# Who moves where—and what housing choices do they make? uncovering spatial polarization through life-course migration in a shrinking megacity

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出版情報：Cities. 169, pp.106508-, 2026-02. Elsevier
バージョン：

Cities 169 (2026) 106508

Contents lists available at ScienceDirect

Cities

journal homepage: www.elsevier.com/locate/cities

# Who moves where—and what housing choices do they make? uncovering spatial polarization through life-course migration in a shrinking megacity

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A B S T R A C T

Spatial polarization is a bottom-up process embedded in life-course trajectories rather than arising solely from macro-scale demographic decline. This study examines how life-course migration and housing choices shape spatial polarization in the Tokyo Metropolitan Area (TMA), a prototypical shrinking megacity. Using an integrated framework—combining survivorship-based cohort estimation, robust multiple linear regression, random forests, and geographically weighted regression—this research links micro-level residential decisions to broader demographic and structural transformations.

Results identify three life-course migration cohorts whose divergent housing choices reinforce a polarized geography of youthful cores, family-oriented inner suburbs, and ageing peripheries. Young adults cluster in central Tokyo's high-density rentals near transit hubs; young families pursue homeownership and educational access in western Tokyo and inner suburbs; while older seniors relocate to eastern Tokyo and peripheral municipalities, shaped by low-cost rentals and rural attachments. Across cohorts, housing tenure emerges as the strongest determinant of Migration Pattern Intensity (MPI), outweighing land prices, neighborhood characteristic, and accessibility.

These findings advance the concept of a "polarized life-course housing trajectory" to explain how housing choices across life stages accumulate into multiscale polarization, intensified by intergenerational transfers. The study introduces this novel lens to bridge macro-structural shrinkage with micro-level residential practices to understand spatial polarization. Policy insights stress integrating foreign labor and multicultural inclusion at the regional scale and promoting multi-generational housing locally to mitigate suburban shrinkage and ageing. These strategies resonate with the SDGs and global sustainability agendas, offering lessons for urban governance in megacities confronting demographic contraction.

## 1. Introduction

Despite the continued global expansion of metropolises (Sun et al., 2024), many megacities are now confronting the inevitability of urban shrinkage (Haase et al., 2016; He et al., 2023; Liu & Liu, 2022; Sorensen, 2019; Tateishi et al., 2021; Tu et al., 2024; Wiechmann & Pallagst, 2012). Concurrently, spatial polarization has emerged as a defining characteristic of this shrinkage (Kidokoro et al., 2021; Kidokoro et al., 2021b). Under polycentric urban configurations, population and material resources become disproportionately concentrated in dominant core cities, while small- and medium-sized cities and peripheral areas are systematically marginalized (Aguilar & Hernandez-Lozano, 2024; Liu et al., 2020). Demographic aging and declining fertility further exacerbate these imbalances, posing acute challenges for equitable and sustainable regional planning (Hiroya et al., 2014; Xu et al., 2024).

Existing studies have primarily interpreted such polarization from a macro-structural perspective, emphasizing measurement through a polarization index (Kidokoro et al., 2021), the neoliberal policymaking context (Saito, 2021), and demographic imbalances that simultaneously drive metropolitan concentration and peripheral shrinkage (Hiroya et al., 2014; Xu et al., 2024). However, this macro focus leaves insufficient attention to the bottom-up mechanisms through which individual migration trajectories reconfigure urban space.

Life-course migration offers a critical theoretical lens for addressing this gap. It captures how family formation, child-rearing, and retirement trigger shifts in tenure, dwelling size and location (Clark & Onaka, 1983), linking micro-level residential decisions to broader demographic change. Housing choices are central to this process (Clark & Huang, 2003), shaping how migration across different life stages contributes to polarization within megacities. More recent evidence indicates that resource reallocations driven by life-course migration exert profound structural effects on intra-urban spatial reconfiguration, particularly under conditions of urban shrinkage and demographic decline (Guimarães et al., 2016; Gurrutxaga, 2020; Slach et al., 2019; Ubarevičienė et al., 2024). However, applying this novel perspective to understand spatial polarization remains challenging, as housing decisions are contingent on life stages and shaped by spatially heterogeneous mechanisms.

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https://doi.org/10.1016/j.cities.2025.106508
Received 2 February 2025; Received in revised form 31 August 2025; Accepted 22 September 2025
Available online 3 October 2025

Multi-model integration provides an effective strategy to tackle these complexities. Robust multiple linear regression (Robust MLR) can reveal stable relationships between housing choices and life-course migration (Filzmoser & Nordhausen, 2021); machine learning approaches such as random forests (RF) extract latent structures from high-dimensional data, including multi-temporal population information and extensive housing-choice variables, while facilitating dimensionality reduction (Zhou et al., 2019); and spatial models like geographically weighted regression (GWR) capture spatial heterogeneity in the relationships between key housing choices and migration behaviors (Gu et al., 2022). Taken together, these complementary methods form a flexible and robust framework for examining complex polarization and migration processes, particularly when models are carefully selected and tuned (Ma et al., 2022; Xue & Yao, 2022).

This study examines the Tokyo Metropolitan Area (TMA), a prototypical shrinking megacity, using a multi-model integration approach to explore how life-course migration and housing choices shape spatial polarization even within a developed polycentric structure (Fig. 1). From a life-course perspective, it addresses four interrelated questions:

1) Which life-course groups are migrating?
2) Where do they migrate from and to?
3) What housing choices do they make, and how do these choices vary across regions?
4) How do migration and housing choices at different life stages contribute to spatial polarization in a shrinking megacity?

By addressing these questions, the study sheds light on the everyday migration and housing practices underpinning polarization and highlights strategies for managing mobility and restructuring residential resources. In doing so, it aligns with the SDGs and global sustainability agendas, fostering more equitable and resilient regional development in shrinking megacities worldwide.

## 2. Literature review

### 2.1. *Life-course migration and housing preferences*

#### 2.1.1. *Housing characteristics*

Housing characteristics, including dwelling type, tenure arrangement, and affordability, critically influence residential choices over the life course. This is evident in how key life transitions—such as marriage, childbirth, and divorce—often prompt shifts in housing tenure from renting to ownership (Clark & Huang, 2003; Wagner & Mulder, 2016). Additionally, changes in employment status and family composition lead to housing upgrades or downgrades, reflecting evolving space requirements and financial capacities (Feijten & Mulder, 2005).

More recent studies have underscored the growing link between housing tenure and intergenerational inequality. Younger cohorts increasingly struggle to secure stable housing—epitomized by the UK's "Generation Rent" and Sweden's "inbetweeners" (Cole et al., 2016; Grander, 2023). Comparative evidence across diverse contexts further demonstrates that parental housing wealth and transfers are central to earlier homeownership and uneven housing trajectories, with housing assets contributing more than labor income to the reproduction of wealth inequality (Japan: Fukuda et al., 2024; Shanghai: Cui et al., 2020; United Kingdom: Savage, 2024; Australia: Bell, 2025; Czech Republic: Lux & Sunega, 2025; Denmark: Daysal et al., 2023; Hongkong and Scotland: Wong, 2019).

Beyond intergenerational disparities, broader market dynamics also constrain housing choices. Rising housing prices limit relocation options, particularly for younger households with limited purchasing power (Winke, 2021). At the same time, in super-aged societies, affordability pressures increasingly affect older adults facing life events such as widowhood or separation from children (Li et al., 2022; Malmberg et al., 2024).

#### 2.1.2. *Neighborhood characteristics*

Neighborhood characteristics play a crucial role in life-course migration behaviors, particularly in terms of demographic composition, local employment structure, and climatic conditions.

High concentrations of unemployed households and minority groups can undermine neighborhood reputation, drive out-migration and deter in-migrants (Crowder et al., 2011; Langella & Manning, 2022). Similarly, a high share of foreign residents may delay home-leaving among young adults, especially women (McAvay & Pailhé, 2022). Yet longitudinal evidence from the United States (1990–2020) suggests a generational shift, as Millennials are more willing to settle in diverse neighborhoods (Brazil & Candipan, 2025).

Beyond demographic composition, the local employment structure also shapes migration behavior. Earlier studies found that primary-sector regions attract individuals at early career stages, whereas secondary- and tertiary-sector regions appeal to more established households (Mulder & Wagner, 1998). More recent findings from Germany indicate that knowledge-intensive, service-oriented, and metropolitan-adjacent regions attract young and highly skilled populations, while primary-sector regions display weaker net migration performance (Meister et al., 2023).

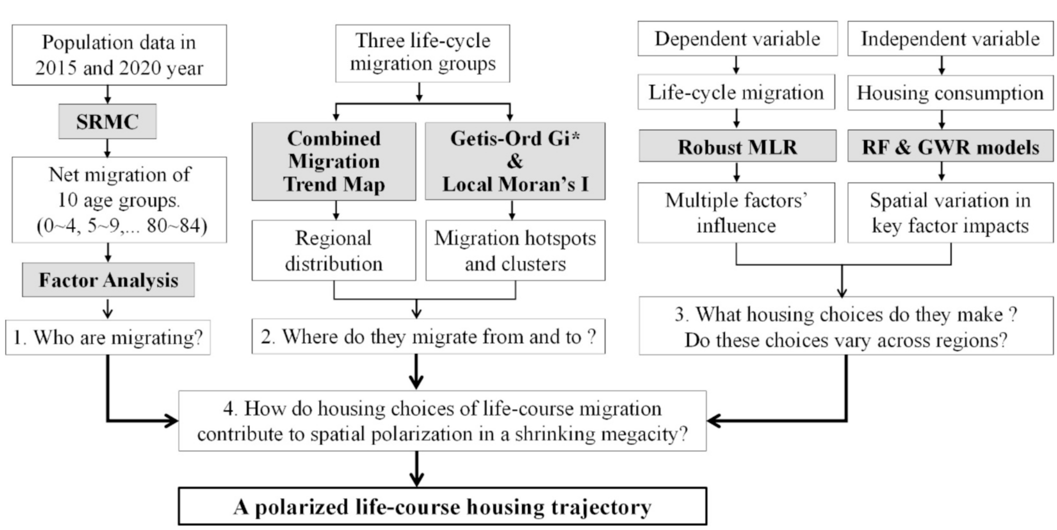



**Fig. 1.** Research framework: multi-model integration approach, research questions and objectives.

Climatic conditions also play an important role in shaping migration across the life course. Evidence from the United States shows that higher temperatures significantly reduce net in-migration, with older populations more sensitive to heat (Baylis et al., 2025). Complementary findings from China demonstrate that extreme rainfall increases migration probabilities, particularly among young adults (Lyu et al., 2025).

