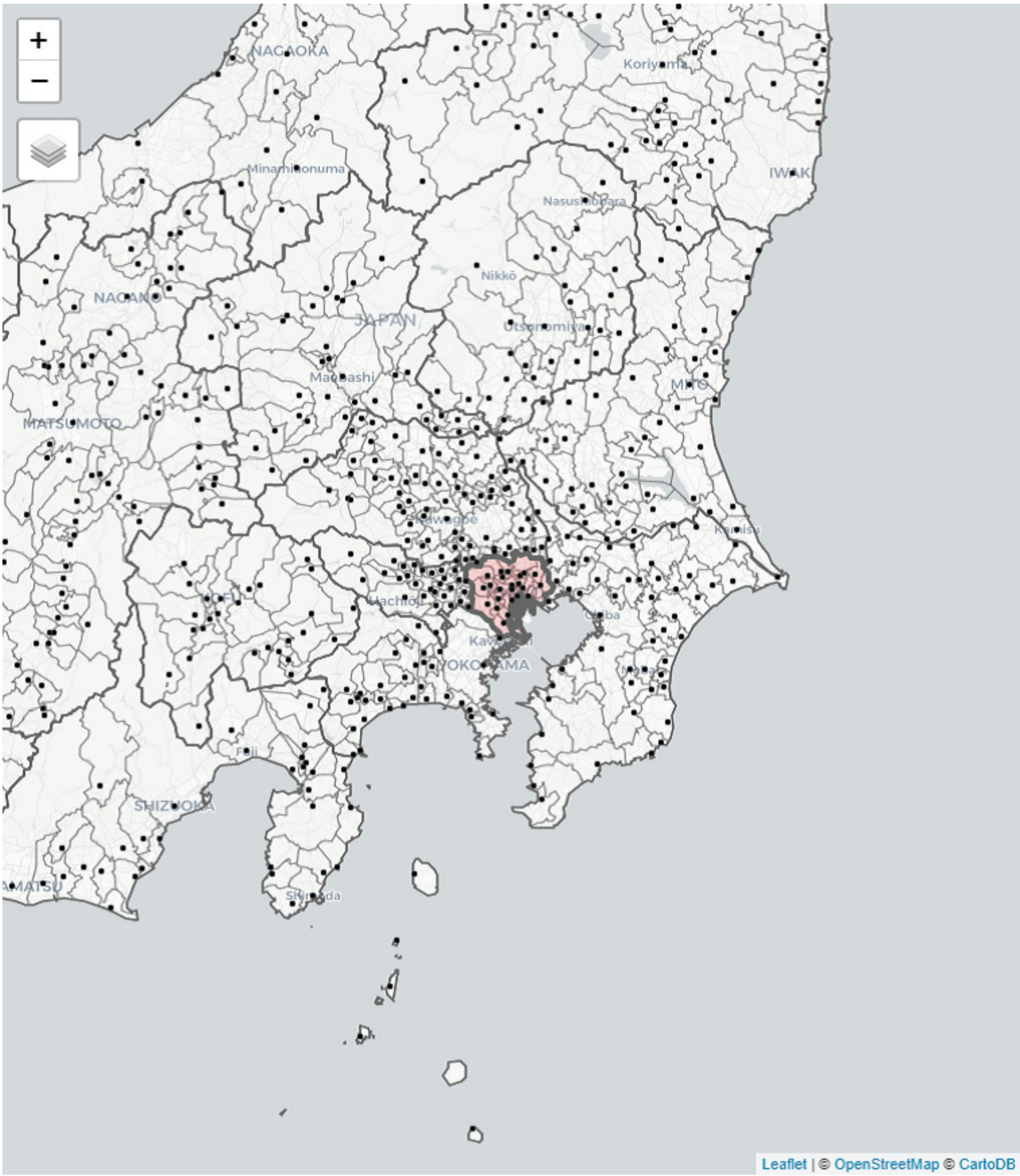
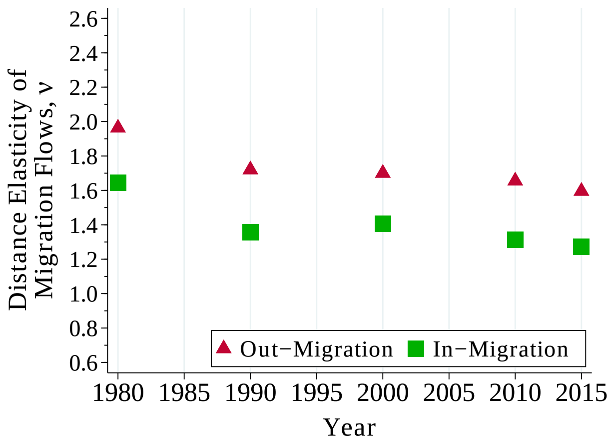
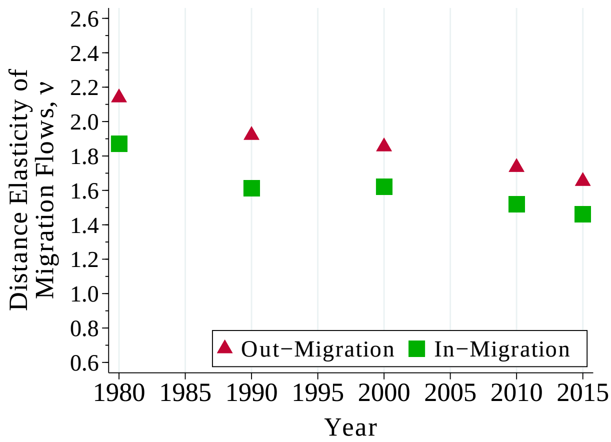


Figure 3 Tokyo's 23 Special Wards and Geographic Information of Inter-municipal Distance Calculation

Note: Author's creation. Black marker on the map represents the location of local government office, which is the base point of inter-municipal distance calculation.



