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Impacts of co-ethnic networks and socioeconomic factors on immigrants' residence choice in Tokyo: A dynamic spatial panel analysis

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ARTICLE

Impacts of co-ethnic networks and socioeconomic factors on immigrants' residence choice in Tokyo: A dynamic spatial panel analysis

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ABSTRACT

Co-ethnic networks and socioeconomic factors play a fundamental role in explaining immigrants' residence choices. However, their role varies across ethnic groups or populations with different assimilation levels. This study assesses the heterogeneous effects of co-ethnic networks and socioeconomic factors on the attractiveness of migration from four developing countries (China, the Philippines, Brazil, and Vietnam) in Tokyo, Japan. Using a dynamic spatial Durbin model, this study analyzed 242 municipal-level spatial panel data from 2012 to 2018. The results show that the effect of co-ethnic networks is significant for immigrants from China and Vietnam. They are likelier to live in municipalities with co-ethnic networks or neighboring municipalities. In contrast, immigrants from the Philippines and Brazil do not increase consistently in any municipality, and Filipino immigrants tend to move away from the municipalities where they were previously concentrated. According to the interpretation of spatial assimilation theory, the results suggest that Chinese and Vietnamese immigrants may be less assimilated than immigrants from Brazil and the Philippines. These findings provide new empirical evidence to analyze the heterogeneity of ethnic immigrants in their choice of residence and evaluate the assimilation theory's applicability. Empirical results provide relevant evidence and recommendations for immigration and assimilation policies.

KEYWORDS

co-ethnic networks; socioeconomic; immigrants; spatial assimilation; social integration; spatial panel econometric model

1. Introduction

Migration flows from developing countries to Organization for Economic Cooperation and Development (OECD) countries have risen since the 1960s. These North-South migratory flows have been primarily driven by migration to the United States and Western Europe (Özden et al., 2011). The increasing number of international migrants poses economic and security problems for North and South countries. Exploring how to manage migration is critical to national security and development (Hollifield and Orlando, 2017) and is a common issue for countries experiencing immigration. For host

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countries, assimilation or social integration policies are essential to solving immigration issues. For example, Murayama and Nagayasu (Murayama and Nagayasu, 2021), explaining the rise in crime among immigrants in Japan, pointed out that Japan currently lacks a social integration policy to eliminate discord between immigrants and natives and to prevent the former from feeling socially isolated. The prerequisite to developing an assimilation policy is understanding the degree of assimilation. Spatial assimilation is considered a key indicator of integration (Alba and Foner, 2015; Murayama and Nagayasu, 2021). Therefore, extensive studies have analyzed the spatial distribution of immigrants in their places of residence and the factors influencing them to understand the degree of assimilation of immigrants, which in turn provides recommendations for developing policies to manage immigrants in geographic space (administrative area). This study explores the causal relationship between ethnic networks, economic characteristics, and immigrants' residential choices, using Japan, an emerging immigrant country, as an example. It also uses spatial assimilation theory to explain the heterogeneity of different ethnic immigrants in their residence choices and the degree of assimilation across ethnic groups. This study argues that there are no one-size-fits-all policies for immigrant management. When developing policies, local governments cannot ignore the differences in assimilation within their regions, among immigrants from different countries, and within each ethnic group.

Japan, a member of the OECD, was late in admitting immigrants, and immigration policies have only begun to change significantly since the 1980s, when the Japanese economy flourished. Japan recognizes that globalization has become a powerful force for development. The global economy has connected the world, the movement of people across borders has brought vitality to the economy, and the trend has become unstoppable. At the same time, Japan is entering an aging society, and its population growth rate is declining. According to the World Bank, Japan's total fertility rate (births per woman) has been declining steadily since the 1980s and has only remained at 1.4 since 2000. Population ages 65 and above (percentage of the total population) increased from 9% in 1980 to 29% in 2021 (WorldBank, 2022). The aging society puts severe pressure on its economic and social development, and Japan urgently needs to attract immigrants to add vitality to its economic and social development.

In 1983, the Japanese government initiated The International Student 100,000 Plan to increase the number of international students in Japanese universities and colleges. The number of international students grew steadily in the 1980s, remained at around 50,000 in 1990, and reached 110,000 in 2003. In 2008, the Japanese government proposed another plan to increase the number of international students in Japan to 300,000 by 2020. In May 2019, the number of international students reached 320,000. The role of international students is not limited to students in education but spans the labor market, where they are both low-skilled and high-skilled workers (Debnár, 2020). In Japan, the large international student population is not only a potential labor force but also a potential source for permanent immigrants. Moreover, the study abroad period provides an adaptation period for international students to learn about the local culture and integrate into the local society.

In addition to accepting international student migration, Japan has introduced measures to attract labor migration. In 1989, Japan revised its immigration law and implemented the changes in 1990. The new immigration law facilitated the entry of skilled immigrants into Japan. In 1993, the Ministry of Justice announced Technical Intern Training Program and began accepting immigrants for manual labor. After 2000, Japan expanded the scope of labor immigration acceptance and began to absorb immigrant workers in fields such as nursing and agriculture, which are facing a labor shortage. In 2011, the Points-based System for Highly Skilled Foreign Professionals was announced to attract highly-skilled immigrant workers.

Due to the policies mentioned above, the number of immigrants living in Japan increased rapidly, reaching over 2.1 million in 2007. Although the number of immigrants declined slightly after the world financial crisis in 2008, it has increased significantly since the introduction of a new residency management system in 2012. According to OECD (2019), Japan ranks among the top OECD countries regarding the total number of new immigrants admitted yearly. Along with the increase in the number of immigrants, the Japanese government has strengthened its regulation of migration flows. In 2012, Japan changed its policy on registering immigrants' places of residence and began to implement the Basic Resident Registration Act, which means that information on the place of residence is listed in the Basic Resident Registration Network. This Basic Resident Registers Network was started in 2002 to record Japanese residents' information (Komine, 2014). The new law is essential for statistical analysis of the movement of immigrants in Japan. Before this policy, collecting exact data on immigrants in Japan was challenging because immigrants could be registered in one place but may live in another. After the new system was implemented, immigration status could be revoked if the correct address was not registered (Komine, 2014).

Although Japan has been gradually absorbing immigrants since the 1980s, due to the late opening of the door to immigration and the limitations of immigration-related data, quantitative studies related to immigration are still lacking in Japan compared to other OECD member countries. The late start of quantitative research related to immigration has created difficulties in the development of immigration policies. However, with accurate and timely records of immigrants' residence after 2012, quantitative studies of immigrants' residence choices or assimilation have become possible in Japan. This study aims to contribute to the accumulation of empirical studies related to immigration in Japan.

Unlike most OECD countries, immigrants in Japan currently account for only 2% of the population, which also includes people born in Japan but did not acquire Japanese citizenship. In contrast, many OECD member countries are known as immigrant countries, where the immigrant (foreign-born) population accounts for 10-20% of the total population (OECD, 2022). In terms of immigration management policies, Japan has created and experimented with a multicultural coexistence immigration policy instead of actively pursuing assimilation policies. As described in the Ministry of Internal Affairs and Communications's 'Report of the Working Group on Multicultural Coexistence Promotion' published in 2006, multicultural coexistence refers to "People of different cultures and ethnic backgrounds living alongside one another as contributors to civil society, and the building of bridges between each other through the acceptance of each other's culture." (Nagy, 2008; MIAC, 2006). Aiden (2011) commented that this policy responds to the increasing number of immigrants in Japan, especially newcomers, who need access to public services. In light of the meaning of multicultural coexistence, it is timely to revisit how tiers of Japanese governments attempt to integrate immigrants into Japanese society. Japan has become an exciting subject of study in the context of such a unique policy of absorbing and managing immigrants.

Japan's cautious absorption of immigrants is due to concerns about the possible adverse social and economic effects of the influx. However, the most recent retrospective studies for OECD countries currently available do not find extreme concerns about the harmful labor market and fiscal impacts caused by new immigrants (Edo et al., 2020). Increased immigration can increase the economic benefits of natives through complementarity with other local factors of production (Borjas, 2005) and increasing or maintaining the average wages of less-educated natives (Docquier et al., 2014). However, it has also been shown that immigrant migration negatively affects the wages of less-educated native workers and increases inequality within countries (Docquier et al., 2014). The concentration of immigrants who are culturally disparate from the native population can lead to increased local spending on public order or public safety (Bove et al., 2021; Kim and Lee, 2021). The negative effects associated with the robust growth of immigrants in a given region pose a challenge to regional management.

One can see that how to promote successful ethnic integration is an issue that policymakers must consider. Current research in spatial assimilation theory argues that excessive concentration of immigrants in a region implies a failure of assimilation policy (Andersson, 1998; Murayama and Nagayasu, 2021). The failure of assimilation is detrimental to the immigrants themselves and can harm society as a whole (Asselin et al., 2006; Musterd and Vos, 2007). However, the reasons for the failure of policy of assimilation may be different for each ethnic group. Therefore, policymakers need to understand the different characteristics or heterogeneity of ethnic groups in their choice of residence and the differences in the degree of assimilation among ethnic groups. Another contribution of this study is to provide evidence for immigration policymakers from the above perspective of ethnic heterogeneity.

The geographic distribution of immigrants within Japan is uneven, with the vast majority of immigrants located in the three major metropolitan areas. According to the Foreign Resident Statistics published by the Japanese Ministry of Justice, nearly half of immigrants live in Tokyo. This is because Tokyo is the most economically active area in Japan, with many companies, business centers, and job opportunities that pay higher wages than other areas. In addition, most immigrants come from developing countries with low GDP per capita, such as China, the Philippines, Vietnam, and Brazil. Tokyo continues to attract many immigrants due to its vast local demand for the labor force and its cosmopolitan social environment. However, while the significant growth of immigrants has brought dynamism to the economy, it has also posed a challenge to the Japanese and autonomous governments in formulating relevant immigration policies.