### 2.1.3. Accessibility

Accessibility is a key determinant of relocation decisions, with different groups prioritizing different facilities over the life course. For young adults and carless households, proximity to public transit hubs facilitates commuting and daily activities (Giuliano & Dargay, 2006). Families with children often relocate to secure access to higher-quality schools, as educational accessibility shapes both residential choice and commuting patterns (Clark & Huang, 2003). Beyond schools, access to green space is associated with lower relocation intentions among families and older adults (Dovbischuk & Kley, 2024). As driving ability declines in older age, neighborhood walkability to medical services, daily facilities, and parks emerges as a critical determinant of relocation behavior (Redelmeier et al., 2023; Takano et al., 2002). Taken together, these findings underscore how accessibility to transit, education, green space, and services differentially influences migration across life stages.

## 2.2. Migration and polarization in Japan

The Tokyo Metropolitan Area (TMA) provides an exemplary context for examining how life-course migration and housing choices shape spatial polarization. Japan, at the global forefront of aging and fertility decline, is often regarded as a demographic "pioneering experiment" with profound policy implications (McCurry, 2015; Raymo, 2022). Unlike Europe and North America, regional disparities in Japan are largely driven by internal migration: since 2012, population growth in Tokyo's core has relied entirely on inflows from non-metropolitan regions rather than natural increase (Fig. 2; Fig. 3). Hiroya et al. (2014) warned of a highly polarized society with a looming "demographic black hole," predicting the disappearance of nearly 20 % of peripheral cities by 2040.Today, 63.2 % of Japan's land is designated as depopulated, housing only 9.3 % of the population, while the TMA—covering less than 10 % of the territory—concentrates 41.26 % of the total (Ministry of Internal Affairs and Communications, MIC, 2023).

Beyond demographic concentration, polarization in the TMA is reinforced by deepening social contradictions. Foreign workers, only 3 % of the workforce yet nearly half of recent labor-force growth, are vital for filling shortages but provoke exclusionary rhetoric (Organisation for Economic Co-operation and Development (OECD), 2024; Asahi Shimbun 2025).

Meanwhile, central Tokyo experiences gentrification fueled by foreign capital inflow, with rising rents displacing low-income residents (Hernon, 2025). In contrast, peripheral areas face population loss, infrastructure deficits, and the rise of elder-to-elder caregiving (United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), 2014).

Although the TMA has developed an advanced polycentric network, functional linkages among peripheral hubs remain weak (Liu et al., 2020). Even Tsukuba Science City struggles to retain young talent amid population aging and infrastructure deficits (Tateishi et al., 2021). As shown in Fig. 4, this study defines the TMA as the empirical setting. Shaped by five National Capital Region Development Plans (NCRDP) between 1958 and 2015 (Wang et al., 2024), the TMA has evolved into a three-tiered, ring-shaped polycentric network organized around four designated planning areas that integrate business centers, regional core cities, and hub cities (see Appendix 1).

## 2.3. Research gap and contribution

In the context of continuing population decline, internal migration has become a key driver of regional disparities in Japan, making it crucial to identify the population groups shaping these flows. The collapse of the Jutaku Sugoroku paradigm (Fukuda et al., 2024) further underscores the need to examine how life-course housing trajectories are being reshaped, and how migration and housing choices across different social groups contribute to a polarized society.

Nevertheless, existing research has paid limited attention to these mechanisms. Prior studies have mainly focused on three areas: (1) the effects of demographic structure, industrial composition, and the urban environment on spatial disparities (Kidokoro et al., 2021; Kidokoro et al., 2021b); (2) the role of neoliberal policy shifts and institutional change in reinforcing core–periphery divides (Saito, 2021; Ogawa & Kondoh, 2022); and (3) the interaction between population dynamics and city size in sustaining Tokyo's concentration alongside peripheral decline (Hiroya et al., 2014; Xu et al., 2024). A smaller body of work has examined residents' perceptions in growing and shrinking neighborhoods, but such localized surveys limit the generalizability of findings (Fukuda et al., 2024; Sho et al., 2024).

While valuable, these strands of research provide limited insights into how ordinary migration and housing practices generate spatial polarization. To address this gap, this study develops a Life-Course Housing Trajectory Paradigm by analyzing migration and housing choices across life stages together with factors such as tenure structure, housing density and form, and accessibility to transport and parks. Applied to the TMA—a prototypical shrinking megacity—this framework advances theoretical understanding of polarization and offers policy-relevant insights for more equitable and sustainable urban development.

# 3. Research methodology

## 3.1. Research data

Population data by 5-year age groups from 2015 to 2020 was provided by ZENRIN, based on the World Geodetic System and JGD2000. In

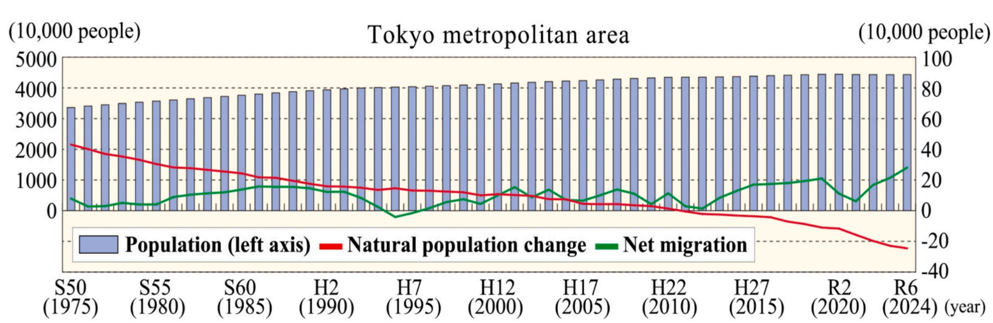



**Fig. 2.** Trends in natural population change and net migration in the Tokyo metropolitan area from 1975 to 2024. Source: Hiroya et al. (2014), redrawn by the author.

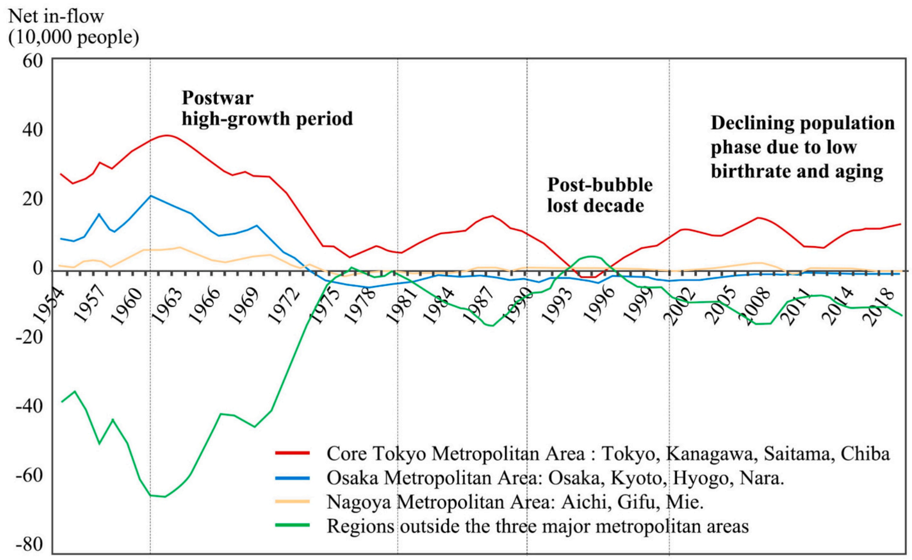



**Fig. 3.** Population migration dynamics in Japan's three major metropolitan areas and non-metropolitan regions from 1954 to 2018. Source: Hiroya et al. (2014), redrawn by the author.

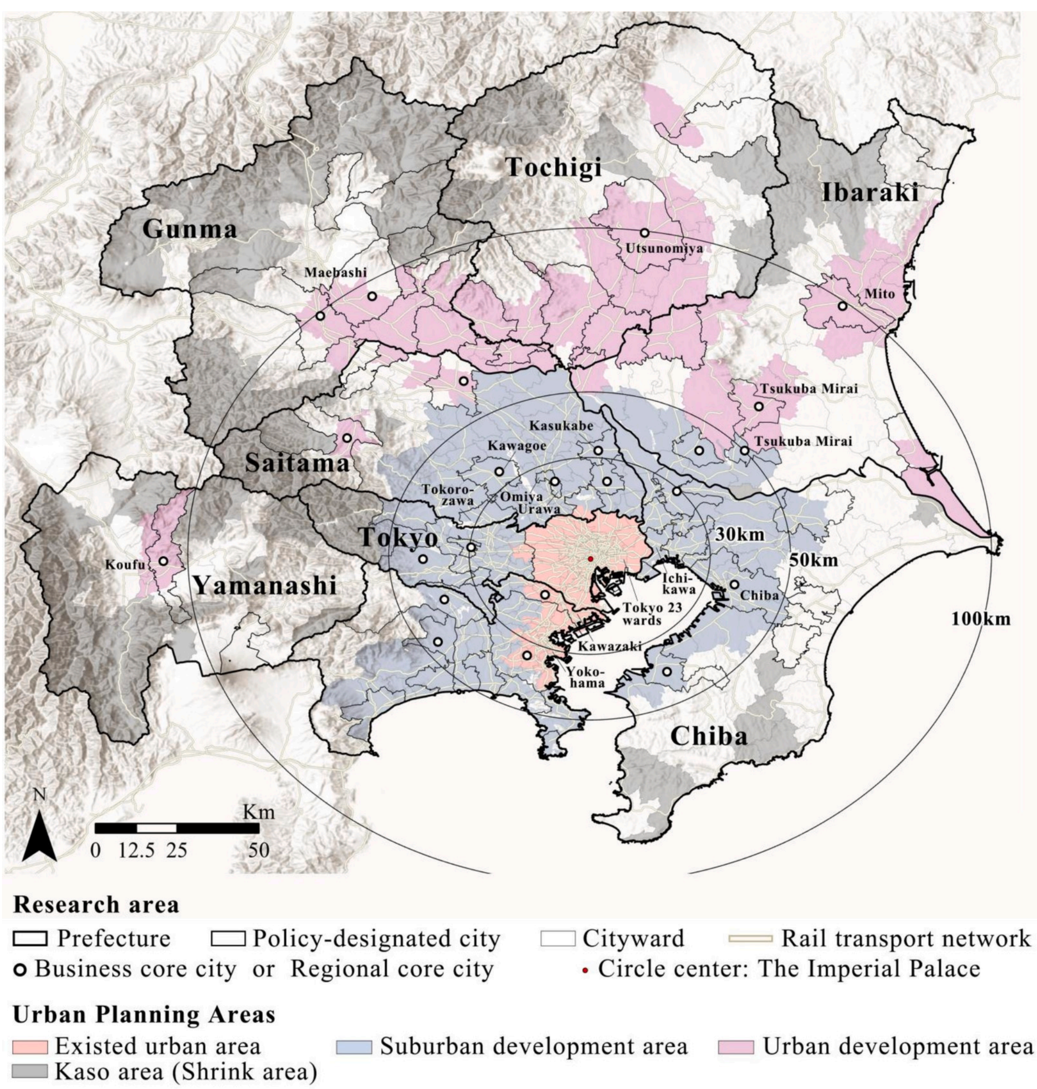



**Fig. 4.** Tokyo Metropolitan Area (TMA) and its polycentric "multi-core, multi-ring" structure.

addition, survival rates from 2015 to 2020 were provided by the National Institute of Population and Social Security Research (IPSS) (2023), and the accuracy is municipal boundaries. Appendix 2 also presents detailed information on independent variables related to housing choices used in this study, including their abbreviations, explanations, data sources, and value ranges.