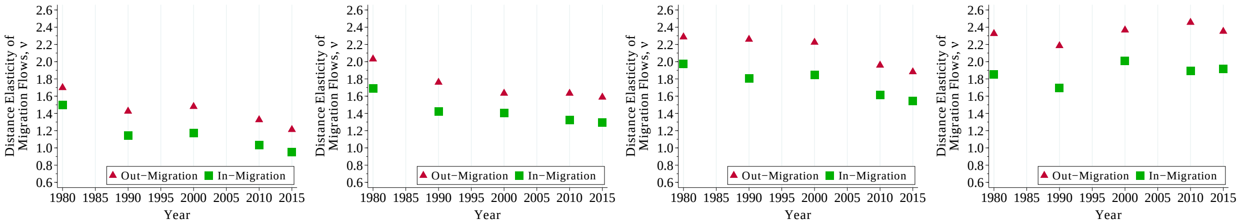
(a) Male



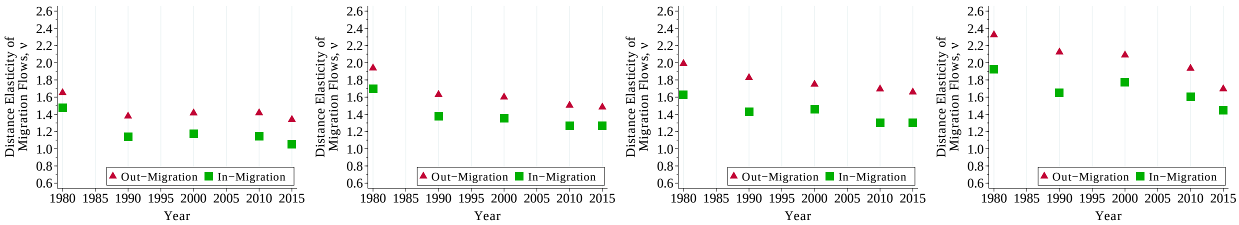
(b) Female

Figure 4 Estimated Distance Elasticity of Migration Flows

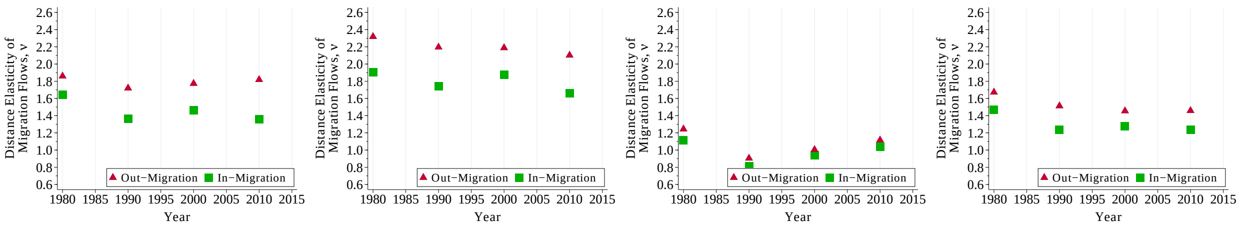
Note: The distance elasticity of migration flows represents the coefficient of inter-municipal distance in the gravity equation. Migration survey of Population Census was not conducted in 1985, 1995 and 2005.



(a) Age 15–29 **(b)** Age 30–44 **(c)** Age 45–59 **(d)** Age 60 and Over



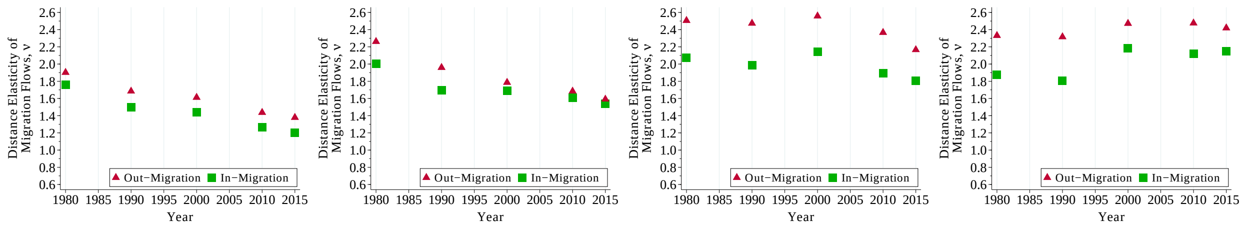
(e) Single **(f)** Married without Children **(g)** Married with Children Age 0–5 **(h)** Married with Children Age 6–15



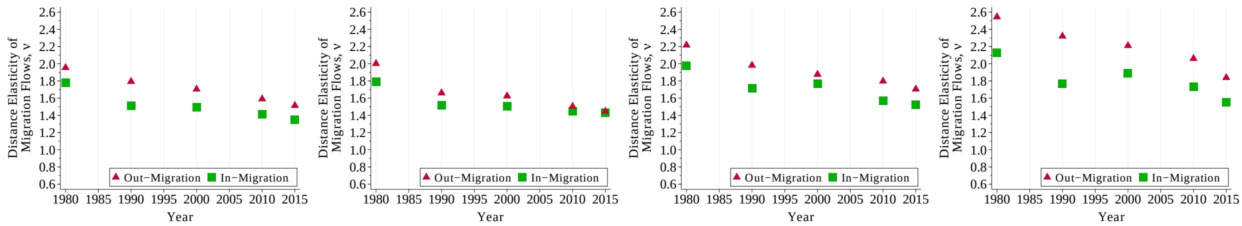
(i) Single with High School Degree and Below **(j)** Married with High School Degree and Below **(k)** Single with University Degree and Above **(l)** Married with University Degree and Above

Figure 5 Estimated Distance Elasticity of Migration Flows for Males

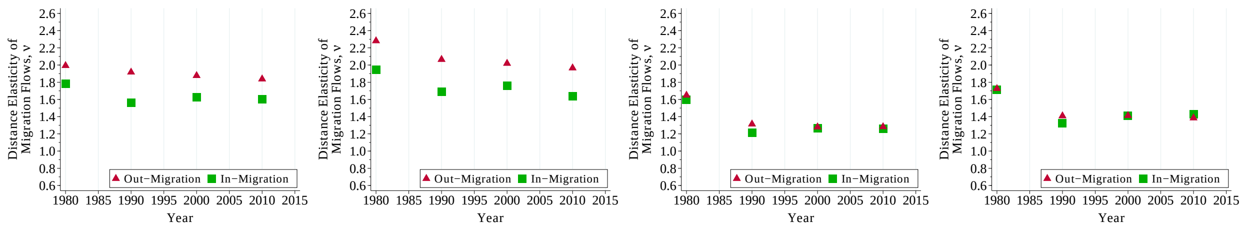
Note: The distance elasticity of migration flows represents the coefficient of inter-municipal distance in the gravity equation. Migration survey of Population Census was not conducted in 1985, 1995 and 2005. Education survey of Population Census was not conducted in 1985, 1995, 2005, and 2015.



(a) Age 15–29 **(b)** Age 30–44 **(c)** Age 45–59 **(d)** Age 60 and Over



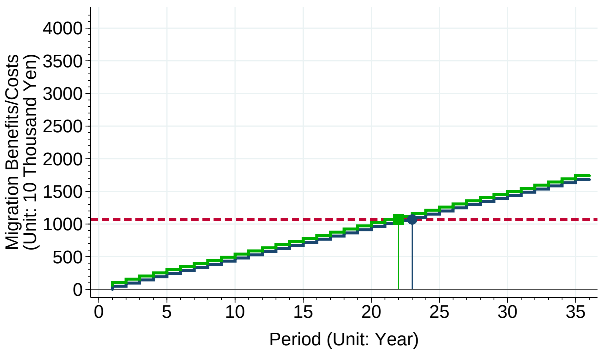
(e) Single **(f)** Married without Children **(g)** Married with Children Age 0–5 **(h)** Married with Children Age 6–15



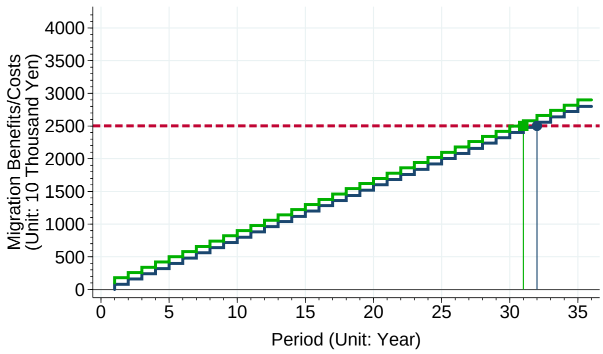
(i) Single with High School Degree and Below **(j)** Married with High School Degree and Below **(k)** Single with University Degree and Above **(l)** Single with University Degree and Above

Figure 6 Estimated Distance Elasticity of Migration Flows for Females

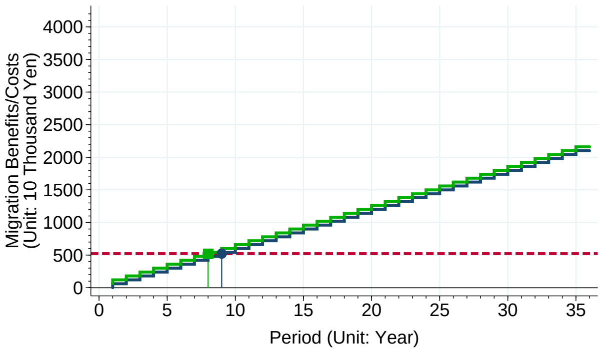
Note: The distance elasticity of migration flows represents the coefficient of inter-municipal distance in the gravity equation. Migration survey of Population Census was not conducted in 1985, 1995 and 2005. Education survey of Population Census was not conducted in 1985, 1995, 2005, and 2015.