Against the background described above, this study analyzes the heterogeneity in the factors that influence the choice of residence among immigrants from four countries with different immigration backgrounds in the Tokyo area, which has the highest number and proportion of the immigrant population, as the target. Following the spatial assimilation theory, this study explains that the heterogeneous effects of co-ethnic networks stem from the different degrees of assimilation among four countries. Spatial assimilation theory suggests that migrants become less dependent on co-ethnic networks and move away from ethnic ghettos as economic conditions improve. And ethnic ghettos usually refer to geographical areas, such as neighborhoods, metropolitan areas, states, or regions. Assimilation studies in the United States suggest using smaller areas, and the "census tract" is the most common unit used for analysis (Iceland et al., 2011; Wright et al., 2005).

However, current studies on spatial assimilation of immigrants at the geographic level in Japan are limited to first-level administrative units of analysis. Studies that use first-level administrative divisions as units for analysis prevent researchers from observing the movement of immigrants within metropolitan areas. Instead, it is easy to imagine that the movement of immigrants within metropolitan areas is widespread. Therefore, unlike the current studies for Japan, this study uses a smaller administrative unit (second-level administrative) as the study unit. The second-level administrative unit is also the smallest administrative unit with statistical data on immigrant and economic factors in Japan. This approach of using smaller administrative divisions as the units for analysis is appropriate for Japan, where the immigrant population is relatively small and concentrated in metropolitan areas.

To summarize, this study used a spatial econometric model to compare the factors (co-ethnic networks and socioeconomic factors) and the concentration trends that influence the choice of immigration residence in Japan. The data were aggregated at the second administrative division (242 municipalities in the Tokyo area). This study focuses on immigrants of non-Japanese citizenship rather than just foreign-born immigrants. The analysis tries to determine whether there is a heterogeneity or degree of spatial assimilation in the choice of residence for all four countries. To the author's knowledge, this study is the first to explore the theory of immigrant residence choice and assimilation using a spatial dynamic panel model by looking at lagged terms and their spillover effects. It is also the first study that attempts to apply this method to Japan.

2. Literature Review

Research on immigrants' choice of residence and its effects has been widely studied in Western Europe and the United States, which have a long history of immigration. Since Lee (1966) proposed the push-pull model, theoretical migration studies have attempted to present a generalized understanding of the phenomenon. For example, Harris and Harris and Todaro (1970)'s migration systems theory, Stark (1978); Stark and Taylor (1991)'s new economics of labor migration, and Massey (1990)'s cumulative causation theory, each with its strengths, lack a central body of theory in the field of migration. In addition, many empirical studies examine the causes of migrant migration based on push-pull models (De Haas, 2021). Viñuela (2021) demonstrated that place-based economic and labor market factors, such as average income or unemployment rate, play an essential role for immigrants. However, a previous study argued that new immigrants are mainly motivated and attracted by previous immigrants; this is referred to as the co-ethnic network effect. The role of the unemployment rate is not essential in immigrants' choice of location (Ukrayinchuk and Jayet, 2011). In addition to the economic factors that attract immigrants, co-ethnic networks are essential as co-ethnic networks can provide immigrants with more employment opportunities and lower costs of access to information (Edin et al., 2003; Lundquist and Massey, 2005; Price et al., 2005).

Since the 1990s, spatial assimilation theory has gradually dominated in studies of immigrant assimilation and their residential choices. Spatial assimilation model was developed in Massey and Mullan (1984); Massey and Denton (1985) to examine the influence of co-ethnic networks and socioeconomic factors on the dynamic behavior of immigrants in choosing their residence. Spatial assimilation studies tend to focus on changes in the types of immigrant settlement, including migration from ethnically concentrated to non-concentrated areas and migration from declining urban centers to suburban areas with better living conditions, as markers of spatial assimilation (Logan et al., 2002). In addition, the spatial distribution of ethnicity affects the distribution of public health, educational resources, and job opportunities. Spatial assimilation interacts with other assimilation processes, such as the cultural, economic, and social assimilation of immigrants. Some scholars consider this a necessary pathway to complete assimilation (Massey and Denton, 1985). Spatial assimilation theory has been widely discussed and has contributed to various countries' immigration research and policy-making (Mendez, 2009).

Recent empirical studies focus on the spatial effects of economic and ethnic network elements. These studies explained the spatially heterogeneous distribution of immigrants from the perspective of spatial assimilation theory. A spatial econometric analysis conducted in Russia found that a good job market, economic conditions, and health-related benefits attracted local immigrants and made neighborhoods more attractive to immigrants (Wang et al., 2019). Li and Zhang (2021) examined the residential preferences of Chinese, Filipino, Japanese, and Korean immigrants in the United States. They revealed that post-first-generation immigrants were more likely to reside in ethnic areas than first-generation immigrants were, and Asian immigrants had ethnic differences in spatial assimilation patterns. Using the spatial Durbin model (SDM), Jayet et al. (2016) demonstrated that the effect of ethnic networks on the location choice of newly arrived immigrants in Belgium was significant, indicating that cities with higher concentrations of immigrants are likely to gain more immigrants in the future. Moreover, the spatial distribution of immigrants is mainly driven by location-specific factors, such as housing and labor market, depending on the degree of economic development in the immigrant's home country.

In recent years, with immigration increasing, researchers have begun to focus on immigrants' residence choices in Japan. Korekawa (2020) used the census tract level data to determine how Chinese and Brazilian immigrants aged 22-59 exit their ethnic communities and argued that spatial assimilation is not preference for a specific area, as in the United States, but is rather, entirely reflected in the micro-choice of homeownership in the course of an individual's life. Using data from 47 prefectures (first administrative level) in Japan, Murayama and Nagayasu (2021) revealed that immigrants from overseas tend to move to ethnically concentrated areas in Japan, with the trend decreasing as the immigrants move within the country. Rather than being based on individual countries, Murayama and Nagayasu's analysis divides countries with similar migratory characteristics into four groups: the East Asian group (Korea and China), the Southeast Asian group (Vietnam, Philippines, Indonesia, and Nepal), the South American group (Brazil and Peru), and the Western group (UK and US). Their results demonstrate that spatial assimilation theory can explain the phenomenon of migrants arriving in Japan from overseas and migrating within Japan. Moreover, the assimilation rate was heterogeneous across country groups, with slow assimilation of immigrants from low-income countries or countries with different cultures from Japan. Finally, they point out that policies that merely increase the number of immigrants to make up for Japan's labor shortage while neglecting the promotion of social integration policies will lead to the expansion of social problems and social divisions. They reminded Japan of the urgent need for a social integration policy.

Although the above studies found that spatial assimilation theory applies to Japan, there is still a gap in research on smaller geographic units in Japan. Therefore, this study examines whether spatial assimilation theory can explain the assimilation process of immigrants from different countries (China, Philippines, Brazil, and Vietnam) in smaller geographic units than prefectures in Japan by whether co-ethnic networks influence residence choice. Moreover, this study also discusses whether its effects are heterogeneous across countries.

One point to note is that the definition of immigrants in this study differs from studies in OECD member countries, which generally define immigrants as a population whose place of birth is abroad. In Japan, statistics related to the immigrant population only collect the nationality and not the place of birth. Therefore, second-generation immigrants who did not acquire Japanese citizenship but were born and raised in Japan are also counted in immigration statistics. Although they do not have Japanese citizenship, most have permanent residency and receive the same education as children of non-immigrant parents in Japan. In addition, foreigners (including international students, skilled workers, professionals, and spouses) who do not have Japanese citizenship but have the right to stay for an extended period (more than three months) are included in the definition of immigrants. The alternative definition is a unique feature of the study related to immigration to Japan.

3. Methods

3.1. Spatial Auto-Correlation

This study uses Global Moran's I (Moran, 1950) to evaluate whether spatial patterns of immigration are random, clustered, or dispersed. Moran's I is calculated as:

$$\mathrm{I} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} \left(x_i - \bar{x}\right)\left(x_j - \bar{x}\right)}{\left(\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}\right) \sum_{i=1}^{n} \left(x_i - \bar{x}\right)^2} \tag{1}$$

where I is Moran's I, n is the number of spatial units ($n = 242$) indexed by unit i and unit j ($i \neq j$), x is the variable of interest, $\bar{x}$ is the mean of x, and w_{ij} is the spatial weight value between i and j. Moran's I values are between plus one and minus one. If Moran's I is significant and the value is positive, it implied spatial clustering (positive spatial autocorrelation), while a negative value indicated spatial dispersion (negative spatial autocorrelation). When Moran's I is greater than zero, the high-value unit is close to the high-value unit, and the low-value unit is close to the low-value unit, while if Moran's I is less than 0, the high-value unit is close to the low-value unit, and the low-value unit is close to the high-value unit.

For the spatial weight w_{ij}, the first-order binary contiguity matrix based on the rook criterion is considered. Two spatial units are defined as neighbors if they have a common border. When examining Moran's I, the spatial weight matrix W is row-standardized, and the sum of the row elements of the spatial weight matrix equals one.

Moran's I values measure whether spatial clustering occurred in the entire study area but do not indicate the location of spatial clustering. In addition, Global Moran's I is used, as the data show spatial clustering of high and low values to measure the overall spatial autocorrelation.

3.2. Dynamic Spatial Durbin Model

In this study, the dynamic spatial Durbin model with spatial and time-fixed effects is chosen as the empirical model. One reason is that, compared with traditional econometric models, spatial econometric models consider the interaction between geospatial units in addition to the control variables of traditional econometric models. This interaction is often neglected in traditional econometric models. The dynamic spatial Durbin model is used to investigate the effect of the independent factors on the dependent variable in local and neighboring municipalities, as well as to assess the dependent variable's geographical dependency, temporal dependence, and spatiotemporal dependence. In analyses of migrants' residence choice, the spatial interaction between adjacent areas has been demonstrated in both theory and empirically (Nowotny, 2012).