### 3.2. Justification of multi-model integration

First, the Survival Rate Method between Censuses (SRMC) method combined with Factor analysis (FA) is applied to estimate age-specific net migration for ten cohorts between 2015 and 2020, with factor scores representing migration pattern intensity (MPI). Although survivorship-based estimates may introduce some error, this approach has proven robust and effective in handling large demographic datasets, particularly in the Japanese context (Koike, 2010; Takatori, 2018).

Second, complementary models are integrated to analyze the determinants of MPI. Robust MLR establishes a global baseline by clarifying the direction of explanatory variables, yet it assumes spatial homogeneity and provides limited insight into variable importance. RF addresses this limitation by ranking predictors through a flexible non-parametric approach, thereby supporting variable selection (Genuer et al., 2010). However, both Robust MLR and RF fall short in capturing spatial variation. GWR is therefore employed to examine how key variables operate across space, thus revealing regional heterogeneity in migration drivers. Importantly, GWR cannot accommodate all 44 explanatory variables simultaneously, as each variable generates local coefficients at every spatial unit, resulting in parameter explosion, severe local multicollinearity, and risks of overfitting (Wheeler & Tiefelsdorf, 2005). For this reason, global estimation from MLR remains indispensable as a reference framework (Abdulhafedh, 2022). Although RF also produces global estimates, its reliance on non-linear structures makes the results less transparent and less directly comparable to those of GWR, which is grounded in a linear framework (Fox et al., 2020).

Together, this workflow of "trend estimation—baseline regression—variable selection—spatial heterogeneity" combines methodological robustness with complementary analytical strengths, enabling a comprehensive understanding of migration patterns in terms of their magnitude, spatial structure, and underlying driving mechanisms.

### 3.3. Methodology

#### 3.3.1. Survival rate method between censuses (SRMC)

In this study, net population migration of 10 age groups from 0 years old at five-year intervals from 2015 to 2020 are calculated:

$$M_{t1\sim t2}(a, a+4) = P_{t2}(a+5, a+9) - P_{t1}(a, a+4) \times S_{t1\sim t2}(a, a+4) \quad (1)$$

Where $P_t$ represent the population in year t, a is the starting age of a given cohort. S refers to the average survival rate of a given area, and M is the number of net migrants. $M_{t1\sim t2}(a, a+4)$ indicates the net migration of the population aged $a \sim a+4$ from year t1 to t2.

#### 3.3.2. Factor analysis (FA)

FA based on Principal Component Analysis (PCA) was conducted to identify common features in the net migration of ten age groups. This method is widely used to reduce data dimensionality and reveal underlying structures (Shrestha, 2021; Takatori, 2018). Data adequacy was confirmed by the Kaiser-Meyer-Olkin (KMO) statistic (>0.7) and Bartlett's Test of Sphericity ($p < 0.05$), indicating sufficient correlation among variables. The number of factors to extract was determined using the Kaiser criterion and the Scree test to maximize explained variance. Orthogonal rotation was applied to improve interpretability, and factor loadings were used to assess the contribution of each age group to a given factor. In this study, the resulting factor scores are employed as indicators of MPI, representing the relative strength of age-specific net migration embedded in each extracted factor.

#### 3.3.3. Multiple linear regression analysis (MLR)

MLR was used to examine the linear relationships between MPI and 44 explanatory variables, under the assumption of acceptable levels of multicollinearity (Gao et al., 2022). The general form of the model is:

$$Y = b_0 + b_1X_1 + b_2X_2 + \ldots + b_nX_n + \epsilon \quad (2)$$

Where Y is the dependent variable, $X_1$, $X_2$, … $X_n$ are the independent variables, b represents regression coefficients, $b_0$ is the intercept, and $\varepsilon$ is the error term.

Given the high-dimensional nature of the dataset, robust regression methods were employed to account for heteroskedasticity and outliers. Specifically, we implemented Ordinary Least Squares (OLS) with heteroskedasticity-consistent robust standard errors and Iteratively Reweighted Least Squares (IRWLS) in RStudio. Standardized coefficients ($\beta$) were subsequently computed to enable comparison across variables measured in different units. Model performance was evaluated using the Root Mean Square Error (RMSE) and the coefficient of determination ($R^2$). Statistical significance was assessed at the 5 % level ($p \leq 0.05$), and multicollinearity was diagnosed using the Variance Inflation Factor (VIF), with values above 10 indicating potential instability in the estimates. Detailed formula derivations and computation code are provided in Appendix 3.

#### 3.3.4. Random forest (RF)

RF, proposed by Breiman (2001), is an ensemble learning method that aggregates multiple decision trees using bootstrap samples and random variable selection at each split, thereby reducing overfitting and improving prediction stability. To ensure robustness, three key parameters—number of trees (*ntree*), number of variables at each split (*mtry*), and minimum *node size*—were optimized following the procedure of Xue and Yao (2022). The value of *ntree* was increased until the Mean Squared Error (MSE) stabilized, after which the combination of *mtry* and *nodesize* minimizing the RMSE was selected (Table 1). The R code used for this analysis is provided in Appendix 4.

From the optimized RF model, the ten most important variables were first identified (Table 2), and the model was re-tuned using this reduced set. A backward elimination procedure was then applied, sequentially removing the least important predictors until the subset minimizing out-of-bag (OOB) error was obtained (Appendix 5). This final subset was incorporated into the GWR analysis in GISPro 3.4. To address potential multicollinearity during GWR estimation, variables with the lowest importance or weakest spatial autocorrelation were excluded (Table 2: E_pHea and rec_Dem).

#### 3.3.5. Geographically weighted regression (GWR)

GWR is a local linear regression method based on spatially varying relationships, which is widely used in analyzing spatial disparity (Comber et al., 2023). The mathematical expression is as follows:

$$Y_i = B_0(u_i, v_i) + \sum_{j=1}^{k} B_j(u_i, v_i)X_{ij} + e_i \quad (3)$$

where in location i, $Y_i$ is the dependent variable, $X_{ij}$ is the j-th independent variables; $B_0$ and $B_j$ are the influence coefficients, while (ui,vi) is the coordinates.

In this study, a Gaussian continuous model was used, and the optimal bandwidth was determined by the Golden Section Search method,

**Table 1**
Optimal random forest parameters and number of independent variables for each factor.

| | Factor1 | Factor2 | Factor3 |
|---|---|---|---|
| Independent variables | 44 | 44 | 44 |
| nTree | 200 | 200 | 200 |
| Mtry | 8 | 10 | 10 |
| nodesize | 17 | 6 | 5 |

**Table 2**
Spatial autocorrelation of key variables based on Moran's I.

| | Variable | Moran's index | z-Score | Sig. |
|---|---|---|---|---|
| Housing characteristic | F_Home | 0.567295 | 150.747837 | *** |
| | F_Pri | 0.633632 | 168.375079 | *** |
| | logLp2016 | 0.874462 | 232.368415 | *** |
| Neighborhood characteristic | E_NoFam | 0.850534 | 226.163802 | *** |
| | **E_pHea** | **0.081441** | **21.657441** | *** |
| | **rec_Dem** | **0.236582** | **63.846173** | *** |
| Accessibility | N_StaH | 0.999145 | 265.487227 | *** |
| | N_StaL | 0.996745 | 264.876932 | *** |
| | Rod | 0.809311 | 215.062335 | *** |
| | N_ParkH | 0.992044 | 263.630638 | *** |

(* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$).

minimizing the corrected Akaike Information Criterion (AICc) (Fotheringham et al., 2002). A bisquare kernel weighting scheme was applied, assigning higher weights to closer grids and zero weights beyond the neighborhood range (Tu et al., 2019). Model residuals were further tested using Moran's I with eight nearest neighbors; a significant Moran's I ($p < 0.05$) indicates that spatial autocorrelation remains in the residuals, suggesting the model does not fully capture heterogeneity (Comber et al., 2023).

## 4. Results

### 4.1. Identification of three life-course cohorts

Net migration across ten age groups, estimated using the SRMC method, reveals a clear life-course and urban–periphery divide: younger cohorts (under 40) predominantly move into the metropolitan core, whereas older cohorts (40+) tend to move outward from central Tokyo (see Appendix 6).

The ten age-group migration data proved suitable for factor analysis (KMO = 0.714; Bartlett's test $p < 0.001$). Three factors were extracted, corresponding to typical life-course migration cohorts. Table 3 presents the factor loadings, indicating the population composition associated with each migration pattern:

(1) **Factor 1** reflects migration among young nuclear families. As the 0–4 and 5–9 cohorts do not migrate independently, their mobility is closely linked to the 30–39 cohort. The 40–49 group exhibits a comparatively low loading (0.568), suggesting a weaker association with this pattern.
(2) **Factor 2** captures migration of the advanced elderly, with the 70–79 and 80–84 cohorts showing high loadings (0.83), substantially higher than those of the 50–69 cohorts.
(3) **Factor 3** represents migration of young adults (18+) entering higher education or the labor market. Given Japan's neighborhood-based compulsory education system, cohorts below 15 seldom migrate independently, and high school attendance in other regions rarely leads to registered migration.

**Table 3**
Rotated component matrix of factor analysis on net migration by age groups.

| Net migration of different age groups | Component | | |
|---|---|---|---|
| | Factor1 | Factor2 | Factor3 |
| 0–4 years old | **0.887** | 0.009 | −0.188 |
| 30–39 years old | **0.870** | 0.203 | 0.005 |
| 5–9 years old | **0.812** | −0.072 | 0.229 |
| 40–49 years old | **0.568** | 0.174 | 0.446 |
| 80–84 years old | 0.002 | **0.839** | 0.089 |
| 70–79 years old | 0.024 | **0.834** | −0.381 |
| 60–69 years old | 0.164 | **0.684** | −0.537 |
| 50–59 years old | 0.482 | **0.551** | −0.205 |
| 10–19 years old | −0.059 | −0.299 | **0.803** |
| 20–29 years old | 0.132 | −0.091 | **0.782** |

(Extraction method: principal component analysis. Rotation method: varimax with Kaiser normalization. The rotation converged in 6 iterations.)