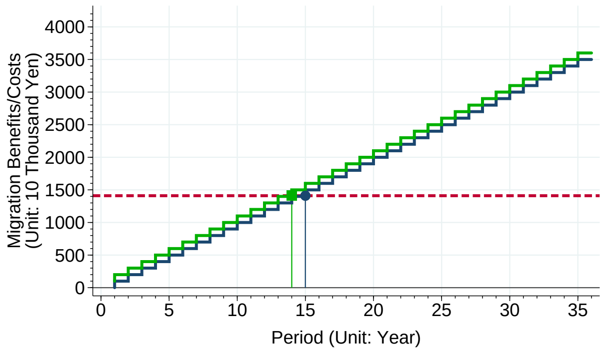
(a) Single Male with High School Degree and Below



(b) Married Male with High School Degree and Below



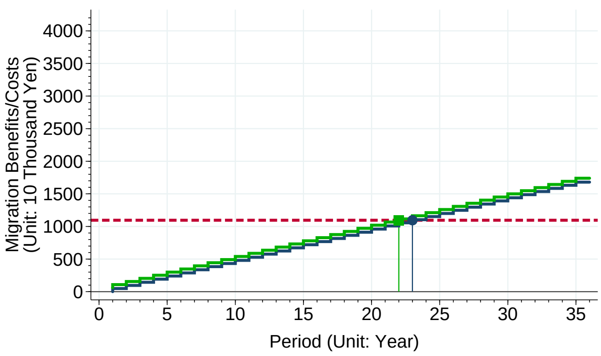
(c) Single Male with University Degree and Above



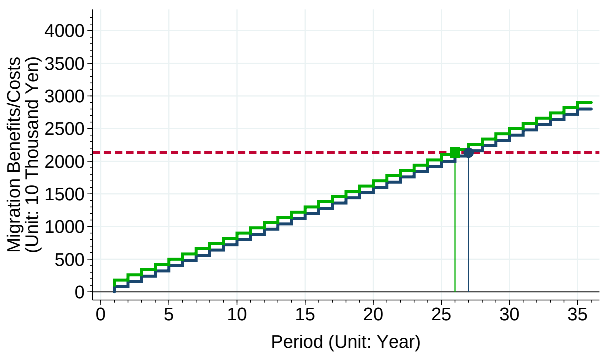
(d) Married Male with University Degree and Above

Figure 7 Ex Ante Evaluation of Current Migration Subsidy for Males

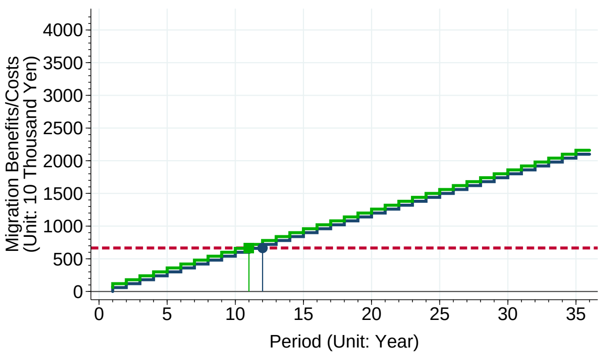
Note: Author's creation based on Columns (3) and (7) of Tables 5 and 6. Red dotted line represents migration costs. Blue solid line represents migration benefits without migration subsidy. Green sold line represents migration benefits with migration subsidy. The point at the intersection of migration benefits and costs represents the payback period of interregional migration.



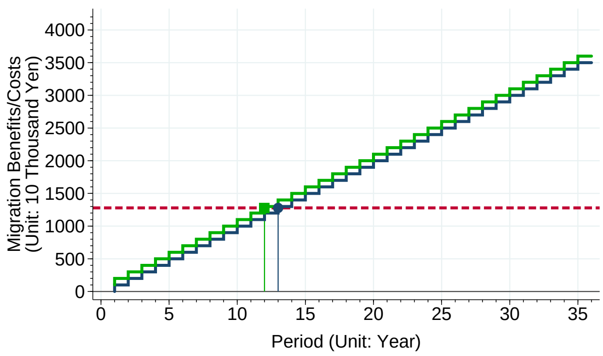
(a) Single Female with High School Degree and Below



(b) Married Female with High School Degree and Below



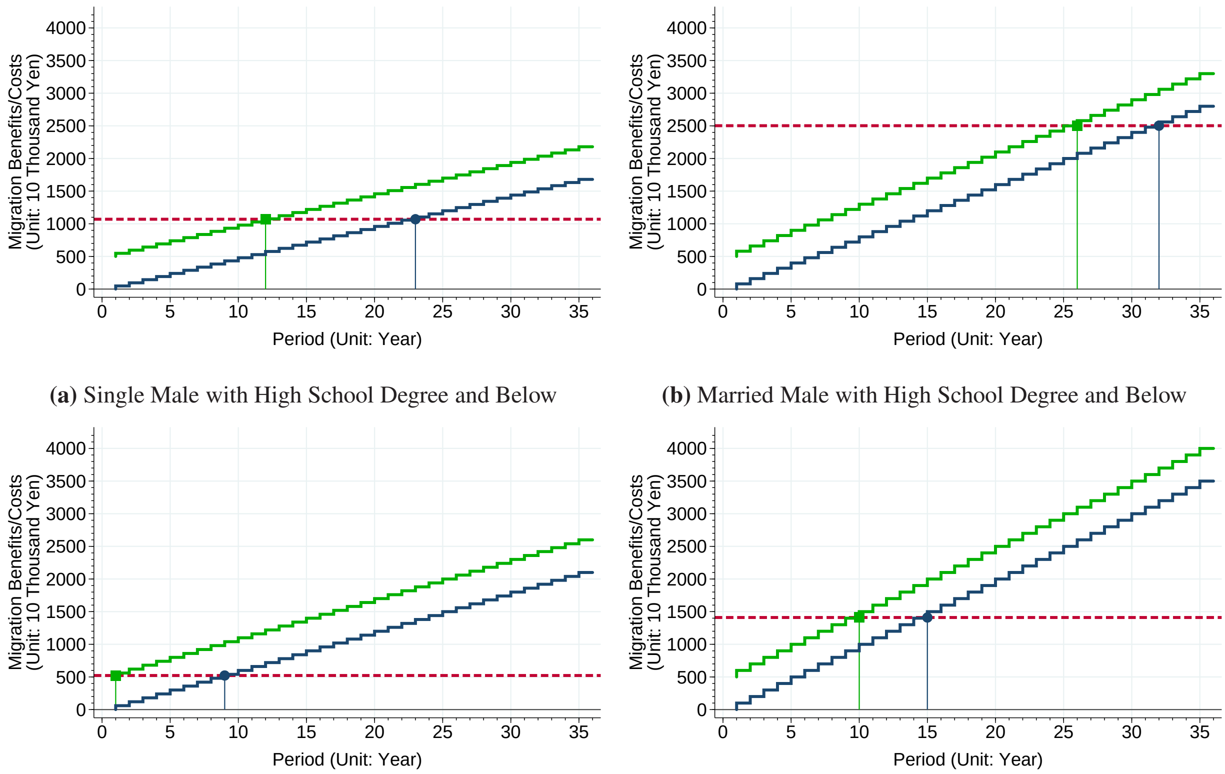
(c) Single Female with University Degree and Above



(d) Married Female with University Degree and Above

Figure 8 Ex Ante Evaluation of Current Migration Subsidy for Females

Note: Author's creation based on Columns (3) and (7) of Tables 7 and 8. Red dotted line represents migration costs. Blue solid line represents migration benefits without migration subsidy. Green sold line represents migration benefits with migration subsidy. The point at the intersection of migration benefits and costs represents the payback period of interregional migration.