Another reason is that since migration growth itself is a dynamic process, the current migration growth not only depends on the current period factors but is also influenced by the prior period factors. Compared with the static spatial panel model, the dynamic spatial panel model has the advantage of taking into account both the dynamic and spatial spillover effects of migration growth and also avoiding the endogeneity problem of "chicken-and-egg" (Elhorst, 2014). Therefore, the dynamic spatial model could effectively assure the estimation findings' correctness and dependability.

Expressly, the general form of the dynamic spatial Durbin model with the space-and-time fixed effect is as follows:

$$y_{it} = \rho \sum_{j=1}^{n} W y_{jt} + \tau y_{it-1} + \eta \sum_{j=1}^{n} W y_{jt-1} + \beta X_{it} + \theta \sum_{j=1}^{n} W X_{jt} + \mu_i + \lambda_t + \varepsilon_{it} \tag{2}$$

where i is spatial unit id, j is neighboring unit id, t is a time of year. W is a 242×242 matrix. y_{it} denotes the dependent variable of immigrant growth rate (IGR) in unit i at time t, β denotes the direct coefficient of the independent variable, X_{it} denotes the independent variables in unit i at time t. ρ denotes the spatial lag coefficient of the dependent variable y. τ denotes the lag coefficient of the dependent variable y. η denotes the spatial and temporal lag coefficient of the dependent variable y. β denotes the coefficient of the independent variable X. θ denotes the spatial lag coefficient of the independent variable X. μ denotes the space fixed effect. λ denotes the time fixed effect. ε denotes the error term. The maximum-likelihood (ML) method is used to estimate the dynamic SDM. In addition, if $\rho = \eta = 0$, the model become an astatic SDM.

According to LeSage and Pace (2009), the estimated coefficients β of equation (2) are not the actual effects on y_{it}, as the equation includes the spatial lag term of y_{it}. The actual effect is decomposed into a direct and indirect effect. The direct effect is the magnitude of the effect of the independent variable on the dependent variable in a unit. It includes feedback effects, which means the effect on neighboring units, in turn, affects that local unit. The indirect effects, also known as spatial spillover effects, are used to measure the effect of a dependent variable in a neighboring unit on the independent variable in the local unit.

The direct and indirect effect decomposition can be performed using the following steps. First, equation (2) can be rewritten as follows:

$$Y_{it} = (\mathrm{I} - \rho \mathrm{W})^{-1} (\tau \mathrm{I} + \eta \mathrm{W}) \mathbf{Y}_{i,t-1} + (\mathrm{I} - \rho \mathrm{W})^{-1} (\mathbf{X}_{it}\beta + \mathrm{W}\mathrm{X}_{it}\theta) + (\mathrm{I} - \rho \mathrm{W})^{-1} (\mu_i + \lambda_t + \varepsilon_{it}) \tag{3}$$

where I denotes the identification matrix.

Second, the partial derivative matrix of the expected value of the kth independent variable of y_{it} concerning X_{it} at a point in the long-term scale can be written as the following equation:

$$\left[\frac{\partial E(\mathrm{Y}_{1t})}{\partial X_{1k}} \cdots \frac{\partial E(\mathrm{Y}_{Nt})}{\partial X_{Nk}} \right] = [(1-\tau)\mathrm{I} - (\rho + \eta)\mathrm{W}]^{-1} (\beta \mathrm{I} + \mathrm{W}\theta) \tag{4}$$

Accordingly, the following equations can calculate the direct, indirect, and total effects of the dynamic spatial Durbin model in the long-term.

Direct effects in long-term:

$$\left[((1-\tau)I-(\rho+\eta)W)^{-1}\left(\beta_k I_N+\theta_k W\right)\right]^{\bar{d}} \tag{5}$$

Indirect effects in long-term:

$$\left[((1-\tau)I-(\rho+\eta)W)^{-1}\left(\beta_k I_N+\theta_k W\right)\right]^{\overline{rsum}} \tag{6}$$

Total effects in long-term:

$$\left[((1-\tau)I-(\rho+\eta)W)^{-1}\left(\beta_k I_N+\theta_k W\right)\right]^{\bar{d}}+\left[((1-\tau)I-(\rho+\eta)W)^{-1}\left(\beta_k I_N+\theta_k W\right)\right]^{\overline{rsum}} \tag{7}$$

where $\bar{d}$ denotes the operator that calculates the average of the diagonal elements of the matrix, and the $\overline{rsum}$ denotes the operator that calculates the average of the row sum of the non-diagonal elements. Third, if the effect of y_{it-1} is not attended to, which means $\tau = 0$ and $\eta = 0$ hold simultaneously, then the matrix of partial derivatives of the expected value of the kth independent variable of y_{it} for X_{it} at a point on the short-term scale can be written as the following equation:

$$\left[\frac{\partial E\left(\mathrm{Y}_{1t}\right)}{\partial X_{1k}}\cdots\frac{\partial E\left(\mathrm{Y}_{Nt}\right)}{\partial X_{Nk}}\right]=(\mathrm{I}-\rho\mathrm{W})^{-1}(\beta\mathrm{I}+\mathrm{W}\theta) \tag{8}$$

Accordingly, the following equations can calculate the direct, indirect, and total effects of the dynamic spatial Durbin model in the short-term.

Direct effects in short-term:

$$\left[(I-\rho W)^{-1}\left(\beta_k I_N+\theta_k W\right)\right]^{\bar{d}} \tag{9}$$

Indirect effects in short-term:

$$\left[(I-\rho W)^{-1}\left(\beta_k I_N+\theta_k W\right)\right]^{\overline{rsum}} \tag{10}$$

Total effects in short-term:

$$\left[(I-\rho W)^{-1}\left(\beta_k I_N+\theta_k W\right)\right]^{\bar{d}}+\left[(I-\rho W)^{-1}\left(\beta_k I_N+\theta_k W\right)\right]^{\overline{rsum}} \tag{11}$$

3.3. Spatial Weight Matrix

This study uses the row-standardized first-order contiguity matrix W as the spatial weight matrix. The element value w_{ij} of W is non-zero when unit i and unit j are neighbors; otherwise, it remains zero. The weights used in the analysis are rook contiguity weights, which represents whether spatial units shared the boundary. If the set of bounds of i and j is denoted by the $bnd(i)$ and $bnd(j)$, then the rook contiguity weight is defined by:

$$w_{ij} = \begin{cases} 1, \ \text{bnd}\ (i) \cap \ \text{bnd}\ (j) \neq \varnothing \\ 0, \ \text{bnd}\ (i) \cap \ \text{bnd}\ (j) = \varnothing \end{cases} \tag{12}$$

W is standardized after every element value w_{ij} is divided by the sum of its row to ensure that every row is one.

3.4. Identify Different Patterns of Immigrants' Location Choice through Co-ethnic Networks

Equation (2) analyzes the relationship between the dependent variable immigrant growth rates y_t and the three independent variables of y_{t-1}, $W \times y_t$, and $W \times y_{t-1}$. By comparing the signs and magnitudes of the coefficients, this study identifies different patterns of immigrants' location choices from four countries. The immigrant growth rate in period t is used as the independent variable to indicate the degree of co-ethnic networks in the unit i in period t. The coefficient of the independent variable y_{t-1} indicates whether that co-ethnic network consistently attracted an increase in the immigration of co-ethnic. The magnitude of the coefficient indicates the magnitude of the influence in co-ethnic networks. $W \times y_t$ indicates the spillover effect of this co-ethnic network attraction in period t. $W \times y_{t-1}$ indicates the effect of the immediately adjacent migration network on the immigrant growth rate of the unit i in period $t-1$.

This study follows Ishikawa (2007) and defines the immigrant growth rate per 1,000 people y_{it} in equation (2), as follows:

$$y_{it} = \frac{P_{it} - P_{it-1}}{\sum_{i=1}^{242} P_{it}} \times 1000 \tag{13}$$

where y_{it} is the co-ethnic immigrant growth rate of spatial unit i at year t, P_{it} is the co-ethnic population stock of spatial unit i at year t, P_{it-1} is the co-ethnic population stock of spatial unit i at year $t-1$, and $\sum_{i=1}^{242} P_{it}$ indicates the total co-ethnic population of the 242 spatial units at year t. The co-ethnic immigrant growth rate y_{it} equals the co-ethnic immigrant population growth in each unit as a percentage of the total co-ethnic population in Tokyo and measures the degree of spatial concentration of a co-ethnic immigrant population across units. The value of y_{it} is more significant than zero, indicating that the co-ethnic immigrants in unit i have increased compared to the last year. Conversely, a value less than zero indicates that the number of co-ethnic immigrants decreased. A higher positive value indicates a more significant increase in the co-ethnic population in unit i than other units. In other words, the co-ethnic population is concentrated in this unit. Conversely, a lower negative value indicates a more significant co-ethnic population moving out of the unit.

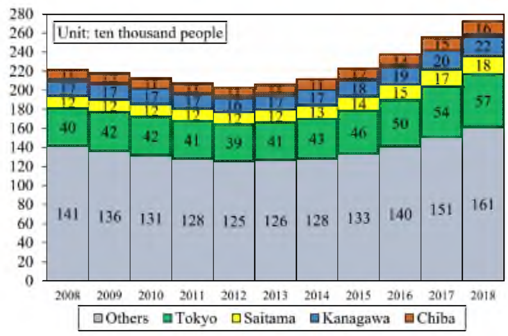

Figure 1. The number of immigrants in Japan by prefecture over time. The data source is the Statistics on Foreign Residents in Japan produced by Ministry of Justice.