Furthermore, the three life-course cohorts identified in the TMA align with socially significant Japanese generations (Hayashi, 2022; Yamashita, 2010). First, the 70–84 age group (Factor 2, born 1936–1950) corresponds to the postwar baby boom (Dankai) generation, who drove Japan's rapid economic growth and now exemplify its super-aged society. Second, the 30–39 age group (Factor 1, born 1981–1990) represents the post-bubble economy cohort, who entered the labor market around 2000 with relatively stable prospects compared to the "employment ice age" generation. Third, the 18–29 age group (Factor 3, born 1991–2005) corresponds to the Yutori generation and Generation Z, characterized as digital natives with more flexible and less conventional lifestyles.

### 4.2. Migration Pattern Intensity (MPI)

Fig. 5 displays the MPI of the three life-course cohorts, where higher values correspond to stronger net inflows.

#### 4.2.1. Regional-scale variation

At the scale of the four urban planning areas, the mean MPI reveals significant life-course and core-periphery differences (Table 4). In established urban areas, the mean MPI for young adults (Y) is positive and nearly fifty times higher than in suburban development areas. For young nuclear families (C), MPI remains positive only within a 50 km radius of central Tokyo. In contrast, older seniors (S) show negative MPI values within 20 km but positive values beyond 50 km.

Fig. 6 further illustrates regional differentiation in life-course migration by mapping the distribution of positive and negative MPI across municipalities in the TMA. Outside the 50-km circle, about 70 % of municipalities record positive MPI only for older seniors (Y–C–S+), while 22 % experience total out-migration (Y–C–S–). In contrast, municipalities in the inner suburbs around 30 km exhibit positive MPI for all life-course groups (Y + C + S+), whereas those within 10 km consistently show positive MPI for young adults (**Y+** C+ S-; **Y+** C- S-; **Y+** C- S+).

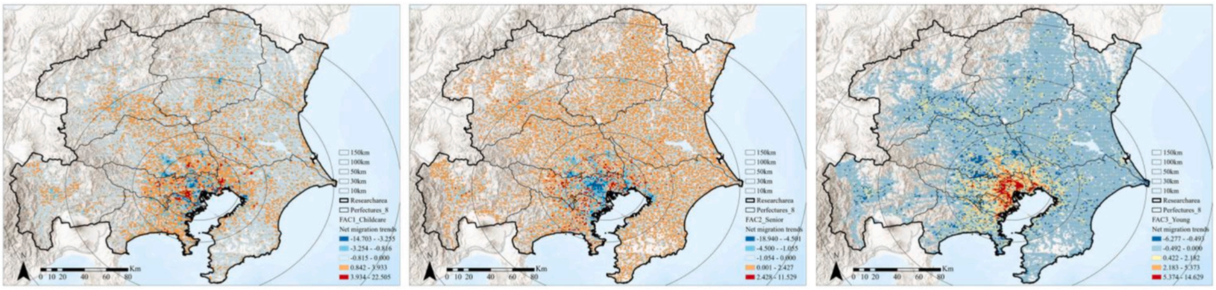
#### 4.2.2. Local-scale clustering

Global Moran's I indicates significant spatial autocorrelation of MPI across the three life-course cohorts (Table 5). The Getis-Ord Gi statistic identifies significant local clustering and spatial heterogeneity of MPI within the 50 km zone (Fig. 7).

Across all life-course groups, Kawagoe, Kasukabe (business core cities), and Tokorozawa (a local hub city) appear as significant cold spots, whereas hot spots are concentrated in business-core cities within the inner suburbs. Clear spatial disparities also appear within Tokyo itself: young adults tend to cluster in the 23 special wards; young nuclear families show concentrations in Setagaya Ward and the western districts; while older seniors predominate in the eastern districts of Tokyo.

### 4.3. Results of Robust MLR

Model diagnostics (Table 6) show that OLS with robust SE provides a better fit for MPI among young adults, whereas robust regression more effectively captures the patterns for young nuclear families and older seniors. Specifically, the 44 variables explain 63.8 % of MPI variation for young adults, whereas explanatory power is much lower for young nuclear families ($R^2 = 0.218$) and older seniors ($R^2 = 0.302$). Multicollinearity is generally low (mean VIF = 2.2), although F_Home (11.6) and F_Pri (8.6) are retained due to their theoretical importance. Fig. 8 summarizes the linear associations between MPI and the 44 explanatory variables, highlighting significant differences in the impact of housing choices on MPI across life-course cohorts.



A. Migration patterns of Childcare group B. Migration patterns of Senior group C. Migration patterns of Young group

**Fig. 5.** Migration Pattern Intensity of three life-course cohorts.

**Table 4**
Life-course migration trends vary significantly across urban planning areas.

| | Established urban areas (0–20 km) | Suburban development area (20–50 km) | Urban development area (50–100 km) | Shrink Area (100 km∼) |
|---|---|---|---|---|
| Young adults | 2.25 | 0.04 | −0.20 | −0.23 |
| Young nuclear families | 0.22 | 0.15 | −0.07 | −0.08 |
| Older senior | −0.60 | 0.08 | 0.04 | 0.05 |

#### 4.3.1. *Housing characteristic*

Preferences for housing typologies differ markedly across the three life-course cohorts. Young adults tend to avoid dwellings of fewer than three stories in low-density areas (−0.16* H_LowB). In contrast, young nuclear families favor low-rise, low-density housing (0.031*** H_LowB). Older seniors, however, are more likely to reside in high-density commercial–residential mixed-use areas (0.030*** HighB) or in low-rise residential areas (0.021*** LowB).

Housing tenure effects also vary substantially across cohorts: young adults are significantly associated with private rental housing (0.103*** F_Pri) and company-provided housing (0.026*** F_Com), young nuclear families with homeownership (0.026*** F_Home), and older seniors with rental tenure (0.033*** F_Pri).

Additionally, housing typologies and tenure exert a much stronger influence on MPI than land price change.

#### 4.3.2. *Neighborhood characteristic*

Within neighborhood demographic composition, non-working households exhibit a pronounced negative association only for older seniors (−0.329*** E_Nofam).

Employment environments also reveal distinct cohort-specific effects. For young adults, MPI increases in the information industry (0.017**E_gInf) and the health and welfare sector (0.016** E_pHea) but decreases in the education sector (−0.046*** E_oEdu). By contrast, MPI among young nuclear families is positively linked to the education sector (0.007* E_oEdu) and academic services (0.003* E_lAcada). Distinctly, MPI for older seniors rises with the health and welfare sector (0.066** E_pHea).

Natural environmental preferences also reveal clear generational differences. Young adults are more likely to settle in lower-elevation areas (0.033** rec_Dem; −0.011 Incli) with reduced rainfall (−0.038*** Rain), which are highly suitable for intensive urban development. Young nuclear families show a distinct preference for steeper terrains (0.003* Incli). Older seniors are more likely to reside in cooler climatic regions (0.0079* rec_Tem; −0.009* Dec_Tem).

#### 4.3.3. *Accessibility*

The effects of transport and green-space accessibility on MPI vary across cohorts. Among young adults, higher road density reduces MPI (−0.020* Rod), whereas proximity to major transit hubs increases it (−0.019* N_StaH). District parks also enhance MPI (−0.017* N_ParkN), in contrast to comprehensive parks (−0.017* rec_N_ParkN). For young nuclear families, access to medium-scale stations is beneficial (−0.006* N_StaM), while large-scale stations show the opposite association (0.007* N_StaL). In the case of older seniors, MPI increases near principal hubs (−0.009* N_StaH) but decreases in the vicinity of small block parks (0.009* N_ParkN).

### 4.4. *Results of RF*

RF consistently outperforms robust MLR in identifying key variables for MPI, as reflected in lower RMSE and higher $R^2$ values overall (Table 7). Table 8 further highlights the commonalities and differences in variable importance across the three life-course cohorts.

For young adults, the importance of non-working households (18.14), private-rental rate (14.09), and transport accessibility is higher for MPI.

For young nuclear families, homeownership rate (24.31), private-rental rate (19.99), and proximity to principal transit hub (15.80) show greater importance for MPI.

For older seniors, the influence of non-working households (15.94) and transport accessibility is prominent. Notably, proximity to comprehensive parks (10.37) appears only among the key variables for older seniors.

### 4.5. *Results of GWR*

#### 4.5.1. *Model performance*

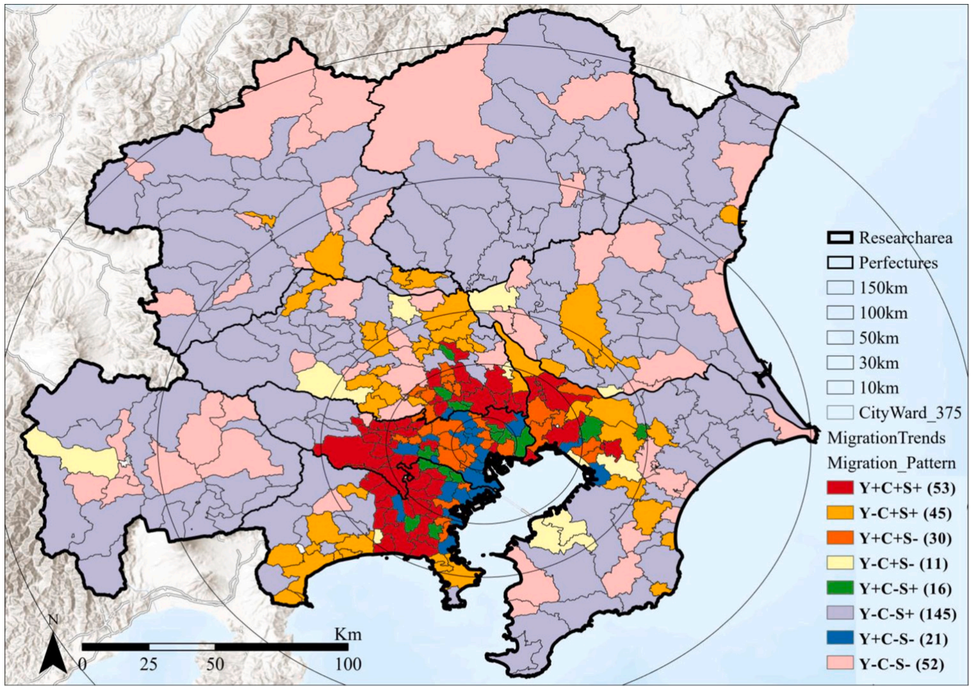
According to Table 9, spatial autocorrelation in the GWR residuals was not statistically significant (Global Moran's I, $p > 0.05$), suggesting that the model fits are not subject to spatial bias. The selected variables explained nearly 80 % of MPI variance for young adults and about 40 % for both young nuclear families and older seniors, reflecting relatively suitable model performance compared with previous studies (Ma et al., 2022). Further analysis was conducted for areas with local $R^2$ values of at least 0.3 (Fig. 9).