(a) Single Male with High School Degree and Below

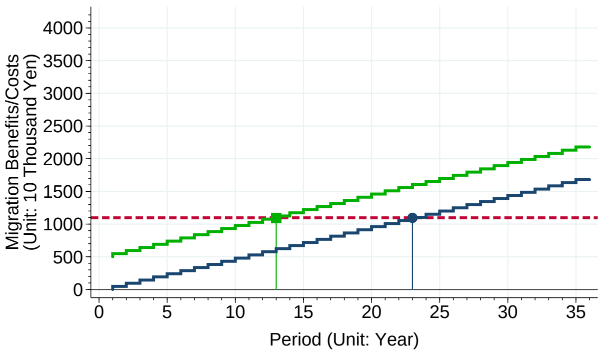
(b) Married Male with High School Degree and Below

(c) Single Male with University Degree and Above

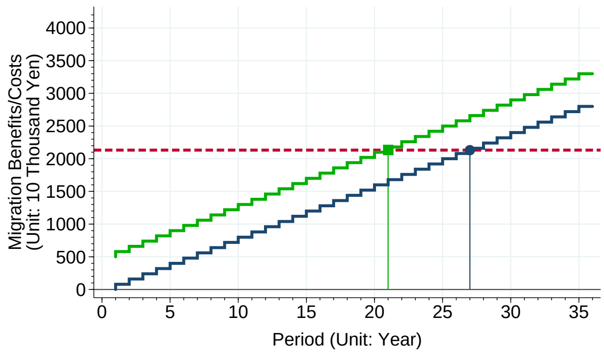
(d) Married Male with University Degree and Above

Figure 9 Ex Ante Evaluation of 5 Million Yen Migration Subsidy for Males

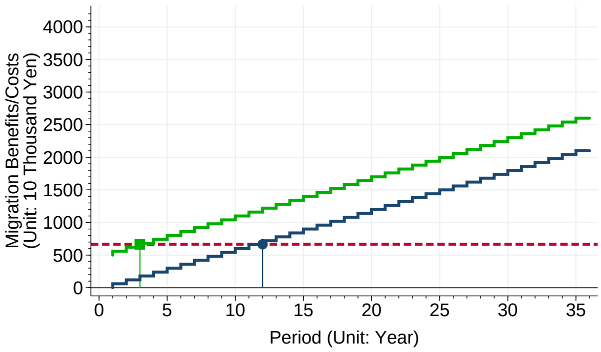
Note: Author's creation based on Columns (4) and (8) of Tables 5 and 6. Red dotted line represents migration costs. Blue solid line represents migration benefits without migration subsidy. Green sold line represents migration benefits with migration subsidy. The point at the intersection of migration benefits and costs represents the payback period of interregional migration.



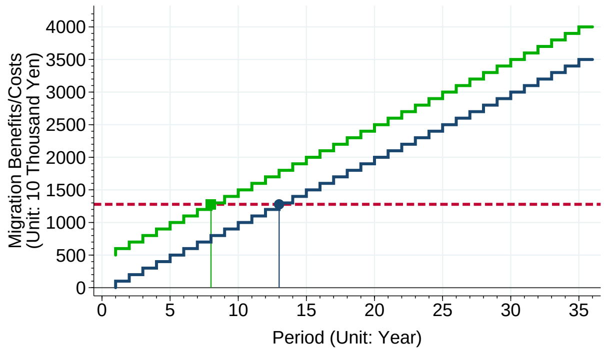
(a) Single Female with High School Degree and Below



(b) Married Female with High School Degree and Below



(c) Single Female with University Degree and Above



(d) Married Female with University Degree and Above

Figure 10 Ex Ante Evaluation of 5 Million Yen Migration Subsidy for Females

Note: Author's creation based on Columns (4) and (8) of Tables 7 and 8. Red dotted line represents migration costs. Blue solid line represents migration benefits without migration subsidy. Green sold line represents migration benefits with migration subsidy. The point at the intersection of migration benefits and costs represents the payback period of interregional migration.

Online Appendix

Ex Ante Evaluation of Migration Subsidy: Evidence from Japan

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Contents

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Online Appendix A.

Estimation Results of Distance Elasticity of Gravity Equation from Migration Flows Between 23 Wards of Tokyo and Other Municipalities

Tables A.1–A.4 present the estimation results of distance elasticity of gravity equation from the migration flows with respect to 23 wards of Tokyo.

[Tables A.1–A.4]

Table A.1 Poisson Regression Results of Density Elasticity of Gravity Equation from Migration Flows for 23 Wards of Tokyo by Gender

	Dependent Variable: Migration Flows into/out of 23 Wards of Tokyo		
	All	Male	Female
Year	(1)	(2)	(3)
	Migration out of 23 Wards of Tokyo		
1980	2.010	1.963	2.139
	(0.0046)	(0.0054)	(0.0089)
1985			
1990	1.778	1.720	1.921
	(0.0048)	(0.0057)	(0.0088)
1995			
2000	1.750	1.700	1.854
	(0.0052)	(0.0064)	(0.0091)
2005			
2010	1.682	1.655	1.734
	(0.0058)	(0.0073)	(0.0097)
2015	1.616	1.595	1.653
	(0.0060)	(0.0077)	(0.0098)
	Migration into 23 Wards of Tokyo		
1980	1.719	1.645	1.870
	(0.0062)	(0.0076)	(0.0109)
1985			
1990	1.443	1.358	1.613
	(0.0065)	(0.0080)	(0.0112)
1995			
2000	1.484	1.405	1.622
	(0.0056)	(0.0071)	(0.0092)
2005			
2010	1.396	1.314	1.520
	(0.0063)	(0.0082)	(0.0099)
2015	1.351	1.271	1.461
	(0.0062)	(0.0082)	(0.0096)

Note: Standard errors are in the parentheses. Origin and destination fixed effects are included in Poisson regressions. The number of municipalities is 1,741 as of October 1, 2015. The number of observations is 39,514 (= $1,718 \times 23$). Migration information is not surveyed in 1985, 1995, and 2005 Population Census. Educational information is not surveyed in 1985, 1995, 2005, and 2015 Population Census.

Table A.2 Poisson Regression Results of Density Elasticity of Gravity Equation from Migration Flows for 23 Wards of Tokyo by Age Group

	Dependent Variable: Migration Flows across Municipalities							
	Male				Female			
	Age 15–29	Age 30–44	Age 45–59	Age ≥ 60	Age 15–29	Age 30–44	Age 45–59	Age ≥ 60
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Migration out of 23 Wards of Tokyo							
1980	1.699	2.031	2.287	2.326	1.902	2.261	2.506	2.331
	(0.0093)	(0.0075)	(0.0155)	(0.0359)	(0.0133)	(0.0142)	(0.0240)	(0.0606)
1985								
1990	1.425	1.760	2.259	2.184	1.684	1.959	2.473	2.316
	(0.0096)	(0.0081)	(0.0165)	(0.0329)	(0.0131)	(0.0147)	(0.0234)	(0.0526)
1995								
2000	1.479	1.633	2.224	2.367	1.612	1.786	2.558	2.472
	(0.0118)	(0.0089)	(0.0170)	(0.0369)	(0.0144)	(0.0142)	(0.0244)	(0.0540)
2005								
2010	1.326	1.633	1.959	2.455	1.437	1.684	2.367	2.476
	(0.0162)	(0.0094)	(0.0200)	(0.0349)	(0.0181)	(0.0132)	(0.0285)	(0.0475)
2015	1.212	1.588	1.882	2.351	1.379	1.591	2.166	2.419
	(0.0175)	(0.0099)	(0.0199)	(0.0359)	(0.0191)	(0.0131)	(0.0265)	(0.0485)
	Migration into 23 Wards of Tokyo							
1980	1.499	1.693	1.976	1.852	1.761	2.004	2.074	1.877
	(0.0116)	(0.0112)	(0.0244)	(0.0609)	(0.0147)	(0.0192)	(0.0352)	(0.0843)
1985								
1990	1.142	1.423	1.805	1.693	1.495	1.693	1.989	1.806
	(0.0126)	(0.0121)	(0.0233)	(0.0556)	(0.0151)	(0.0198)	(0.0347)	(0.0805)
1995								
2000	1.171	1.402	1.846	2.011	1.439	1.688	2.141	2.183
	(0.0126)	(0.0099)	(0.0193)	(0.0451)	(0.0136)	(0.0146)	(0.0289)	(0.0653)
2005								
2010	1.033	1.324	1.614	1.892	1.264	1.606	1.896	2.121
	(0.0167)	(0.0109)	(0.0214)	(0.0424)	(0.0170)	(0.0140)	(0.0309)	(0.0602)
2015	0.952	1.296	1.545	1.915	1.203	1.541	1.803	2.146
	(0.0168)	(0.0111)	(0.0203)	(0.0419)	(0.0168)	(0.0137)	(0.0269)	(0.0564)