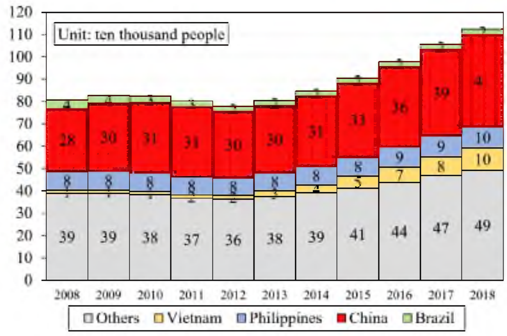

Figure 2. The number of immigrants in Tokyo area by country over time. The data source is the Statistics on Foreign Residents in Japan produced by Ministry of Justice.

4. Data

4.1. Study Area and Data

The study area included the Tokyo metropolitan area and the neighboring Chiba, Kanagawa, and Saitama prefectures and excluded the remote islands. Tokyo is a metropolis with the largest immigrant population in Japan and was thus considered suitable for this study.

Figure 1 shows the change in the total number of immigrants in 47 prefectures of Japan and in each prefecture of Tokyo from 2008 to 2018, as reported in Statistics on Foreign Residents in Japan by the Ministry of Justice Foreigners (The raw data can be downloaded from the Japanese government statistics site e-Stat $https://www.e-stat.go.jp/$). Using 2012 as the cut-off year, the data revealed that the immigrant population declined slightly until 2012; however, in 2012, after the new foreigner residency policy was implemented in Japan, the total immigrant population increased significantly each year. In 2018, the total number of immigrants was 2.73 million, of which 1.12 million lived in Tokyo, accounting for 40% of the total number of foreigners. This proportion was 36% in 2008, with 1.12 million immigrants living in Tokyo, including half of the population in the Tokyo metropolitan area, 16% in Saitama, 20% in Kanagawa, and 14% in Chiba.

The immigration statistics in Figure 1 were obtained from the Ministry of Justice of Japan. The data are reported twice yearly, at the end of June and December. The data used to calculate the growth rate of immigrants in this study were the statistics for the end of December each year. In addition, the data provided statistics on the number of people at the prefectural level, broken down by immigrant nationality. The 2018 statistics show that Japan's top five immigrant populations were China, South Korea, Vietnam, the Philippines, and Brazil. Four of these countries are developing countries that were examined in this study.

Figure 2 shows the number of immigrants from China, the Philippines, Brazil, and Vietnam as a percentage of the total immigrants in Tokyo. In 2018, the total number of immigrants from these four countries accounted for 56% of the total number of immigrants in Tokyo. Moreover, the overall rate increased from 2008, with the growth increasing annually after 2012. The country with the most significant increase was Vietnam, which increased 10-fold from 2008 to 2018. The number of Chinese immigrants increased by 46%. The number of immigrants from the Philippines increased by 25%. Conversely, immigration from Brazil declined, falling by 50% in ten years.

International migration has been chiefly explained as utility-maximizing behavior. The economic gap between the migrant and the home country stimulates a solid desire to move to a more prosperous country. This reason also applies to migration behavior within a country. Jayet et al. (2016) identified house prices and employment rates as factors influencing migrants' choice of residence in Belgium. Wang et al. (2019) noted that better job markets and financial situations affected the choice of residence of migrants within Russia.

Therefore, this study used five economic factors as independent variables, including log of population density, ratio of population aged 15 and over, ratio of population aged 65 and over, log of residential land value, and log of average individual income tax payment. Land price was used as a proxy variable for housing price. Data on land prices were obtained from the Ministry of Land, Infrastructure, Transport, and Tourism of Japan. The data on individual income tax payments, provided by the Ministry of Internal Affairs and Communications, was used as a proxy variable for the local financial situation. The land area data used to calculate population density were obtained from the Geospatial Information Agency of Japan. The population ratios were used as a proxy variable for the local labor market and the population data obtained from the Statistics Bureau of Japan. All data used in this paper are from government websites, and the URLs of the data sources are shown in Table A1.

The analysis was based on municipal units (ku: ward, shi: city, machi: town, mura: village) from the 2015 census. The municipality was chosen as the spatial geographic unit, as it was the lowest level spatial unit published by the Japanese government for demographic and socioeconomic data statistics. In particular, immigrant and Japanese population statistics were gathered from 242 municipalities, which are Japanese governmental units that include all of Tokyo except the remote islands.

4.2. Statistical Description

Table 1A shows the descriptive statistics for Chinese, Filipino, Brazilian, and Vietnamese immigrant growth rates in 2013. Table 1B shows the descriptive statistics for dependent and independent variables from 2014 to 2018.

In 2013, the average growth rate of immigrants in 242 units in Tokyo was positive for those from China, the Philippines, and Vietnam, while it was negative for those from Brazil. The highest average growth rate was from Vietnam, with an average growth rate of 1.40 per 1,000, followed by 0.09 per 1,000 in the Philippines and 0.06 per 1,000 in China.

From 2014 to 2018, the highest average immigrant growth rate among the four countries continued to be Vietnam, with 0.94 per 1,000. China and the Philippines followed at 0.25 and 0.16 per 1,000, respectively. The average immigrant growth rate in Brazil was consistently negative. Moreover, comparing the median and mean values of immigrant growth rate revealed that the mean values were more significant than the median for all four countries, showing a positively skewed distribution. The median and mean values of the control variables were closer to each other, showing normal distribution.

Table 1. Descriptive statistics

Panel A: 2013 (N=242)

Dependent variable	**Mean**	**Median**	**Std.Dev.**	**Min.**	**Max.**
IGR of China (1,000 people)	0.056	-0.002	0.317	-0.520	3.805
IGR of Philippines (1,000 people)	0.092	0.038	0.206	-0.417	1.087
IGR of Brazil (1,000 people)	-0.167	-0.043	0.585	-3.450	3.663
IGR of Vietnam (1,000 people)	1.397	0.302	3.677	-1.285	42.760

Panel B: 2014-2018 (N=1210)

Dependent and independent variable	**Mean**	**Median**	**Std.Dev.**	**Min.**	**Max.**
IGR of China (1,000 people)	0.254	0.052	0.585	-0.608	5.497
IGR of Philippines (1,000 people)	0.158	0.071	0.265	-0.711	1.779
IGR of Brazil ((1,000 people)	-0.002	0.000	0.523	-3.036	3.469
IGR of Vietnam (1,000 people)	0.944	0.419	1.886	-1.251	25.394
Log of population density	3.180	3.556	1.531	-1.558	5.407
Log of average income taxes payment	4.862	4.835	0.274	4.296	6.230
Log of residential land value	11.508	11.636	1.079	9.159	14.805
Ratio of population aged 15	0.609	0.611	0.046	0.431	0.712
Ratio of population aged 65 and over	0.273	0.263	0.059	0.152	0.505

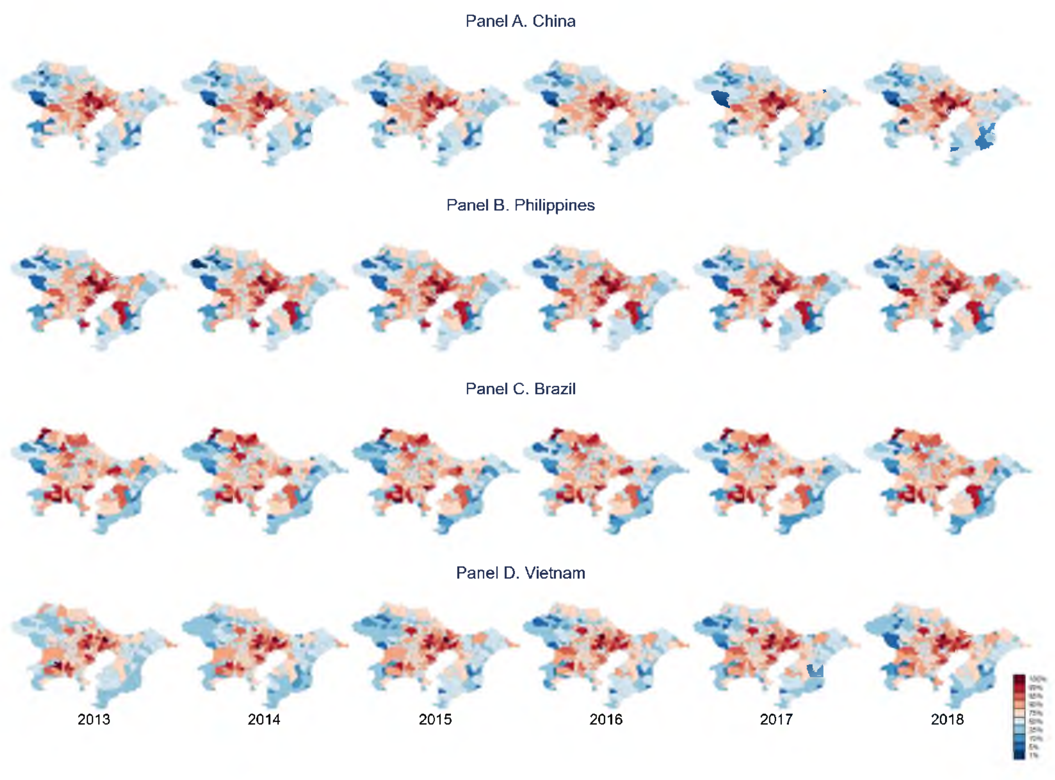

Figure 3. Quantile distribution of immigrant growth rates.