#### 4.5.2. *Spatially varying effects on young adults' MPI (Fig. 10)*

(1) Housing characteristic

In western Tokyo and adjacent suburbs, both homeownership and private rental rates are positively associated with young adults' MPI, whereas in the east only rental rates show positive effects.

Moreover, a 1 % increase in land price (log-transformed) significantly reduces young adults' MPI in central Tokyo. A 1 % increase in




| Code | Combination of migration patterns | Area Percent (%) |
|---|---|---|
| ＞50km | Y- C- **S+** | **67%** (38.87%) |
| ＞50km | **Y- C- S-** | **22%** (13.94%) |
| 50km | Y- C+ S+ | 12.06% |
| 50km | Y- C+ S- | 2.95% |
| 30km | **Y+ C+ S+** | **14.21%** |
| 10km | **Y+** C+ S- | 8.04% |
| 10km | **Y+** C- S- | 5.63% |
| 10km | **Y+** C- S+ | 4.29% |

**Fig. 6.** Polarized spatial patterns of Life-course migration in the Tokyo metropolitan area.
(Y: young adults; C: young nuclear family; S: older seniors).

**Table 5**
Results of the Global Moran's I test of migration trends across life-course groups.

| Variable | Moran's index | z-Score | Sig. |
|---|---|---|---|
| Young adults | 0.650641 | 173.049637 | *** |
| Young nuclear family | 0.241419 | 64.240796 | *** |
| Older seniors | 0.313404 | 83.36559 | *** |

(* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$)

homeownership and rental rates corresponds to maximum gains of about 26 and 30 MPI units, respectively, while land price accounts for a much smaller reduction of around 3 units.

(2) Neighborhood characteristic

Non-working households (NoFam) are linked to lower MPI in peripheral municipalities such as Kawagoe, Kasukabe, and Tokorozawa. An increase of 500 households, typical for most municipalities (see Appendix 7), corresponds to a maximum decline of 2 units in MPI. Conversely, positive associations appear in established urban areas, particularly in western Tokyo's 23 wards, Kawasaki, and central Yokohama.

(3) Accessibility

Road and transit accessibility show complementary effects. Road density is positively related to MPI in central Tokyo, while proximity to

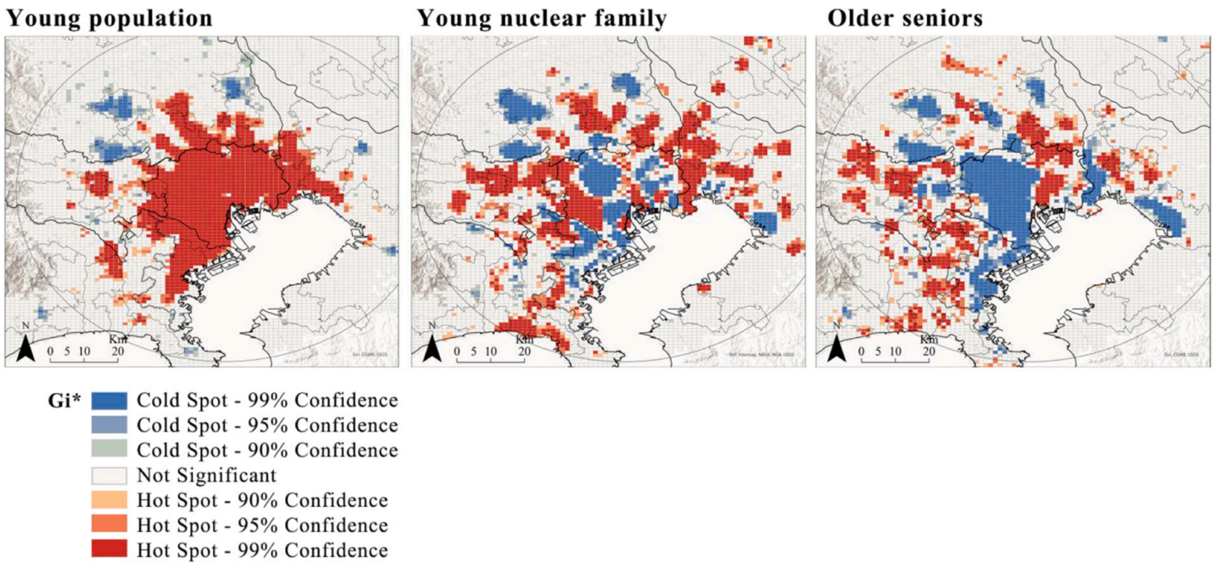



**Fig. 7.** Life-course migration pattern intensity (MPI) hotspots and cold spots based on Getis-Ord Gi*.

**Table 6**
Performance of Robust linear regression methods across Life cycle groups.

| Methods | OLS with robust SE | | | Robust regression | | |
|---|---|---|---|---|---|---|
| Life-course groups | Young Nuclear family | Older seniors | Young population | Young Nuclear family | Older seniors | Young population |
| Multiple $R^2$ | 0.065 | 0.181 | 0.639 | 0.219 | 0.304 | 0.328 |
| **Adjusted $R^2$** | 0.063 | 0.179 | **0.638** | **0.218** | **0.302** | 0.327 |
| **RSME** | 1.020 | 0.955 | **0.632** | **1.067** | **0.971** | 0.837 |

major transit hubs (StaH) enhances MPI in eastern Tokyo, Kawasaki, Yokohama, and the MPI cold spots. Proximity to large-scale stations (StaL), in turn, has stronger positive effects in western Tokyo and areas near Chiba. Quantitatively, each additional kilometer of road increases MPI by up to 0.3 units, while 1 km closer proximity to a transit hub or large station corresponds to increases of up to 1.6 and 2 units, respectively.

#### 4.5.3. *Spatially varying effects on young nuclear families' MPI (Fig. 11)*

(1) Housing characteristic

Homeownership rates are positively related to young nuclear families' MPI in western Tokyo, particularly in Setagaya, while private rental rates show positive effects only in Kasukabe. Rising land prices, by contrast, exert negative effects in business core cities. A 1 % increase in homeownership and private rental rates corresponds to maximum gains of about 47 and 22 MPI units, respectively, whereas a 1 % increase in land price reduces MPI by about 5 units.

(2) Neighborhood characteristic

Non-working households (NoFam) have a negative impact on MPI, especially in Kawagoe, Kasukabe, and Tokorozawa. An additional 500 non-working households is linked to a maximum decline of about 3 MPI units.

(3) Accessibility

Proximity to principal transit hubs (StaH) contributes positively to MPI, with the strongest effects observed in inner-suburban business cities such as Saitama and Kawaguchi. Being 1 km closer to a major hub is associated with an increase of up to 2 MPI units.

#### 4.5.4. *Spatially varying effects on older seniors' MPI (Fig. 12)*

(1) Housing characteristic

The positive effect of private rental rate is limited to the outermost Nerima Ward and outlying business core cities such as Kawagoe, Ōmiya–Urawa, Ichikawa, and Koshigaya. By contrast, in central Tokyo, a 1 % increase in the private rental rate corresponds to a maximum decline of about 18 MPI units. Land price also exerts negative effects, concentrated in the central and western 23 wards, where a 1 % increase is associated with a decrease of up to 1.8 MPI units.

(2) Neighborhood characteristic

Non-working households (NoFam) are negatively associated with MPI in Kawagoe, Kasukabe, Tokorozawa, and Chiba, as well as in the western parts of Tokyo's 23 wards. An additional 500 non-working households corresponds to a maximum decline of about 2 units.

(3) Accessibility

Accessibility variables reveal distinct east–west contrasts. In eastern Tokyo, road density, proximity to transit hubs, and proximity to regional comprehensive parks (ParkH) exert positive influences on MPI, whereas in the 23 western wards they exert negative effects. Quantitatively, a one-unit increase in road density, proximity to transit hubs, and proximity to parks corresponds to maximum changes of 0.3, 1.8, and 1.3 MPI units, respectively.

#### 4.5.5. *Summary of key determinants*

The GWR models incorporating selected key variables best explained variation in MPI. Among these, housing tenure—captured by homeownership and rental rates—consistently emerged as the dominant determinant across all life-course groups, with unit changes producing much larger effects than other factors (Table 10). This highlights the central role of tenure structure in shaping life-course migration dynamics.

| Methods | | | OLS with robust SE | Robust regression | | VIF |
|---|---|---|---|---|---|---|
| Life cycle groups | | | Young | Childcare | Elderly | |
| | | | β | β | β | |
| 1. Housing characteristic | 1.1 Housing typologies | HighB | | -0.022 *** | 0.030 *** | 1.916 |
| | | Factory | | -0.003 . | | 1.141 |
| | | LowB | -0.160 *** | 0.031 *** | 0.021 *** | 2.741 |
| | | Low_DB | | -0.013 ** | -0.119 *** | 2.323 |
| | 1.2 Housing tenure | F_Home | -0.053 *** | 0.026 *** | | **11.599** |
| | | F_UR | -0.110 *** | -0.021 *** | | 2.885 |
| | | F_Pri | 0.103 *** | -0.039 *** | 0.033 *** | **8.595** |
| | | F_Com | 0.026 *** | -0.009 *** | | 1.769 |
| | | F_Sub | -0.010 * | | | 1.131 |
| | 1.3 Land price | logLp2016 | | 0.005 * | 0.008 * | 2.172 |
| 2. Neighborhood characteristic | 2.1 Demographic Composition | P_Forei | -0.033 *** | 0.004 * | | 1.322 |
| | | E_Woman | | | -0.004 . | 1.074 |
| | | E_NoFam | 0.778 *** | 0.207 *** | -0.329 *** | 4.504 |
| | 2.2 Employment Profile | E_AgrFam | -0.011 * | 0.003 * | -0.017 *** | 1.219 |
| | | E_cMine | | | | 1.019 |
| | | E_dConstr | -0.010 . | | | 1.424 |
| | | E_fElec | | | | 1.007 |
| | | E_gInf | 0.017 ** | | | 1.137 |
| | | E_hTran | | | | 1.200 |
| | | E_iSale | -0.016 ** | | | 1.291 |
| | | E_jFin | | | | 1.105 |
| | | E_kReal | | | | 1.049 |
| | | E_lAcade | -0.010 * | 0.003 * | | 1.058 |
| | | E_mAcc | | | | 1.298 |
| | | E_nSer | | | | 1.133 |
| | | E_oEdu | -0.046 *** | 0.007 *** | -0.004 . | 1.091 |
| | | E_pHea | 0.016 ** | -0.008 *** | 0.066 *** | 1.370 |
| | | E_qMixser | | | | 1.025 |
| | | E_rOser | | | | 1.155 |
| | 2.3 Natural Environment | rec_Dem | 0.033 *** | | -0.009 * | 1.019 |
| | | Incli | -0.011 . | 0.003 . | | 1.911 |
| | | Rain | -0.038 *** | | | 1.400 |
| | | rec_Tem | | | 0.0079 * | 2.555 |
| 3. Accessibility | 3.1 Road Network Accessibility | Rod | -0.020 * | 0.052 *** | 0.025 *** | 4.577 |
| | 3.2 Public Transit Accessibility | N_StaS | | | | 1.279 |
| | | N_StaM | 0.019 ** | -0.006 ** | | 2.655 |
| | | N_StaL | | 0.007 ** | | 2.703 |
| | | N_StaH | -0.019 * | | -0.009 * | 3.052 |
| | | N_Bus | | | | 1.182 |
| | 3.3 Green Space Accessibility | N_ParkN | | | 0.009 . | 5.021 |
| | | N_ParkR | -0.017 * | | | 2.448 |
| | | rec_N_ParkU | -0.017 *** | | | 1.042 |
| | | N_ParkH | | | | 1.463 |
| | | N_ParkG | | | | 3.930 |
| Average | / | / | / | / | / | **2.23** |