Note: Standard errors are in the parentheses. Origin and destination fixed effects are included in Poisson regressions. The number of municipalities is 1,741 as of October 1, 2015. The number of observations is 39,514 (= $1,718 \times 23$). Migration information is not surveyed in 1985, 1995, and 2005 Population Census. Educational information is not surveyed in 1985, 1995, 2005, and 2015 Population Census.

Table A.3 Poisson Regression Results of Density Elasticity of Gravity Equation from Migration Flows for 23 Wards of Tokyo by Marital Status

	Dependent Variable: Migration Flows across Municipalities							
	Male Age ≤ 50				Female Age ≤ 50			
	Single	Married			Single	Married		
	All	Without Children Age 0–15	With Children Age 0–5	With Children Age 6–15	All	Without Children Age 0–15	With Children Age 0–5	With Children Age 6–15
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Migration out of 23 Wards of Tokyo							
1980	1.651	1.938	1.990	2.324	1.954	2.002	2.216	2.545
	(0.0104)	(0.0133)	(0.0094)	(0.0157)	(0.0161)	(0.0179)	(0.0220)	(0.0247)
1985								
1990	1.378	1.630	1.826	2.123	1.793	1.660	1.981	2.320
	(0.0100)	(0.0136)	(0.0106)	(0.0200)	(0.0155)	(0.0172)	(0.0239)	(0.0285)
1995								
2000	1.415	1.600	1.749	2.089	1.704	1.625	1.876	2.210
	(0.0114)	(0.0136)	(0.0128)	(0.0274)	(0.0155)	(0.0166)	(0.0281)	(0.0372)
2005								
2010	1.417	1.504	1.695	1.934	1.591	1.504	1.797	2.061
	(0.0143)	(0.0149)	(0.0133)	(0.0329)	(0.0171)	(0.0174)	(0.0252)	(0.0434)
2015	1.339	1.483	1.658	1.696	1.514	1.447	1.705	1.838
	(0.0151)	(0.0161)	(0.0137)	(0.0370)	(0.0176)	(0.0179)	(0.0227)	(0.0465)
	Migration into 23 Wards of Tokyo							
1980	1.479	1.698	1.630	1.923	1.777	1.790	1.975	2.130
	(0.0125)	(0.0184)	(0.0145)	(0.0243)	(0.0166)	(0.0234)	(0.0302)	(0.0382)
1985								
1990	1.140	1.375	1.429	1.652	1.514	1.518	1.717	1.765
	(0.0126)	(0.0189)	(0.0174)	(0.0300)	(0.0168)	(0.0228)	(0.0350)	(0.0436)
1995								
2000	1.175	1.357	1.460	1.775	1.492	1.503	1.768	1.891
	(0.0116)	(0.0153)	(0.0154)	(0.0307)	(0.0135)	(0.0183)	(0.0318)	(0.0436)
2005								
2010	1.144	1.268	1.301	1.607	1.412	1.445	1.572	1.734
	(0.0140)	(0.0165)	(0.0175)	(0.0368)	(0.0149)	(0.0189)	(0.0322)	(0.0497)
2015	1.052	1.270	1.305	1.446	1.350	1.433	1.524	1.554
	(0.0140)	(0.0170)	(0.0173)	(0.0394)	(0.0145)	(0.0187)	(0.0287)	(0.0488)

Note: Standard errors are in the parentheses. Origin and destination fixed effects are included in Poisson regressions. The number of municipalities is 1,741 as of October 1, 2015. The number of observations is 39,514 (= $1,718 \times 23$). Migration information is not surveyed in 1985, 1995, and 2005 Population Census. Educational information is not surveyed in 1985, 1995, 2005, and 2015 Population Census.

Table A.4 Poisson Regression Results of Density Elasticity of Gravity Equation from Migration Flows for 23 Wards of Tokyo by Education Level

	Dependent Variable: Migration Flows across Municipalities							
	Male				Female			
	High School Degree		University Degree		High School Degree		University Degree	
	Single	Married	Single	Married	Single	Married	Single	Married
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Migration out of 23 Wards of Tokyo							
1980	1.859	2.319	1.243	1.672	1.993	2.281	1.648	1.725
	(0.0131)	(0.0084)	(0.0181)	(0.0107)	(0.0172)	(0.0122)	(0.0445)	(0.0359)
1985								
1990	1.719	2.195	0.904	1.513	1.917	2.064	1.313	1.408
	(0.0134)	(0.0104)	(0.0159)	(0.0104)	(0.0172)	(0.0132)	(0.0365)	(0.0282)
1995								
2000	1.774	2.188	1.004	1.455	1.876	2.019	1.279	1.411
	(0.0156)	(0.0125)	(0.0171)	(0.0113)	(0.0184)	(0.0148)	(0.0298)	(0.0251)
2005								
2010	1.818	2.102	1.115	1.458	1.837	1.966	1.282	1.385
	(0.0217)	(0.0155)	(0.0195)	(0.0115)	(0.0230)	(0.0175)	(0.0269)	(0.0206)
2015								
	Migration into 23 Wards of Tokyo							
1980	1.643	1.907	1.111	1.467	1.785	1.947	1.597	1.710
	(0.0156)	(0.0133)	(0.0218)	(0.0152)	(0.0177)	(0.0173)	(0.0489)	(0.0452)
1985								
1990	1.363	1.742	0.810	1.235	1.564	1.692	1.214	1.326
	(0.0169)	(0.0167)	(0.0194)	(0.0152)	(0.0188)	(0.0192)	(0.0375)	(0.0367)
1995								
2000	1.460	1.875	0.940	1.279	1.626	1.762	1.263	1.412
	(0.0172)	(0.0160)	(0.0159)	(0.0122)	(0.0171)	(0.0174)	(0.0228)	(0.0257)
2005								
2010	1.360	1.659	1.036	1.238	1.604	1.636	1.257	1.429
	(0.0245)	(0.0208)	(0.0174)	(0.0129)	(0.0227)	(0.0212)	(0.0206)	(0.0220)
2015								

Note: Standard errors are in the parentheses. Origin and destination fixed effects are included in Poisson regressions. The number of municipalities is 1,741 as of October 1, 2015. The number of observations is 39,514 (= $1,718 \times 23$). Migration information is not surveyed in 1985, 1995, and 2005 Population Census. Educational information is not surveyed in 1985, 1995, 2005, and 2015 Population Census.