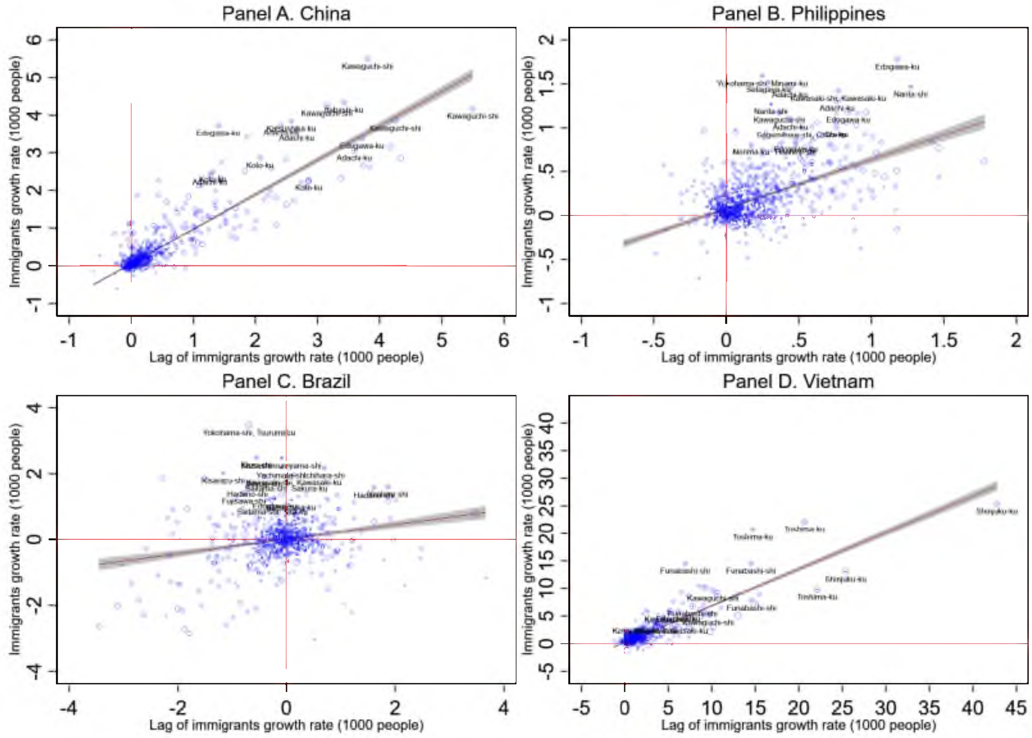

Figure 4. Lagged immigrant growth rate tracks heterogeneity in co-ethnic networks across municipalities.

4.3. Heterogeneity in Co-Ethnic Networks

Figure 3 shows the quadratic distribution of migration growth rates by country. Dark red indicates that the municipality had an approximately higher migration growth rate than other municipalities. Conversely, dark blue indicates that the municipality had an approximately lower migration rate than other municipalities. Dark red and dark blue represent the three municipalities with the highest and lowest 1% migration rates among the 242 municipalities.

The distribution of colors in the map shows spatial clustering and different spatial patterns between the countries. The distribution of Chinese and Vietnamese immigrants revealed an apparent spatial clustering, primarily concentrated in the central areas of Tokyo (Panels A and D). Moreover, in municipalities with high co-ethnic immigration growth rates, the number of Chinese and Vietnamese immigrants continued to grow, spreading to neighboring municipalities. In contrast, Filipinos and Brazilians (Panels B and C) tended to live outside the center municipalities of Tokyo and congregated in the center. From 2013 to 2018, Filipino migration grew in the center municipalities of Tokyo or its neighboring municipalities; however, the immigration growth rate did not increase consistently in several municipalities. Similarly, the top three municipalities in Brazilian migration rates varied yearly, with no particular municipality consistently increasing immigration numbers. Thus, different countries exhibited different spatial patterns of immigration growth, suggesting that the effects of co-ethnic networks were heterogeneous across countries.

Figure 4 shows how heterogeneity in the linear relationship between local co-ethnic networks and co-ethnic immigrant growth was reflected in the reduced-form relationship between immigrant growth rate and its time lag. This study used pooled data across 242 municipalities from 2013 to 2018. Scatter points reflected co-ethnic networks and immigrant growth rate. The size of the points was weighted by immigrant population. Each panel shows an ordinary least squares (OLS) regression fit to scatter points with 95% confidence intervals.

Figure 4A shows that most scatter points were in the first quadrant. It indicates that Chinese immigrants were increasing in the vast majority of municipalities in Tokyo; however, the magnitude of the increase varies. Moreover, municipalities with high immigration growth rates, such as Kawaguchi-City in Saitama-Prefecture and Edogawa-Ku in Tokyo, continued to attract immigrant concentrations for years. Figure 4B shows that the clustering among the growth rates of Filipino immigrants in each municipality was similar to that of Chinese immigrants. However, there was an overall tendency to cluster around the coordinate origin. Edogawa-Ku has a more pronounced clustering trend and a relatively high total Filipino immigrants.

Figure 4C shows the factors of immigrant clustering in Brazil. Unlike the other three countries, Brazilian immigrants moved out of many municipalities in Tokyo, as there were far more municipalities in the third quadrant than in the other countries. Moreover, although the linear relationship was positive, the slope was much smaller than in the other three countries. Figure 4C implies that Brazilian immigrants assimilated into Japanese society more than the other three countries. The attraction effect of co-ethnic networks may be relatively weaker among Brazilian immigrants. Figure 4D shows the strong influence of co-ethnic networks on residence choice among Vietnamese immigrants. Similar to China, the number of Vietnamese immigrants tended to increase in most areas of Tokyo and was concentrated in large numbers in areas such as Shinjuku-Ku and Toshima-Ku, and continued to significantly increase annually. The immigrant growth rate per 1,000 people was much higher than the other countries. This was consistent with the statistics results presented in Table 1.

5. Empirical Results

5.1. Spatial Disparities in Immigration Growth Rate

Figure 5 reports Global Moran's I from 2013 to 2018 by country. Moran's I values indicated that the growth rates of migrants from China, the Philippines, and Vietnam were significantly correlated spatially. Figure 4 suggests that the immigrant growth rates of China, the Philippines, and Vietnam were not evenly distributed across municipalities within Tokyo. More aggregated spatial distribution was associated with a correspondingly higher growth rate of migrants. However, Moran's I values of migration growth rates of China increased substantially over time; whereas Moran's I values for the Philippines and Vietnam did not significantly change over the years. This illustrated the increasing correlation between the growth rate of migration and spatial distribution of China and the more stable correlation between the growth rate of migration and spatial distribution of the Philippines and Vietnam.

In contrast, the correlation between the growth rate of migration and the spatial distribution of Brazil was only weakly present in 2014. In addition to the row-standardized first-order rook contiguity weight, this study experimented with the first-order queen contiguity, inverse distance, and inverse distance squared weight. Using different spatial weights did not change the results.

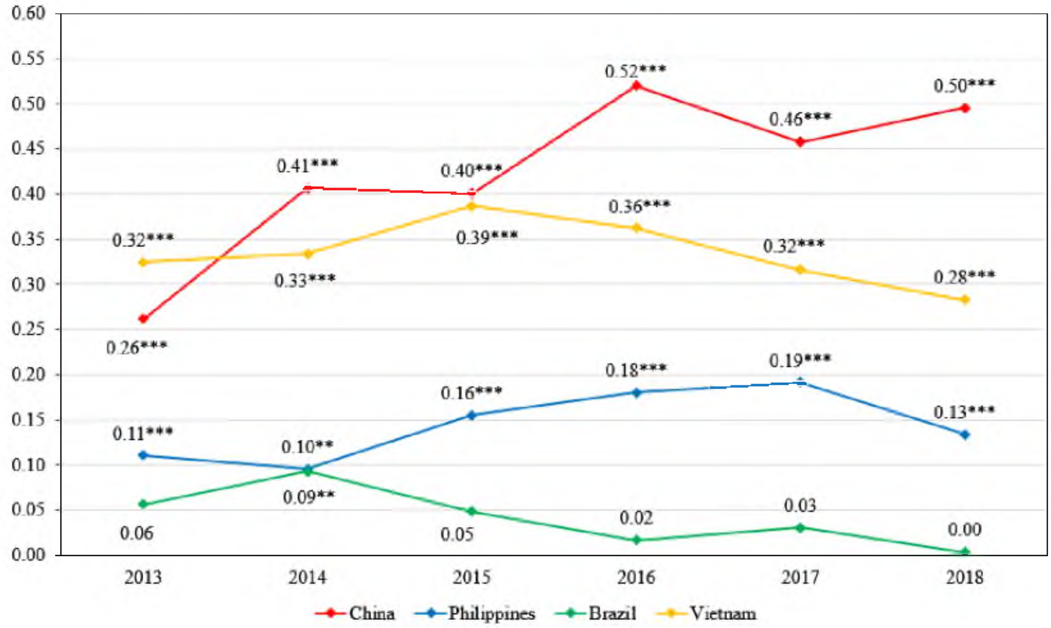

Figure 5. Moran's I values of immigrant growth rates across countries and overtime. *, **, and *** represent the 10 percent, 5 percent, and 1 percent significance levels, respectively.

5.2. Estimation Results of the Static and Dynamic Spatial Panel Model

The estimation results of the Static (Panel A) and dynamic (Panel B) spatial Durbin models based on spatial and time-period fixed effects are reported in Table 2. The effect of co-ethnic networks manifested differently for each of the four countries. Chinese and Vietnamese immigrants continued to grow in ethnically concentrated municipalities. The results suggested that co-ethnic networks consistently influenced the choice of residence of Chinese and Vietnamese immigrants. In addition, ρ was significant at a 1% level in both static and dynamic models for China and Vietnam. There was a positive spatial spillover effect on Chinese and Vietnamese immigrants' growth into neighboring municipalities.