Significance (p-values) codes: 0 "***"; 0.001 "**"; 0.01 "*"; 0.05 "." .

Important influencing variables (highlighted in red)

**Fig. 8.** Results of Robust MLR across three life-course cohorts.

## 5. Discussion

### *5.1. Life-course migration and spatial polarization*

Population data from 2015 to 2020 reveal three major life-course migration cohorts in the TMA—young adults (the yutori and Z generations), young nuclear family (the post-bubble economy generation), and older seniors (the Dankai generation)—whose divergent trajectories produce a multiscale pattern of spatial polarization: youthful urban cores, aging peripheries, and favored inner suburbs. Specifically, inflows concentrate in Tokyo's 23 wards and nearby hub cities, while outflows dominate in peripheral municipalities. Within Tokyo, young adults concentrate in the central wards, young nuclear families gravitate toward western areas such as Setagaya, and older seniors cluster in the eastern wards. These trajectories reflect generational backgrounds that shape migration and housing preferences. Additionally, this spatial

**Table 7**
Comparison of RMSE and $R^2$ between Robust MLR and Random Forest models.

| | Young adults | Young nuclear family | Older seniors |
|---|---|---|---|
| Number of variables | 44 | 44 | 44 |
| Adjusted $R^2$ (Robust MLR) | 64 % | 22 % | 30 % |
| **pseudo $R^2$ (RF)** | **75 %** | **23 %** | 28 % |
| RSME (Robust MLR) | 0.63 | 1.07 | 0.97 |
| **RMSE (RF)** | **0.53** | **0.93** | **0.90** |

differentiation is rooted in Tokyo's east–west divide: the west developed along private railways with owner-occupied housing, while the east, shaped by its industrial and working-class legacy, has remained dominated by low-cost rentals (Kidokoro et al., 2021; Sorensen, 2001).

## *5.2. Migration and housing choices in generational context*

### *5.2.1. Young adults and high-density rental housing*

Our findings show that young cohorts in the stages of higher education or early job seeking are disproportionately concentrated in Tokyo's central wards. This pattern reflects both their digital-era upbringing and the metropolitan core's structural advantages in information industries and welfare provision. Comparable dynamics are evident across other metropolitan contexts, including London's "elevator regions" (Champion et al., 2014), America's "consumer cities" attracting young and highly skilled groups (Couture & Handbury, 2017; Glaeser et al., 2001), China's tier-one gateways such as Beijing, Shanghai, and Shenzhen (Cui et al., 2022; Zhao, 2023), Seoul's concentration of youth employment (Ahn & Kwon, 2024), and Europe metropolitan centers (González-Leonardo et al., 2022; Mulder et al., 2020). Collectively, these cases underscore the persistent attraction of the cores of global metropolises for younger generations. In line with this international evidence, our findings further reveal the relative unattractiveness of peripheral areas, where weaker institutional support is evident in the negative effect of non-working households on in-migration.

Within Tokyo, younger cohorts predominantly occupy high-density rental housing near major transport hubs, reflecting both limited capital accumulation and value orientations toward diversity and lifestyle autonomy. Similar patterns were evident in U.S. metropolitan areas during the 1990s and were amplified by Millennials (Lee et al., 2019). The postponement of marriage and childrearing, together with extended higher education, further reinforces demand for central rental housing (Chudnovskaya, 2019; Druta & Ronald, 2018). Echoing earlier research on the lifestyle freedom and housing choices of young cohorts at the turn of the century, our study reinforces this argument through a multi-generational comparative framework.

### *5.2.2. Young nuclear families and the "education–homeownership" nexus*

In Tokyo, young nuclear families prioritize homeownership and

**Table 8**
Key variable importance based on Random Forest analysis.

| | Young adults | %IncMSE | Young nuclear family | %IncMSE | Older seniors | %IncMSE |
|---|---|---|---|---|---|---|
| | F_Home | 8.59 | F_Home | 24.31 | / | / |
| Housing characteristic | F_Pri | 14.09 | F_Pri | 19.99 | F_Pri | 8.99 |
| | logLp2016 | 11.71 | logLp2016 | 9.23 | logLp2016 | 8.01 |
| Neighborhood characteristic | E_NoFam | 18.14 | E_NoFam | 7.47 | E_NoFam | 15.94 |
| | N_StaH | 12.36 | N_StaH | 15.80 | N_StaH | 14.95 |
| Accessibility | N_StaL | 15.77 | / | / | N_ParkH | 10.37 |
| | Rod | 13.43 | / | / | Rod | 11.33 |

**Table 9**
Performance of GWR models.

| | Young adults | Young nuclear family | Older seniors |
|---|---|---|---|
| Moran's I of standardized residuals | −0.001 | 0.000 | −0.002 |
| ZScore | −0.358 | −0.113 | −0.425 |
| ***p*-value** | **0.721** | **0.910** | **0.671** |
| $\mathbf{R^2}$ | **0.79** | **0.37** | **0.37** |
| Number of Neighbors | 114 | 92 | 146 |
| AICc | 28,139 | 45,059 | 45,982 |