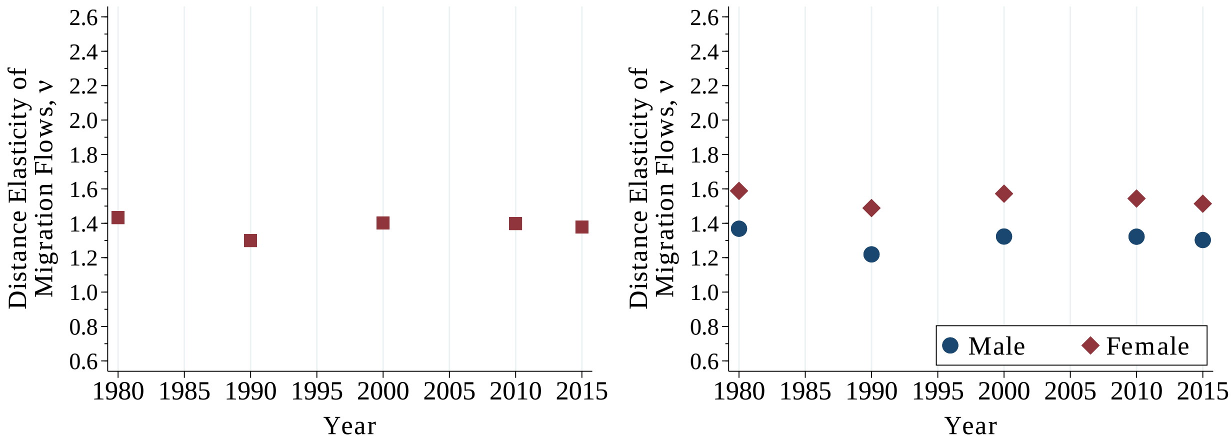
Online Appendix B.

Estimation Results of Distance Elasticity of Gravity Equation From Migration Flows Across All Municipalities

Figures B.1–B.2 visualizes the density elasticities of gravity equation estimated from the migration flows across all municipalities.

Tables B.1–B.4 present the estimation results of distance elasticity of gravity equation from the migration flows across all municipalities.

[Figures B.1–B.2; Tables B.1–B.4]

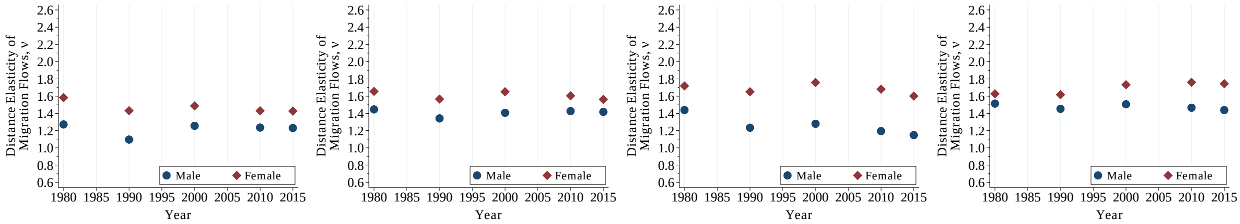


(a) All

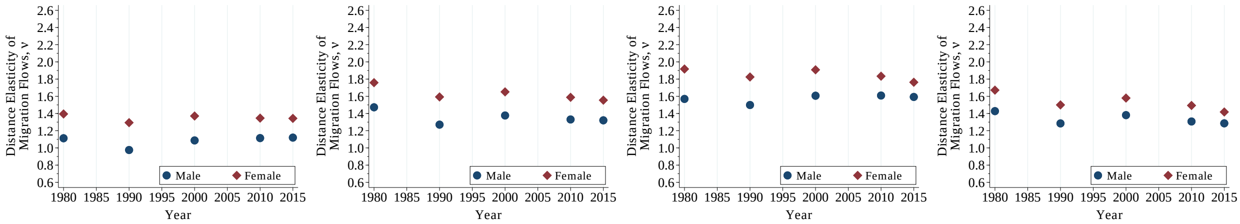
(b) Male and Female

Figure B.1 Estimated Distance Elasticity of Migration Flows Across All Municipalities by Gender

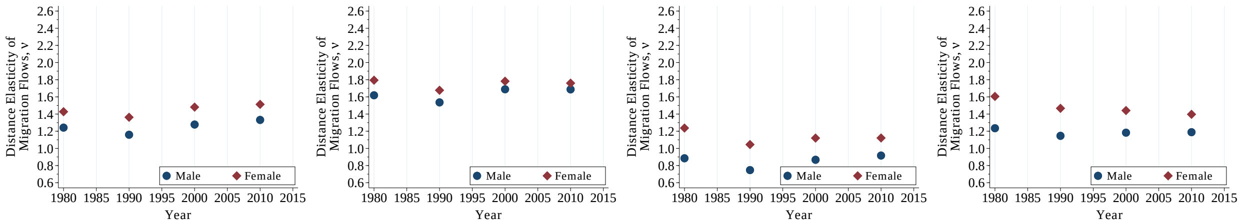
Note: The distance elasticity of migration flows represents the coefficient of inter-municipal distance in the gravity equation. Migration survey of Population Census was not conducted in 1985, 1995 and 2005. Education survey of Population Census was not conducted in 1985, 1995, 2005, and 2015.



(a) Age 15–29 **(b)** Age 30–44 **(c)** Age 45–59 **(d)** Age 60 and Over



(e) Single **(f)** Married without Children Age 0–15 **(g)** Married with Children Age 0–5 **(h)** Married with Children Age 6–15



(i) Single, High School Degree and Below **(j)** Married, High School Degree and Below **(k)** Single, University Degree and Above **(l)** Married, University Degree and Above

Figure B.2 Estimated Distance Elasticity of Migration Flows Across All Municipalities by Individual Attribute

Note: The distance elasticity of migration flows represents the coefficient of inter-municipal distance in the gravity equation. Migration survey of Population Census was not conducted in 1985, 1995 and 2005. Education survey of Population Census was not conducted in 1985, 1995, 2005, and 2015.

Table B.1 Poisson Regression Results of Density Elasticity of Gravity Equation from Migration Flows Across All Municipalities by Gender

	Dependent variable：Migration Flows across All Municipalities		
	All	Male	Female
Year	(1)	(2)	(3)
1980	1.432	1.368	1.589
	(0.0003)	(0.0004)	(0.0006)
1985			
1990	1.299	1.219	1.488
	(0.0003)	(0.0004)	(0.0006)
1995			
2000	1.402	1.323	1.572
	(0.0003)	(0.0004)	(0.0005)
2005			
2010	1.398	1.322	1.544
	(0.0003)	(0.0004)	(0.0006)
2015	1.378	1.303	1.514
	(0.0003)	(0.0004)	(0.0006)

Note: Standard errors are in the parentheses. Origin and destination fixed effects are included in Poisson regressions. The number of municipalities is 1,741 as of October 1, 2015. The number of observations is 3,031,081 (= 1741×1741). Migration information is not surveyed in 1985, 1995, and 2005 Population Census. Educational information is not surveyed in 1985, 1995, 2005, and 2015 Population Census.

Table B.2 Poisson Regression Results of Density Elasticity of Gravity Equation from Migration Flows Across All Municipalities by Age Group

	Dependent Variable: Migration Flows across Municipalities							
	Male				Female			
	Age 15–29	Age 30–44	Age 45–59	Age ≥ 60	Age 15–29	Age 30–44	Age 45–59	Age ≥ 60
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980	1.272	1.446	1.439	1.514	1.583	1.655	1.719	1.627
	(0.0006)	(0.0006)	(0.0010)	(0.0029)	(0.0008)	(0.0011)	(0.0019)	(0.0048)
1985								
1990	1.096	1.342	1.234	1.453	1.432	1.566	1.651	1.617
	(0.0006)	(0.0006)	(0.0009)	(0.0026)	(0.0008)	(0.0010)	(0.0018)	(0.0046)
1995								
2000	1.256	1.407	1.279	1.506	1.487	1.651	1.758	1.733
	(0.0006)	(0.0006)	(0.0009)	(0.0024)	(0.0008)	(0.0009)	(0.0016)	(0.0041)
2005								
2010	1.235	1.427	1.194	1.466	1.430	1.604	1.681	1.760
	(0.0008)	(0.0006)	(0.0009)	(0.0021)	(0.0009)	(0.0009)	(0.0017)	(0.0034)
2015	1.230	1.417	1.148	1.438	1.427	1.562	1.601	1.744
	(0.0008)	(0.0006)	(0.0009)	(0.0020)	(0.0010)	(0.0009)	(0.0015)	(0.0032)

Note: Standard errors are in the parentheses. Origin and destination fixed effects are included in Poisson regressions. The number of municipalities is 1,741 as of October 1, 2015. The number of observations is 3,031,081 (= 1741×1741). Migration information is not surveyed in 1985, 1995, and 2005 Population Census. Educational information is not surveyed in 1985, 1995, 2005, and 2015 Population Census.