In contrast, the immigrant growth rates of the Philippines and Brazil were insignificant in ρ values. However, they were significant in terms of t-statistics for time or spatial lags in columns (2) and (3) of Panel B. These results were consistent with Figure 4 and implied no spatial spillover effects on the growth of Filipino and Brazilian immigrants. Therefore, the spatial panel data model was not fit to explain the residence choice of immigrants in these two countries. For further verification, this study used the spatial model in subsequent Tables 3–5 to calculate the indirect effect of socioeconomic factors on immigration growth rates in the Philippines and Brazil and determine if the spatial spillover effects were vague or nonexistent.

Additionally, the coefficients of statistically significant independent variables of socioeconomic factors were essentially identical in a sign for both static and dynamic models, suggesting that the effects of these socioeconomic factors on immigrants' choice of residence were stable regardless of the presence or absence of co-ethnic networks effects. However, the effect of socioeconomic factors on immigrants' residence choice was almost nonexistent in the dynamic model that considers the influence of co-ethnic networks. The negative effect of population aging on Chinese immigrants' residence

Table 2. Static and dynamic spatial panel model estimating results.

Panel A. Static spatial panel model

	China	**Philippines**	**Brazil**	**Vietnam**
Log of population density	-0.081	-0.373	0.756	14.558***
	(-0.102)	(-0.555)	(0.388)	(2.829)
Log of average income taxes payment	-0.084	0.045	-0.414	1.912**
	(-0.731)	(0.363)	(-1.364)	(2.540)
Log of residential land value	0.057	0.314*	-0.168	-0.998
	(0.325)	(1.658)	(-0.252)	(-0.579)
Ratio of population aged 15	-3.584	0.457	8.683	-15.806
	(-1.226)	(0.211)	(1.010)	(-0.683)
Ratio of population aged 65 and over	-7.730**	-0.311	3.113	12.582
	(-2.323)	(-0.090)	(0.378)	(0.526)
$W \times$ Log of population density	0.335	-0.003	5.541	-8.888
	(0.315)	(-0.004)	(1.499)	(-1.075)
$W \times$ Log of average income taxes payment	0.028	0.102	0.510	0.260
	(0.154)	(0.403)	(1.066)	(0.253)
$W \times$ Log of residential land value	-0.200	-0.274	-2.785	-5.943*
	(-0.598)	(-0.826)	(-1.582)	(-1.766)
$W \times$ Ratio of population aged 15	-6.596	-5.162	-1.726	156.171
	(-0.997)	(-1.107)	(-0.104)	(0.952)
$W \times$ Ratio of population aged 65 and over	-6.837	-7.235	4.023	151.903
	(-1.003)	(-1.507)	(0.264)	(0.968)
ρ	0.391***	0.033	0.056	0.220***
	(5.642)	(0.829)	(1.271)	(2.602)
Observations	1452	1452	1452	1452
R^2	0.094	0.066	0.000	0.013

Panel B. Dynamic spatial panel model

	China	**Philippines**	**Brazil**	**Vietnam**
Lagged IGR (1,000 people)	0.237***	0.007	0.250***	0.626***
	(4.520)	(0.152)	(3.979)	(8.591)
$W \times$ Lagged IGR (1,000 people)	0.046	0.135*	0.115*	0.047
	(0.625)	(1.729)	(1.715)	(0.277)
Log of population density	1.177	-0.535	1.696	2.901
	(1.155)	(-0.735)	(0.781)	(0.911)
Log of average income taxes payment	0.072	0.021	-0.240	0.901*
	(0.611)	(0.171)	(-0.898)	(1.744)
Log of residential land value	-0.008	0.268	-0.057	(-2.299)
	(-0.036)	(1.123)	(-0.083)	(-2.299)
Ratio of population aged 15	-2.196	2.679	7.141	15.253
	(-0.920)	(0.783)	(0.811)	(1.326)
Ratio of population aged 65 and over	-1.922	1.330	4.316	19.791
	(-0.719)	(0.293)	(0.472)	(1.332)
$W \times$ Log of population density	-0.246	-1.254	1.274	-3.502
	(-0.212)	(-1.031)	(0.370)	(-0.525)
$W \times$ Log of average income taxes payment	0.027	0.156	0.376	-0.250
	(0.147)	(0.601)	(0.872)	(-0.283)
$W \times$ Log of residential land value	-0.766*	-0.662	-0.293	1.888
	(-1.787)	(-1.468)	(-0.174)	(0.894)
$W \times$ Ratio of population aged 15	-8.178	-4.579	-9.504	-23.760
	(-1.303)	(-0.663)	(-0.562)	(-0.670)
$W \times$ Ratio of population aged 65 and over	-5.105	-10.425	-2.249	-27.810
	(-0.741)	(-1.617)	(-0.136)	(-0.727)
ρ	0.191***	0.024	0.065	0.179***
	(2.905)	(0.571)	(1.513)	(3.223)
Observations	1210	1210	1210	1210
R^2	0.144	0.073	0.003	0.248

Notes: t-statistics are in parentheses. *, **, and *** represent the 10 percent, 5 percent, and 1 percent significance levels, respectively.

choice and positive effect of land price on Filipinos' residence choice were only identified in the static model. In contrast, in column 4 of Panel B, the dynamic model's coefficients of average individual income taxes payment and land price were significant at 10% and 5% levels, respectively. This implied that municipalities with higher average individual income taxes paid and municipalities with relatively low land prices attracted Vietnamese immigrants, as municipalities with high average individual income taxes payment had more business activities, producing more jobs and attracting immigrants. In addition, the relatively low land prices meant low rent, attracting Vietnamese immigrants.

Furthermore, the coefficients of spatial effects revealed that among the effects of socioeconomic factors in neighboring municipalities, the land price hindered the choice of residence of Chinese immigrants at a significance level of 10%. Chinese immigrants did not choose to live in municipalities where the neighboring land prices were high.

Finally, the R-square of the dynamic model was higher than that of the static model, indicating that the dynamic model better accounted for immigrants' choice of residence. Future studies should consider co-ethnic attraction when discussing reasons for immigrants' choice of residence.

5.3. *Estimation Results of Dynamic Spatial Panel Model with Direct and Indirect Effects*

Table 3 reports the estimated direct, indirect, and total effects of socioeconomic factors on the immigrant growth rate across countries in the dynamic SDM model presented in Table 2. The effects were divided into short-term and long-term, with the short-term not considering the effect of the time lag of the immigrant growth rate and the long-term considering the effect of the time lag of the dependent variable and its spatial lag term. The dynamic model considered the effect of the co-ethnic networks on the immigrant growth rate. The effect of the independent variable on the local municipality was called the direct effect, and the effect of other neighboring spatial municipalities on the local municipality was called the indirect effect. The total effect was the sum of the direct and indirect effects, meaning the average effect of a change in an independent variable in a municipality on the dependent variable in all municipalities.

In Panel A, when the effect of co-ethnic networks was not considered, each 1% increase in average individual income tax payment increased the immigrant growth rate from Vietnam by 0.9 immigrants per 1,000 people. In contrast, a 1% increase in land prices decreased immigrants' growth rate by 2.6 immigrants per 1,000 people. The immigrant growth rate from China decreased by 0.9 immigrants per 1,000 people for every 1% increase in the land price in the neighboring municipalities. Furthermore, for every 1% increase in the neighboring municipality's ratio of population aged 65 and over, the immigrant growth rate of Filipinos decreased by 10.8 immigrants per 1,000 people.

Considering the effect of co-ethnic networks, Panel B shows that for every 1% increase in the land price, the immigrant growth rate from Vietnam decreased by 6.7 immigrants per 1,000 people. A 1% increase in land prices in neighboring municipalities decreased the growth rate of Chinese immigrants by 1.4 immigrants per 1,000 people. For every 1% increase in the neighboring region's ratio of population aged 65 and over, the growth rate of Filipino immigrants decreaseds by 12.1 immigrants per 1,000 people. Co-ethnic networks enhanced the impact of socioeconomic factors on the immigrant growth rate. However, the impacts of socioeconomic factors on immigrants' growth

Table 3. Estimation results of dynamic spatial panel model with direct and indirect effects.

Panel A. Short-term

	China	Philippines	Brazil	Vietnam
Direct Effect: Log of population density	1.273	-0.468	1.957	3.060
	(1.341)	(-0.673)	(0.953)	(1.014)
Log of average income taxes payment	0.075	0.022	-0.244	0.888*
	(0.665)	(0.190)	(-0.943)	(1.804)
Log of residential land value	-0.042	0.262	-0.077	-2.559**
	(-0.210)	(1.170)	(-0.118)	(-2.414)
Ratio of population aged 15	-2.472	2.871	7.484	15.673
	(-1.055)	(0.847)	(0.855)	(1.333)
Ratio of population aged 65 and over	-1.918	1.666	5.192	20.520
	(-0.729)	(0.369)	(0.561)	(1.418)
Indirect Effect: Log of population density	-0.117	-1.407	1.140	-4.009
	(-0.097)	(-1.203)	(0.340)	(-0.576)
Log of average income taxes payment	0.071	0.184	0.411	-0.040
	(0.338)	(0.683)	(0.937)	(-0.044)
Log of residential land value	-0.932*	-0.646	-0.248	1.772
	(-1.717)	(-1.445)	(-0.142)	(0.783)
Ratio of population aged 15	-11.035	-4.749	-10.267	-26.610
	(-1.484)	(-0.695)	(-0.589)	(-0.649)
Ratio of population aged 65 and over	-7.248	-10.847*	-2.831	-30.256
	(-0.949)	(-1.734)	(-0.165)	(-0.709)
Total Effect: Log of population density	1.156	-1.875**	3.097	-0.949
	(1.269)	(-2.090)	(1.144)	(-0.158)
Log of average income taxes payment	0.145	0.206	0.167	0.849
	(0.685)	(0.802)	(0.482)	(1.095)
Log of residential land value	-0.974*	-0.385	-0.325	-0.788
	(-1.661)	(-0.817)	(-0.165)	(-0.342)
Ratio of population aged 15	-13.507*	-1.878	-2.783	-10.938
	(-1.692)	(-0.247)	(-0.182)	(-0.245)
Ratio of population aged 65 and over	-9.165	-9.181	2.361	-9.736
	(-1.185)	(-1.334)	(0.153)	(-0.237)