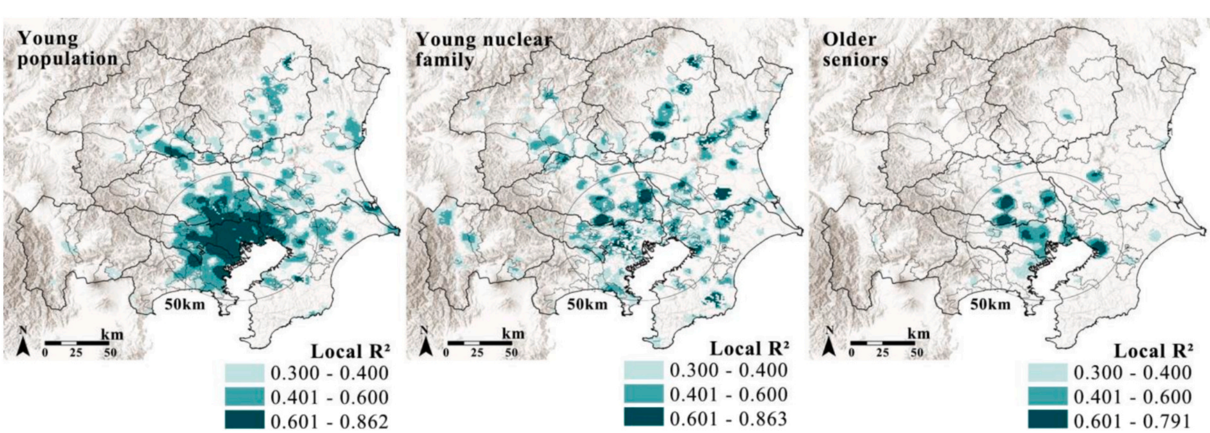



**Fig. 9.** Significantly Affected Regions with Local $R^2$ Values of 0.3 or Higher.

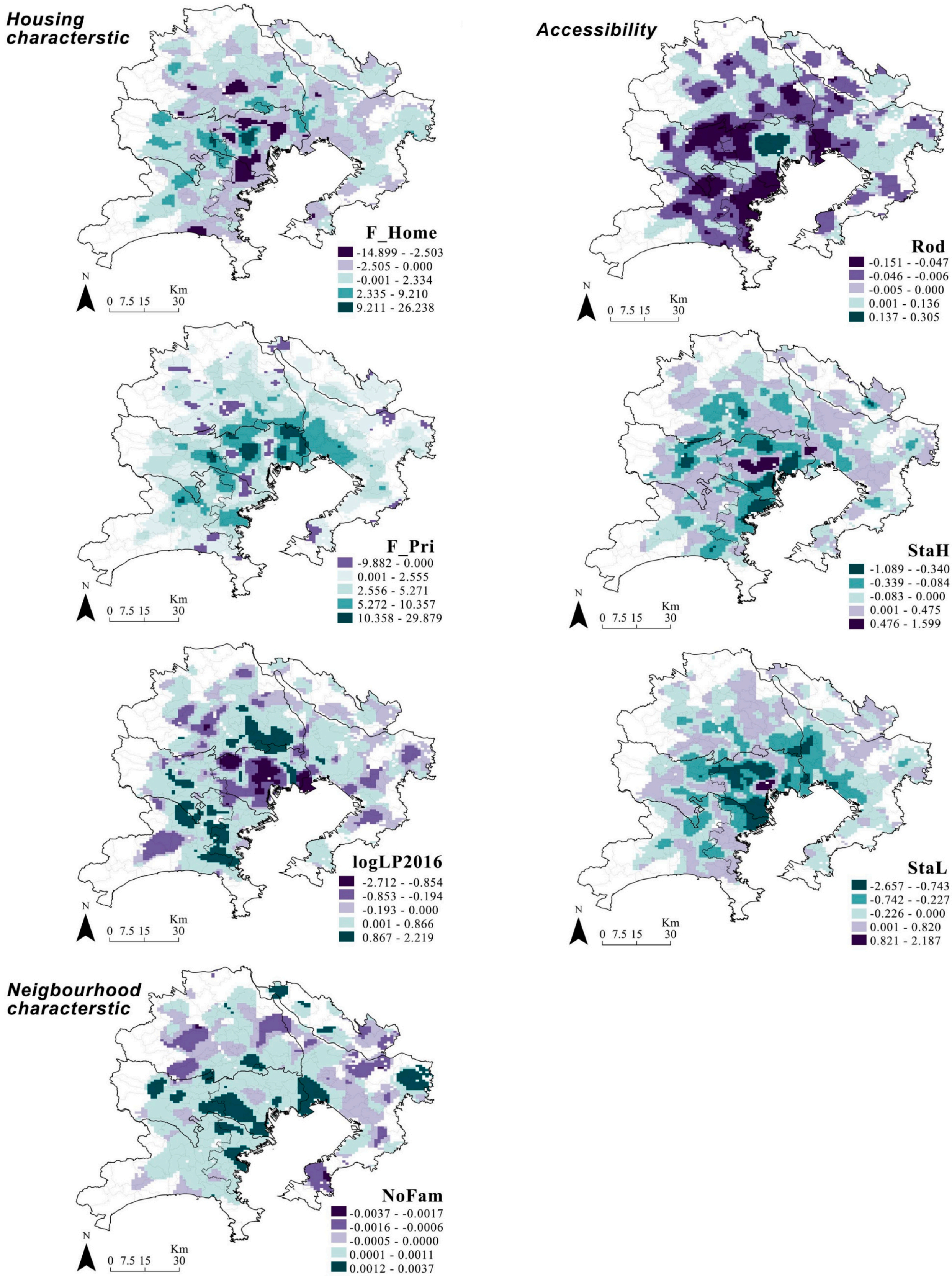



**Fig. 10.** Impact of key housing choices on MPI of young adults varies significantly between existing urban area and suburban development area.

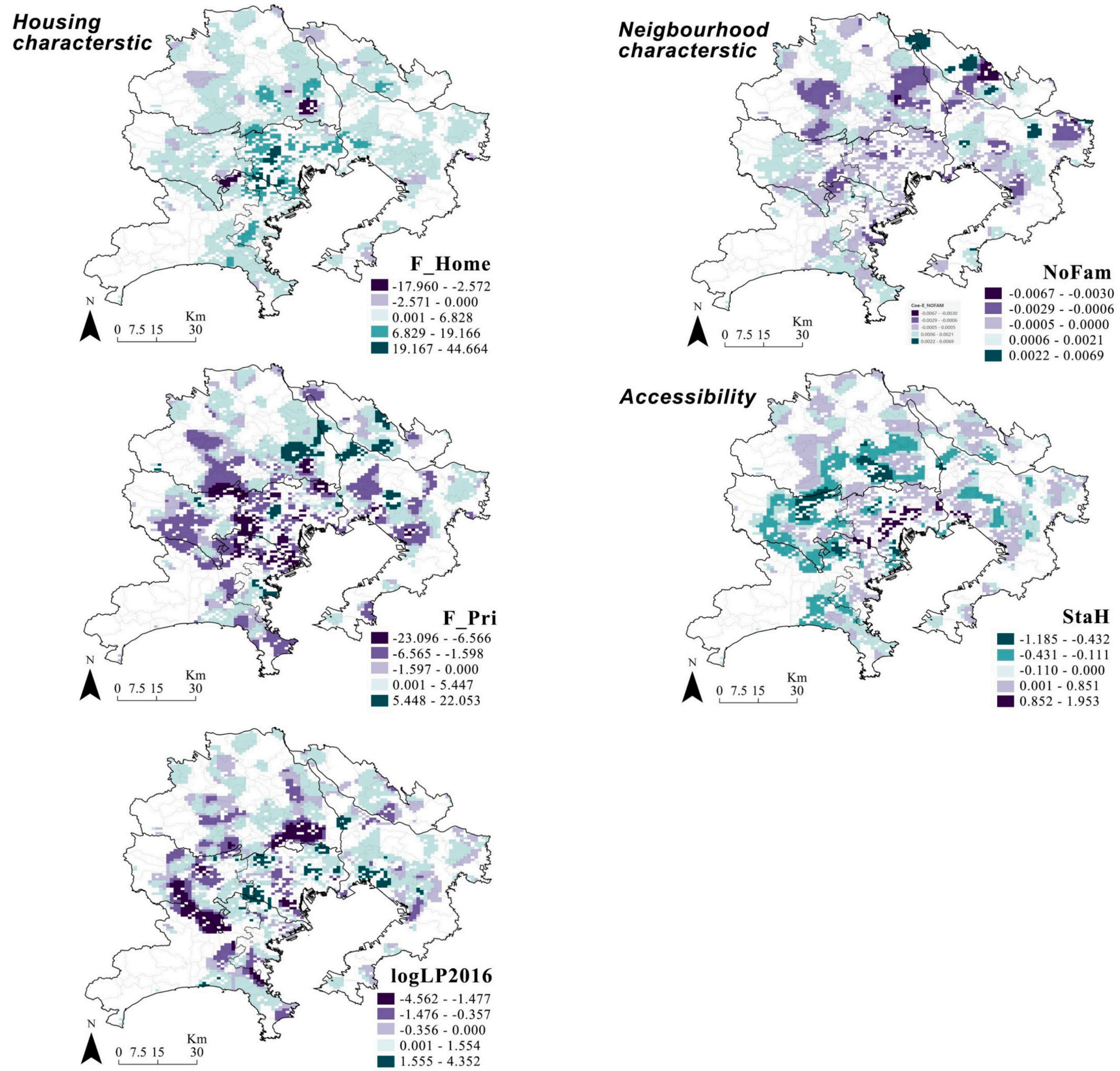



**Fig. 11.** Impact of key housing choices on MPI for young nuclear families within core TMA.

educational accessibility. This trend is most visible in Setagaya Ward, where a Neuvola-style childcare system and childcare-supportive housing schemes have mitigated the combined pressures of stagnant wages and rising childcare costs (Shimomura et al., 2020; Setagaya Ward, 2017; Setagaya Ward, 2025). Affordable slope-side housing developments (ArchDaily, 2020) further enhance Setagaya's appeal for young families.

International evidence consistently shows that family formation strongly drives transitions from renting to ownership—whether through childbirth in Sweden (Chudnovskaya, 2019), family-unit housing policies in Singapore (IREUS, 2022), or marriage-related home purchases in China (Zhao et al., 2023). Building on this evidence, our analysis of Tokyo demonstrates how institutional support for home construction and affordable housing provision encourages young families to settle in the core of metropolitan areas.

Educational aspirations further reinforce this orientation. In East Asia, institutional and cultural factors—such as school-district-based housing in China (Chen et al., 2024) and the high premium on private education in Korea (Park & Lee, 2021)—exacerbate housing inequalities. By contrast, Tokyo has experimented with integrating childcare and housing policies, as in Setagaya, and through suburban transit corridors that provide affordable housing while maintaining access to employment and schooling opportunities for family households.

Finally, young families in TMA consistently prefer detached suburban housing, reflecting the global tendency to link childrearing with space and community life. This preference, widely observed in Europe (Finland: Kulu & Vikat, 2007; Netherlands: Booi et al., 2021; Sweden: Ström, 2010), United Kingdom (NHBC, 2023) and the United States (Institute for Family Studies (IFS), 2024), underscores how detached homes provide space, flexibility, and supportive community

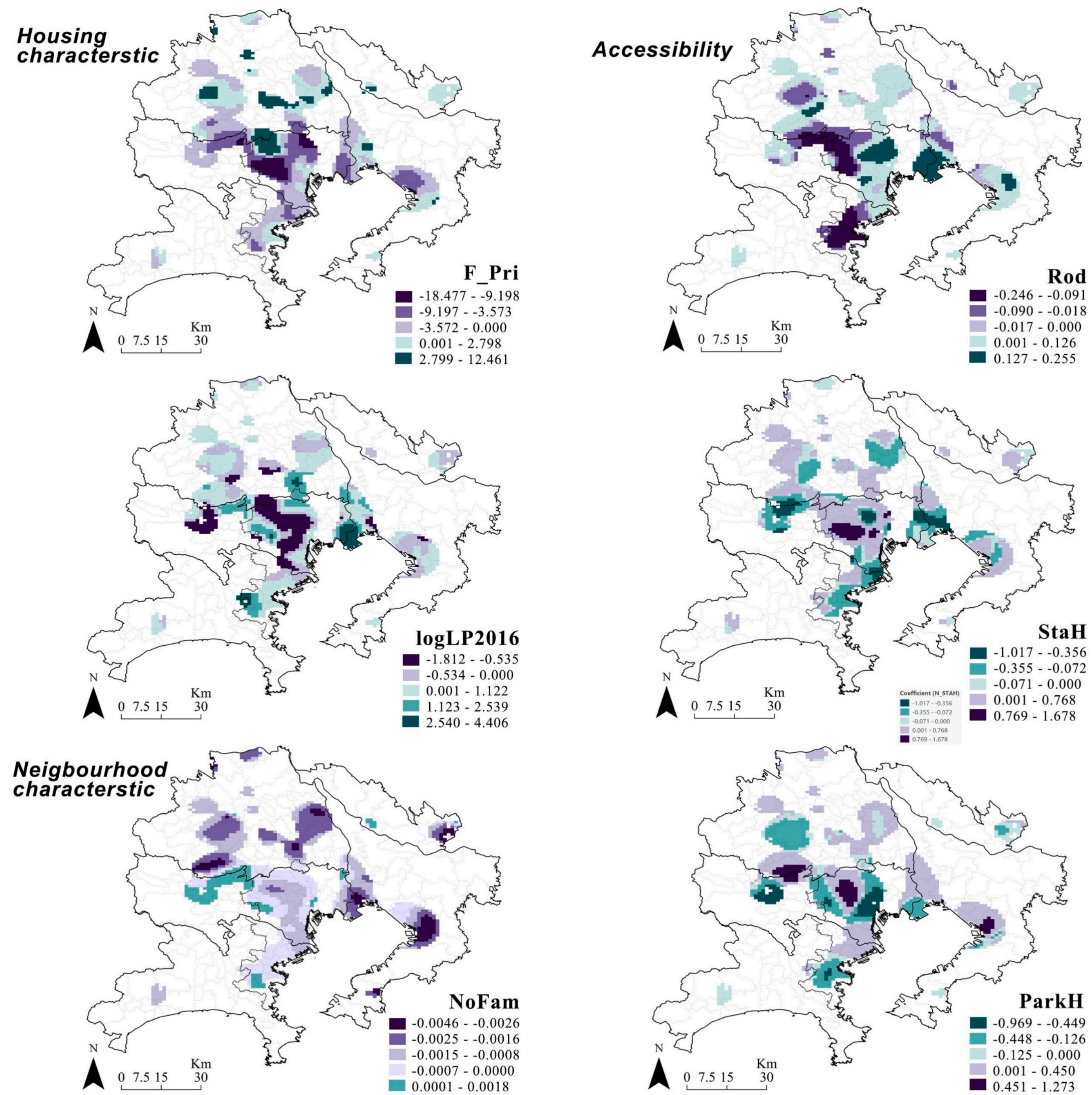



**Fig. 12.** Impact of key housing choices on MPI for older seniors within core TMA.

**Table 10**
Maximum marginal effects of key variables on MPI across life-course cohorts.

| Life-course groups | Young adults | Maximum marginal effect | Young nuclear family | Maximum marginal effect | Older seniors | Maximum marginal effect |
|---|---|---|---|---|---|---|
| | **F_Home** | **26** | **F_Home** | **47** | / | / |
| 1. Housing characteristic | **F_Pri** | **30** | **F_Pri** | **22** | **F_Pri** | **18** |
| | logLp2016 | 3 | logLp2016 | 5 | logLp2016 | 4 |
| 2. Neighborhood characteristic | E_NoFam | 2 | E_NoFam | 3 | E_NoFam | 2 |
| | N_StaH | 0.3 | N_StaH | 2 | N_StaH | 0.3 |
| 3. Accessibility | N_StaL | 1.6 | / | / | N_ParkH | 1.8 |
| | Rod | 2 | / | / | Rod | 1.3 |

environments for raising children. Our findings further show this preference reinforces the polarized geography of family-oriented inner suburbs.