Table B.3 Poisson Regression Results of Density Elasticity of Gravity Equation from Migration Flows Across All Municipalities by Marital Status

	Dependent Variable: Migration Flows across Municipalities							
	Male Age ≤ 50				Female Age ≤ 50			
	Single	Married			Single	Married		
	All	Without Children Age 0–15	With Children Age 0–5	With Children Age 6–15	All	Without Children Age 0–15	With Children Age 0–5	With Children Age 6–15
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980	1.112	1.472	1.570	1.428	1.395	1.759	1.917	1.672
	(0.0007)	(0.0010)	(0.0007)	(0.0010)	(0.0011)	(0.0015)	(0.0014)	(0.0017)
1985								
1990	0.976	1.271	1.499	1.285	1.294	1.593	1.825	1.500
	(0.0006)	(0.0010)	(0.0007)	(0.0011)	(0.0009)	(0.0015)	(0.0015)	(0.0017)
1995								
2000	1.087	1.377	1.607	1.381	1.371	1.652	1.908	1.580
	(0.0006)	(0.0009)	(0.0008)	(0.0013)	(0.0009)	(0.0013)	(0.0016)	(0.0019)
2005								
2010	1.114	1.331	1.609	1.307	1.346	1.588	1.834	1.493
	(0.0007)	(0.0010)	(0.0008)	(0.0016)	(0.0009)	(0.0013)	(0.0015)	(0.0021)
2015	1.120	1.321	1.592	1.286	1.343	1.555	1.763	1.418
	(0.0007)	(0.0010)	(0.0009)	(0.0017)	(0.0010)	(0.0013)	(0.0015)	(0.0021)

Note: Standard errors are in the parentheses. Origin and destination fixed effects are included in Poisson regressions. The number of municipalities is 1,741 as of October 1, 2015. The number of observations is 3,031,081 (= 1741×1741). Migration information is not surveyed in 1985, 1995, and 2005 Population Census. Educational information is not surveyed in 1985, 1995, 2005, and 2015 Population Census.

Table B.4 Poisson Regression Results of Density Elasticity of Gravity Equation from Migration Flows Across All Municipalities by Education Level

	Dependent Variable: Migration Flows across Municipalities							
	Male				Female			
	High School Degree		University Degree		High School Degree		University Degree	
	Single	Married	Single	Married	Single	Married	Single	Married
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1980	1.242	1.619	0.885	1.235	1.428	1.795	1.237	1.605
	(0.0009)	(0.0006)	(0.0012)	(0.0008)	(0.0011)	(0.0009)	(0.0030)	(0.0030)
1985								
1990	1.159	1.536	0.747	1.146	1.363	1.677	1.045	1.467
	(0.0008)	(0.0006)	(0.0010)	(0.0007)	(0.0011)	(0.0009)	(0.0022)	(0.0023)
1995								
2000	1.278	1.689	0.867	1.183	1.481	1.783	1.120	1.441
	(0.0008)	(0.0007)	(0.0009)	(0.0007)	(0.0010)	(0.0009)	(0.0016)	(0.0019)
2005								
2010	1.332	1.687	0.916	1.189	1.513	1.760	1.121	1.397
	(0.0010)	(0.0008)	(0.0010)	(0.0007)	(0.0013)	(0.0010)	(0.0014)	(0.0016)
2015								

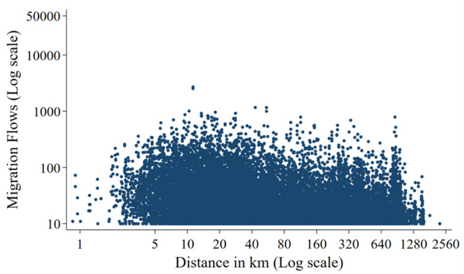
Note: Standard errors are in the parentheses. Origin and destination fixed effects are included in Poisson regressions. The number of municipalities is 1,741 as of October 1, 2015. The number of observations is 3,031,081 (= 1741×1741). Migration information is not surveyed in 1985, 1995, and 2005 Population Census. Educational information is not surveyed in 1985, 1995, 2005, and 2015 Population Census.

Online Appendix C.

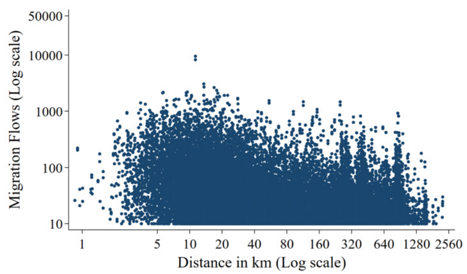
Scatter Plot of Migration Flows and Distance Across All Municipalities

Figures C.1–C.3 show scatter plot of migration flows and distance across all municipalities in the 2010 Population Census.

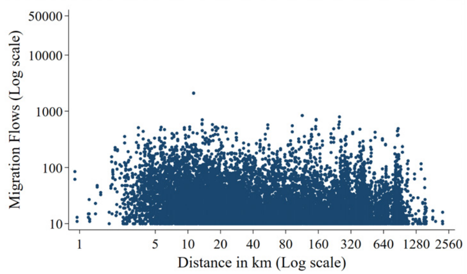
[Figures C.1–C.3]