Panel B. Long-term

	China	Philippines	Brazil	Vietnam
Direct Effect: Log of population density	1.680	-0.513	2.684	8.642
	(1.367)	(-0.750)	(1.006)	(0.504)
Log of average income taxes payment	0.101	0.028	-0.308	2.415
	(0.689)	(0.237)	(-0.919)	(0.959)
Log of residential land value	-0.086	0.247	-0.114	-6.725*
	(-0.322)	(1.098)	(-0.126)	(-1.704)
Ratio of population aged 15	-3.624	2.774	9.569	42.460
	(-1.158)	(0.808)	(0.839)	(0.604)
Ratio of population aged 65 and over	-2.766	1.388	6.845	54.494
	(-0.800)	(0.306)	(0.566)	(0.877)
Indirect Effect: Log of population density	0.121	-1.683	2.376	-14.686
	(0.071)	(-1.326)	(0.473)	(-0.118)
Log of average income taxes payment	0.127	0.215	0.582	2.011
	(0.401)	(0.707)	(0.892)	(0.232)
Log of residential land value	-1.433*	-0.698	-0.399	2.331
	(-1.677)	(-1.372)	(-0.141)	(0.114)
Ratio of population aged 15	-17.351	-4.980	-14.199	-66.374
	(-1.484)	(-0.635)	(-0.532)	(-0.165)
Ratio of population aged 65 and over	-11.423	-12.141*	-2.989	-80.471
	(-0.978)	(-1.721)	(-0.113)	(-0.201)
Total Effect: Log of population density	1.801	-2.196**	5.060	-6.043
	(1.248)	(-2.087)	(1.142)	(-0.051)
Log of average income taxes payment	0.229	0.242	0.274	4.425
	(0.683)	(0.802)	(0.482)	(0.626)
Log of residential land value	-1.519	-0.451	-0.513	-4.394
	(-1.614)	(-0.816)	(-0.159)	(-0.217)
Ratio of population aged 15	-20.975*	-2.206	-4.631	-23.913
	(-1.648)	(-0.247)	(-0.184)	(-0.059)
Ratio of population aged 65 and over	-14.189	-10.753	3.856	-25.977
	(-1.167)	(-1.332)	(0.151)	(-0.065)
Observations	1210	1210	1210	1210
R^2	0.144	0.073	0.003	0.248

Notes: t-statistics are in parentheses. *, **, and *** represent the 10 percent, 5 percent, and 1 percent significance levels, respectively.

Table 4. Estimation results of dynamic spatial panel model including other countries.

	China	Philippines	Brazil	Vietnam
Lagged IGR (1,000 people)	0.245***	0.001	0.251***	0.631***
	(4.324)	(0.015)	(3.972)	(8.801)
$W \times$ Lagged IGR (1,000 people)	0.045	0.126	0.110	0.041
	(0.555)	(1.563)	(1.608)	(0.242)
IGR of China (1,000 people)		0.022	-0.031	0.023
		(0.427)	(-0.329)	(0.073)
IGR of Philippines (1,000 people)	0.021		0.05	0.004
	(0.332)		(0.391)	(0.021)
IGR of Brazil (1,000 people)	-0.004	0.007		-0.045
	(-0.303)	(0.451)		(-0.568)
IGR of Vietnam (1,000 people)	0.005	0.000	0.013	
	(0.686)	(-0.087)	(0.842)	
Log of population density	1.156	-0.513	1.547	3.024
	(1.126)	(-0.724)	(0.715)	(0.892)
Log of average income taxes payment	0.063	0.023	-0.259	0.884*
	(0.536)	(0.192)	(-0.949)	(1.681)
Log of residential land value	0.047	0.261	-0.110	-2.848**
	(0.229)	(1.100)	(-0.156)	(-2.437)
Ratio of population aged 15	-2.701	3.153	6.578	14.444
	(-1.067)	(0.893)	(0.744)	(1.218)
Ratio of population aged 65 and over	-2.325	1.959	3.238	18.421
	(-0.855)	(0.425)	(0.360)	(1.212)
$W \times$ IGR of China (1,000 people)		0.094*	-0.173	-0.753
		(1.716)	(-1.501)	(-1.370)
$W \times$ IGR of Philippines (1,000 people)	0.119		-0.189	-0.362
	(1.506)		(-0.964)	(-1.227)
$W \times$ IGR of Brazil (1,000 people)	-0.023	-0.017		-0.133
	(-1.091)	(-0.803)		(-1.175)
$W \times$ IGR of Vietnam (1,000 people)	0.011	-0.006	-0.008	
	(0.651)	(-0.562)	(-0.242)	
$W \times$ Log of population density	0.154	-1.251	1.199	-2.897
	(0.135)	(-1.033)	(0.349)	(-0.443)
$W \times$ Log of average income taxes payment	-0.052	0.167	0.436	-0.086
	(-0.319)	(0.646)	(0.944)	(-0.094)
$W \times$ Log of residential land value	-0.657*	-0.622	-0.384	1.217
	(-1.666)	(-1.368)	(-0.217)	(0.663)
$W \times$ Ratio of population aged 15	-8.566	-2.069	-13.524	-33.928
	(-1.316)	(-0.289)	(-0.784)	(-0.934)
$W \times$ Ratio of population aged 65 and over	-4.701	-7.583	-7.368	-40.214
	(-0.670)	(-1.138)	(-0.431)	(-1.040)
ρ	0.180***	0.015	0.060	0.174***
	(2.742)	(0.333)	(1.403)	(3.016)
Observations	1210	1210	1210	1210
R^2	0.202	0.071	0.003	0.211

Notes: t-statistics are in parentheses. *, **, and *** represent the 10 percent, 5 percent, and 1 percent significance levels, respectively.

rates were not uniform, and there was heterogeneity across countries.

5.4. Estimation Results of Dynamic Spatial Panel Model Including Other Countries

To explore whether the co-ethnic network effect was valid only for immigrants from their own country, this study included the immigrant growth rates of the other three countries in the model. The results are presented in Table 4. The immigrant growth rates of other countries in the region did not produce attraction and spatial spillover effects. The co-ethnic network effect had an attraction effect only for Chinese and Vietnamese immigrants. In addition, the results implied that the residence of co-ethnic immigrants was not randomly distributed. There were no statistically significant exclusion and attraction effects between the different co-ethnic networks at the municipality level. The attraction of co-ethnic networks was only valid for immigrants of their eth-

Table 5. Estimation results from the static model, dynamic panel and dynamic spatial panel model.

	Static		Dynamic		Dynamic spatial	
	Philippines	**Brazil**	**Philippines**	**Brazil**	**Philippines**	**Brazil**
Lagged IGR (1,000 people)			-0.179***	0.056	0.007	0.250***
			(-3.735)	(0.881)	(0.152)	(3.979)
$W \times$ Lagged IGR (1,000 people)					0.135*	0.115*
					(1.729)	(1.715)
Log of population density	-1.082**	4.011**	-0.973*	3.750**	-0.535	1.696
	(-2.221)	(2.407)	(-1.785)	(2.474)	(-0.735)	(0.781)
Log of average income taxes payment	0.092	-0.199	0.062	-0.182	0.021	-0.240
	(0.607)	(-0.969)	(0.403)	(-0.902)	(0.171)	(-0.898)
Log of residential land value	0.208	-0.707	0.341	-0.631	0.268	-0.057
	(1.045)	(-0.925)	(1.517)	(-0.895)	(1.123)	(-0.083)
Ratio of population aged 15	2.225	14.579*	2.853	13.260*	2.679	7.141
	(0.679)	(1.723)	(0.817)	(1.724)	(0.783)	(0.811)
Ratio of population aged 65 and over	-1.888	15.196*	-1.366	13.941*	1.330	4.316
	(-0.549)	(1.905)	(-0.365)	(1.954)	(0.293)	(0.472)
Observations	1210	1210	1210	1210	1210	1210
R^2	0.629	0.222	0.639	0.225	0.073	0.003
AIC	-973.355	1571.446	-1006.329	1569.577	-959.504	1615.014

Notes: t-statistics are in parentheses. *, **, and *** represent the 10 percent, 5 percent, and 1 percent significance levels, respectively.

nicity.

5.5. Estimation Results of the Static and Dynamic Panel Model

The above results implied that the spatial panel model was not suitable to explain the residence choice of Filipino and Brazilian immigrants. To confirm which model best fits the two countries' data, Table 5 compared the results of the static panel model, dynamic panel model, and dynamic spatial panel model according to the Akaike information criterion (AIC).

The results of the static panel model, dynamic panel model, and dynamic spatial panel model for analyzing immigrant growth from the Philippines and Brazil are reported in Table 5. Columns (1) and (2) present the results of the static panel model, and Columns (3) and (4) present the results of the dynamic panel model. Columns (5) and (6) repeat the dynamic spatial Durbin model results presented in column B of Table 2. According to the AIC, the dynamic panel model fit the data better than other models.

As indicated in Columns (3) and (4), Filipino immigrants tended to move out of ethnic agglomerations and chose to live in less densely populated municipalities. The co-ethnic network effect for Brazilian immigrants was statistically insignificant. Brazilian immigrants tended to choose municipalities with high population density, both with relatively dense labor force populations and in municipalities with relatively dense elderly populations.