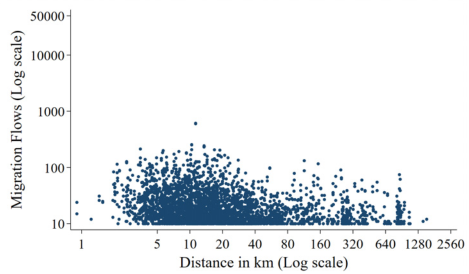
(a) Male, Age 15–29



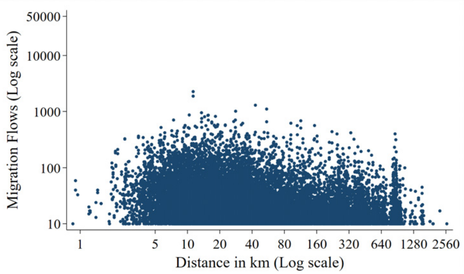
(b) Male, Age 30–44



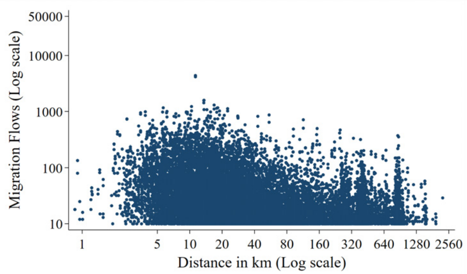
(c) Male, Age 45–59



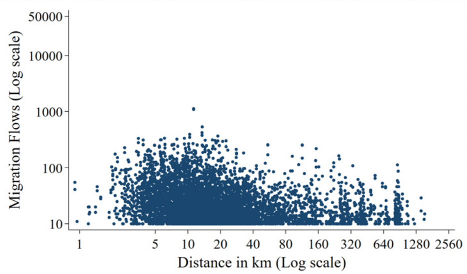
(d) Male, Age 60 and Over



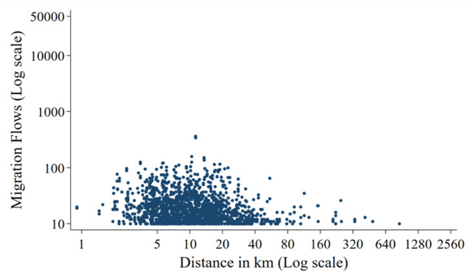
(e) Female, Age 15–29



(f) Female, Age 30–44



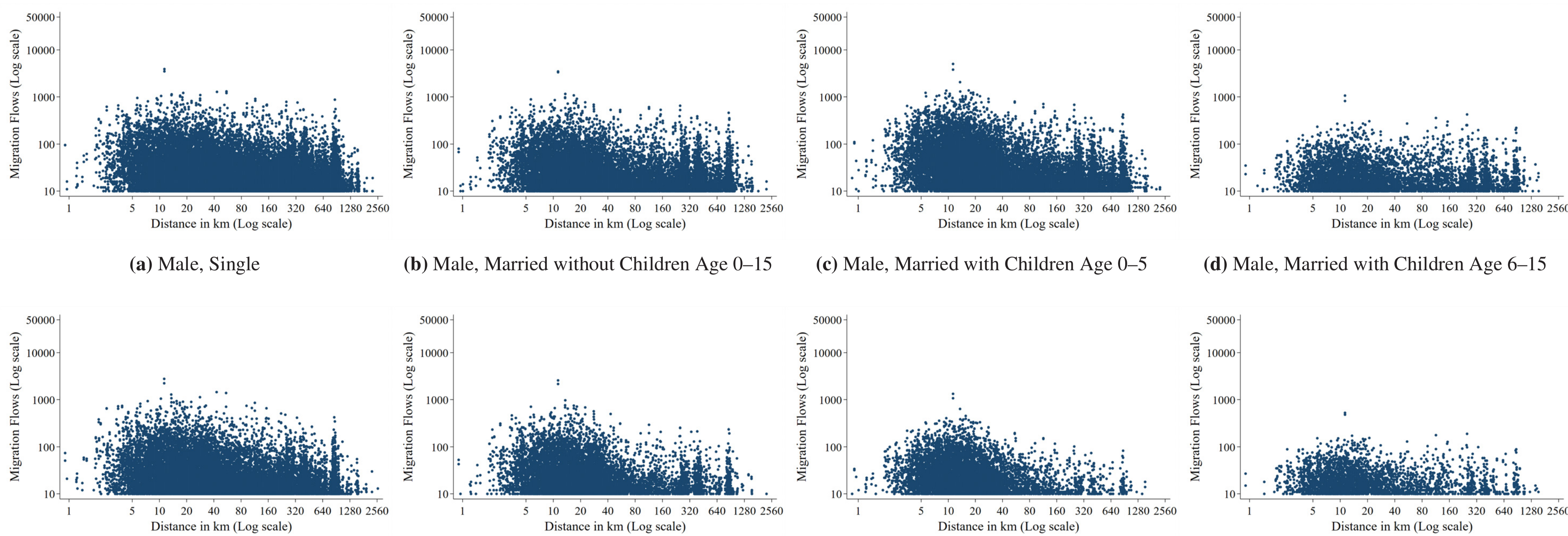
(g) Female, Age 45–59



(h) Female, Age 60 and Over

Figure C.1 Migration Flow and Distance of All Inter-municipal Migration Flows in 2005-2010 by Gender and Age Group

Note: Author's creation based on 2010 Population Census (MIC). Migration flows less than 10 persons are not shown.



(a) Male, Single

(b) Male, Married without Children Age 0–15

(c) Male, Married with Children Age 0–5

(d) Male, Married with Children Age 6–15

(e) Female, Single

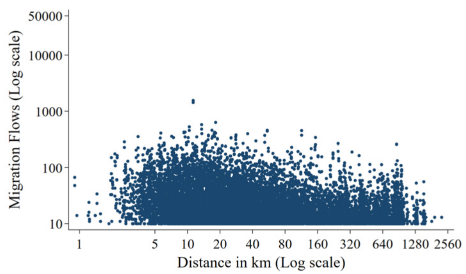
(f) Female, Married without Children Age 0–15

(g) Female, Married with Children Age 0–5

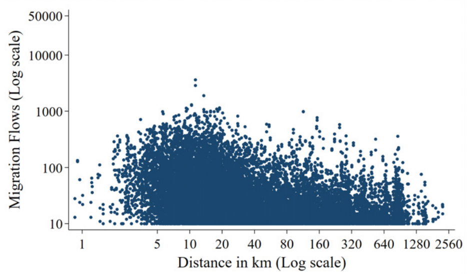
(h) Female, Married with Children Age 6–15

Figure C.2 Migration Flow and Distance of All Inter-municipal Migration Flows in 2005-2010 by Gender and Marital Status

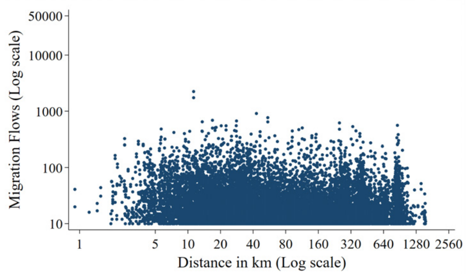
Note: Author’s creation based on 2010 Population Census (MIC). Migration flows less than 10 persons are not shown.



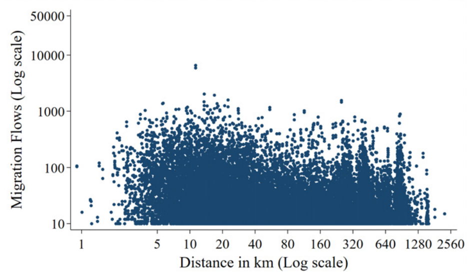
(a) Single Male with High School Degree and Below



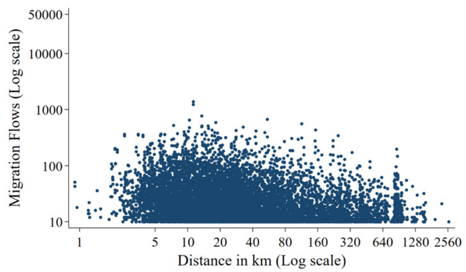
(b) Married Male with High School Degree and Below



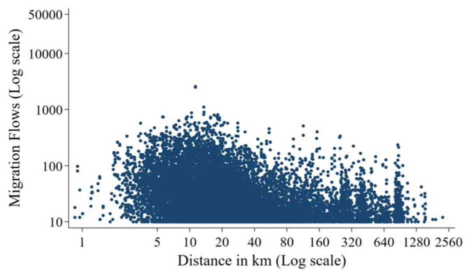
(c) Single Male with University Degree and Above



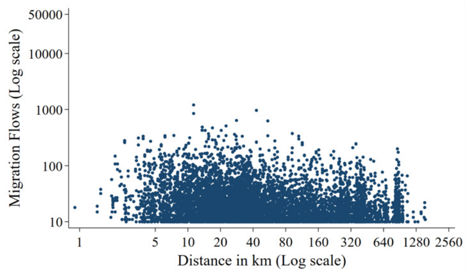
(d) Married Male with University Degree and Above



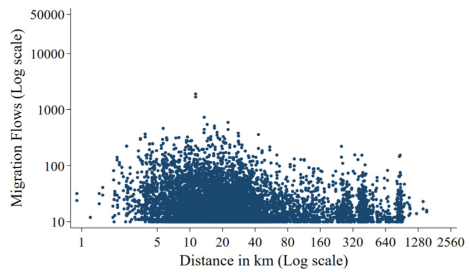
(e) Single Female with High School Degree and Below



(f) Married Female with High School Degree and Below



(g) Single Female with University Degree and Above



(h) Married Female with University Degree and Above

Figure C.3 Migration Flow and Distance of All Inter-municipal Migration Flows in 2005-2010 by Gender and Education Level

Note: Author's creation based on 2010 Population Census (MIC). Migration flows less than 10 persons are not shown.