The results indicated that Filipino and Brazilian immigrants' reliance on co-ethnic networks in their choice of residence disappeared, and there was a high degree of ethnic assimilation in Tokyo.

6. Discussion and Conclusions

The dynamic spatial Durbin model revealed that ρ and τ were significantly positive at the 1% level, whereas η was positive but insignificant, suggesting that the spatio-

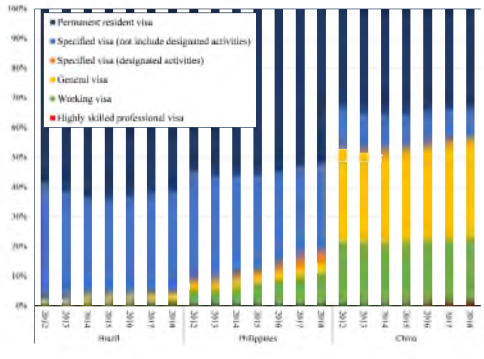

Figure 6. The proportion of status of residence across countries and overtime in Tokyo area. The data source is the Statistics on Foreign Residents in Japan produced by Ministry of Justice.

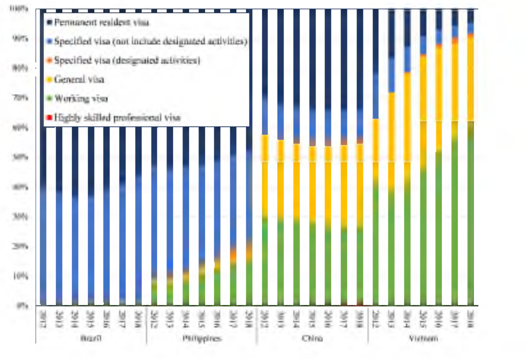

Figure 7. The proportion of status of residence across countries and overtime in Japan. The data source is the Statistics on Foreign Residents in Japan produced by Ministry of Justice.

temporal dependence of co-ethnic networks significantly increased the growth rate of immigrants from China and Vietnam. However, spatio-temporal dependence was not as effective for the Philippines and Brazil. This result implied that immigrants from the Philippines and Brazil assimilated more than immigrants from China and Vietnam.

However, judging the degree of assimilation of an ethnic group solely from the influence of shared ethnic networks is one-sided because there is a distinction between older and newer immigrants within the same ethnic group, who may have completely different levels of assimilation and may be heterogeneous in their choice of place of residence. There are studies using surveys to evaluate the degree of assimilation through immigrants' language ability, earnings, and intermarriage (Bleakley and Chin, 2010; Qian and Lichter, 2001; Villarreal and Tamborini, 2018; Waters and Jiménez, 2005). However, there is a lack of surveys for immigrants in Japan.

Although it is difficult to analyze the degree of assimilation using survey data on individual immigrants in Japan, Japan's Immigration Control and Refugee Recognition Act provides a way to observe the degree of assimilation of an ethnic group from the first-level administrative divisions. Japan has many types of immigrant visas (the descriptions of the visa types are in Table A2), one of which is called a permanent resident visa, the holder of which has the right to reside in Japan permanently. Generally, applicants must have five years of work experience and at least ten years of residence in Japan to apply for this type of visa. Since immigrants with permanent resident visas take much longer to adapt in Japanese society than immigrants with other visas, they assimilate relatively more as their language skills and earnings improve or they intermarry. In addition, those who hold visas for spouse or child of Japanese national, permanent resident and long-term resident visa also considered to have a higher level of assimilation.

Because government statistics do not provide aggregated visa types in municipalities and among ethnic groups could not be aggregated, Figure 6-7 only provide the proportion of immigrants with each type of visa at the Japan and Tokyo area level for each ethnic group. This is used to compare the general picture of the differences in assimilation levels among ethnic groups. Figure 6 shows the percentage of Chinese, Filipino, and Brazilian immigrants with different types of visas in Tokyo area. Figure 6 does not include Vietnam, as there is no publicly available information on the types of visas available for Vietnam at the prefecture level. The figure shows that half of the Chinese immigrants are permanent residents and spouse of a permanent resident, while almost all immigrants from Brazil and the Philippines are holders of permanent resident visa or specified visa. This adds to the rationality and reliability of the empirical results. In other words, because of the high level of assimilation, there is no significant spatio-temporal dependence exists in the co-ethnic networks of Brazilian and Filipino immigrants. When Figures 6 and 7 are compared, the percentage distribution of immigrants from Brazil, the Philippines, and China in each type of visa is nearly identical. Therefore, although there is a lack of data on Vietnamese immigrants in the Tokyo area, it may be assumed that the relative distribution of Vietnamese immigrants in the Tokyo area holding various types of visas is comparable to Figure 7. The Figure shows that the percentage of permanent residents from Vietnam decreased sharply after 2012, caused by the influx of new Vietnamese immigrants. Figure 7 explains that the strong attraction effect of Vietnamese co-ethnic networks is due to the significant increase in new immigrants.

In contrast to the high assimilation of Brazilian and Filipino immigrants, the influence of co-ethnic networks remained decisive in the choice of residence of Chinese and Vietnamese immigrants. It is important to note that half of the Chinese immigrants are permanent residents, and their reliance on co-ethnic networks may not be evident according to the interpretation of assimilation theory. The impact of co-ethnic networks is more evident in the residence choice of newcomer immigrants. Furthermore, two possible clustering patterns among old immigrants are inconsistent with the predictions of spatial assimilation theory. One is to live in the geographical ethnic communities at the beginning of their arrival in Japan and upgrade their housing in the area without moving out of the communities after achieving higher social and economic status. The other is that they move from geographical ethnic communities with poorer conditions to communities with better conditions. The discussion of heterogeneity in the degree of assimilation within ethnic groups is a meaningful direction for future research.

In sum, this study assessed the influence of co-ethnic networks and socioeconomic factors on immigrants' residence choices using regional data on immigrants in the Tokyo region of Japan. Furthermore, the extent of immigrants' assimilation was explored based on influential elements of residence choice and spatial assimilation theory. The results demonstrated that the spatial assimilation progress of immigrants is heterogeneous across ethnic groups in Japan. However, this study has certain limitations. Due to limited data, the second or third-generation immigrants born in Japan but still hold the original nationality cannot be separated from the analysis. It is also not possible to distinguish between old and new immigrants. This limitation needs to be improved in the future as the data are refined.

Although Japan does not actively promote assimilation, it has adopted a policy of constructing mutual respect and building a multicultural society. However, research on whether this policy has influenced the assimilation of immigrants and whether it has contributed to the development of Japanese society is still in its infancy. In addition, whether to pursue assimilation policies in Japan and how to advance them is up for debate. Regardless of any policy, it is necessary to understand the current status and trends in the spatial assimilation of immigrants in Japan to deal with the growing immigration. Policymakers should be aware that the assimilation process is heterogeneous among immigrants from different ethnic groups and may be heterogeneous within ethnic groups. This must be considered when conducting research and developing immigration policies.

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Appendix A.

Table A1. Data source.

Variable	Data Source
Immigrant	Ministry of Justice (MOJ) *https : //www.moj.go.jp/EN/index.html*
Land area	Geospatial Information Authority of Japan (GSI) *https : //www.gsi.go.jp/ENGLISH/*
Population and tax payment	Statistics Bureau of Japan (SBJ) *https : //www.stat.go.jp/english/*
Residential area land price	Ministry of Land, Infrastructure, Transport and Tourism (MLIT) *https : //www.mlit.go.jp/en/index.html*

Table A2. Visa category and period of stay in Japan.

Visa Category	Period of Stay
Highly skilled professional visa	
Highly skilled professional	5yr
Highly skilled foreign professional	5yr
Working visa	
Professor	5, 3, 1yr, 4 or 3m
Artist	5, 3, 1yr, 4 or 3m
Religious activities	5, 3, 1yr, 4 or 3m
Journalist	5, 3, 1yr, 4 or 3m
Business manager	5, 3, 1yr, 4 or 3m
Legal/Accounting services	5, 3, 1yr, 4 or 3m
Medical services	5, 3, 1yr, 4 or 3m
Researcher	5, 3, 1yr, 4 or 3m
Instructor	5, 3, 1yr, 4 or 3m
Engineer et al.*	5, 3, 1yr, 4 or 3m
Intra-company transferee	5, 3, 1yr or 3m
Nursing care	5, 3, 1yr, 4 or 3m
Entertainer	3, 1yr, 6, 3m, or 15d
Skilled labor	5, 3, 1yr or 3m
Specified skilled worker	3, 1yr, 4 or 3m
Technical intern training	1yr, 6m or a designated period of less than 1yr
General visa	
Cultural activities	3, 1yr, 6 or 3m
Student	4yr-3m, 4yr, 3yr-3m, 3yr, 2yr-3m, 2yr, 1yr-3m, 1yr, 6 or 3m
Training	1yr, 6 or 3m
Dependent	5yr, 4yr-3m, 4yr, 3yr-3m, 3yr, 2yr-3m, 2yr, 1yr-3m, 1yr, 6 or 3m
Specified visa	
Spouse or child of Japanese national	5, 3, 1yr or 6m
Spouse of permanent resident	5, 3, 1yr or 6m
Long-term resident	5, 3, 1yr, 6m or a designated period of less than 5yr
Designated activities	5, 4, 3, 2, 1yr, 6, 3m or a designated period of less than 5yr
Designated activities	6m (Long Stay for sightseeing and recreation)
Permanent resident visa	
Permanent resident	No period

Note: *Engineer/Specialist in humanities/International services. yr=year, m=month, d=day. Data source: Ministry of Foreign Affairs of Japan (*https : //www.mofa.go.jp/j_info/visit/visa/long/index.html*).