### 5.2.3. Older seniors: economic stratification and rural attachment

Elderly suburban migration in the TMA reflects both economic stratification—whether older adults are forced to age in place—and generationally embedded "rural attachments" that shape where they choose to move. The intersection of these dynamics intensifies their concentration in the metropolitan periphery and eastern Tokyo.

Our findings show that higher private rental rate encourage elderly in-migration to suburbs, while rising land prices push older adults out of central Tokyo. Similarly, in England, nearly half of older private renters belong to the lowest 20 % income group (National Housing Federation (NHF), 2023), and in the United States where elderly movers are often low-income tenants relocating to reduce costs (Li et al., 2022). This pattern also corresponds to the widely discussed "economically driven suburbanization": in Tokyo's outer suburbs, declining property values draw economically vulnerable seniors to peripheral areas (Saito et al., 2007). Notably, our MLR results indicate that elderly in-migration occurs in both high-density mixed-use areas and lower-density residential districts. This pattern may reflect a bifurcation: affluent seniors often sell suburban homes and relocate to central high-rises to gain access to amenities, while disadvantaged older adults remain effectively "trapped in place" (Uto et al., 2023).

Beyond economic rationales, rural attachments embedded in the life experience of the Dankai generation also shape housing choices: many who migrated from rural areas to Tokyo in their youth have retained a lifelong ideal of detached suburban homes with gardens (Kobayashi, 2012). Comparative evidence reinforces this mechanism: childhood exposure to parental gardens in Germany (Kley & Stenpaß, 2020) and early outdoor experiences with parent in the U.S. (Lee & Burns, 2022) similarly influence later-life residential preferences. Our multi-scalar findings indicate that, while the U-shaped migration pattern commonly emphasized in Japan (Wang et al., 2025) remains relevant, the residential moves of the baby boom generation can also be explained by intergenerational housing attachments, as evidenced by the significant positive impact of large-scale green spaces on their MPI.

## 5.3. A polarized life-course housing trajectory

The GWR results underscore the importance of housing tenure in shaping migration trends across life-course groups.

1) **Young adults: polarization of the housing ladder.** The GWR results show that homeownership has a positive effect only in western Tokyo, while in the eastern wards and outer suburbs it is negatively associated with in-migration. This suggests that in the west, parental housing assets may accelerate young adults' access to the housing ladder, whereas in peripheral areas homeownership reflects depressed property values rather than a valuable opportunity (Uto et al., 2023). While many studies have emphasized the role of parental housing wealth in facilitating earlier ownership (Bell, 2025; Cui et al., 2020; Savage, 2024), our findings highlight that this intergenerational mechanism is spatially contingent in shrinking megacities, exhibiting pronounced urban–suburban divergence.
2) **Young nuclear families: transitional renting and intergenerational support.** In peripheral suburban cities, higher private rental rates significantly increase MPI, whereas rising housing prices suppress in-migration. This suggests that suburban rentals often serve as a transitional tenure, while the pursuit of homeownership is concentrated in core areas—either in growth-oriented near suburbs or in more expensive but child-friendly inner wards such as Setagaya. While prior studies show that prolonged rental periods among young nuclear families can be mitigated by intergenerational support (Daysal et al., 2023; Wong, 2019), our findings extend this by revealing where these dynamics unfold within the TMA and how they exacerbate urban–suburban differentiation under metropolitan shrinkage.
3) **Older seniors: economic stratification and housing uncertainty.** In Japan, for non-single households aged 70–79, savings disparities are stark: 26.2 % hold less than one million yen, while 27.9 % exceed 20 million (Japan Financial Literacy and Education Corporation (J-FLEC), 2024). In the TMA, elderly relocation driven by economic factors reveals a nuanced spatial manifestation, which is further reinforced by structural pressures, as foreign capital inflows and residential tourism displace central tenants (Hernon, 2025), and suburban facilities decline amid population shrinkage and metropolitan concentration (Yoshimichi et al., 2017).

Based on these findings, this study proposes the concept of a "polarized life-course housing trajectory" (see Fig. 13) in the shrinking TMA. This framework highlights an intergenerational residential pathway in which inheriting property in central Tokyo can ensure stable old-age living and facilitate the transfer of wealth, thereby allowing descendants to begin from the "goal" of the contemporary residential Sugoroku game.

## 5.4. Study implications

Based on the empirical findings and international discussion, this study advances two key policy implications.

At the regional scale, an inclusive Care-TOD should be advanced. Extending traditional transport-oriented development, Care-TOD integrates medical, eldercare, childcare, and community support functions with social inclusion. Anchored around rail hubs, it links "15-minute living zones" and barrier-free transport with inclusive housing supply, securing medium-rent and shared-ownership opportunities for foreign and newly arrived families. Some practical measures encouraging foreign in-migration have already begun in Japan (Oda, 2025; Reiher, 2025), such as foreign worker housing in Hokkaido (Shiraiwa, 2025) and the designation of Hometown Cities under TICAD (JICA (Japan International Cooperation Agency), 2025).

At the neighborhood scale, multi-generational cooperative housing and integrated "living–care" renewal should be encouraged. Co-living models and accessory dwelling units foster intergenerational interaction and mutual support, whereas flexible housing mobility schemes enable the redistribution of larger and smaller housing units across generations. A practical example is Fujisawa City's youth–elderly co-housing project (Nobishiro House Kameino), where rent reductions tied to caregiving responsibilities complement housing and care resources (Nobishiro Inc, 2025).

Grounded in the TMA case, these strategies address suburban shrinkage and population aging in Japan while aligning with SDG 10 and SDG 11 and resonating with the New Urban Agenda and WHO's Age-friendly Cities initiative, offering globally relevant insights into intergenerational equity and housing sustainability in rapidly aging megacities.

## 5.5. Limitation

This study has several limitations. First, reliance on census and registry data may introduce biases, as the migration data cover only 2015 and 2020; while this design reduces the influence of the 2011 earthquake, the 2020 Olympics, and the 2021 pandemic, it cannot capture short-term or circular migration (e.g., the "relationship population" in Wang et al., 2025) or vulnerable groups such as the homeless. Second, childcare and medical accessibility were excluded due to collinearity with transit accessibility, which may have reduced explanatory power for young nuclear families and older seniors. Third, future research should combine quantitative models with qualitative methods—such as household interviews or longitudinal surveys—to more fully

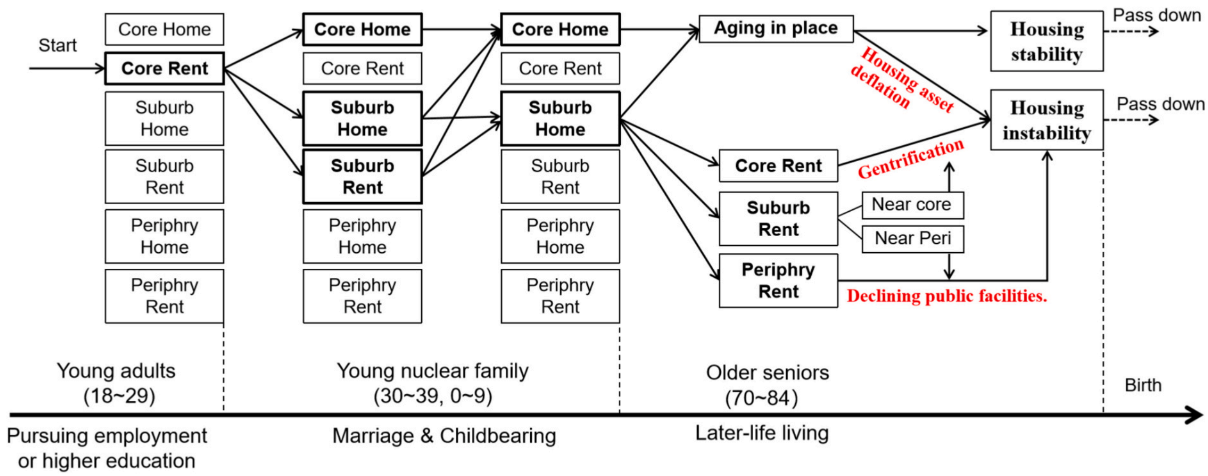



**Fig. 13.** A polarized life-course housing trajectory in the shrinking TMA.

uncover the social and cultural drivers of spatial polarization.

## 6. Conclusion

This study examined how life-course migration and housing choices shape spatial polarization in the TMA, a prototypical shrinking mega-city, using an integrated methodology that combined MLR, RF, and GWR. By linking individual residential decisions to demographic and structural change, the analysis identified three life-course cohorts whose divergent housing choices reinforce the geography of youthful cores, family-oriented inner suburbs, and aging peripheries. These dynamics advance the *Life-Course Housing Trajectory Paradigm*, a framework explaining how routine migration and housing practices accumulate into structural inequalities, which are further intensified by intergenerational transfers amid demographic decline.

Empirically, the TMA case shows how polycentric urban structures simultaneously mitigate and reproduce polarization, offering comparative insights for megacities worldwide confronting demographic shrinkage. The findings underscore the central role of housing tenure in shaping life-course migration and point to the need for policies that integrate foreign labor, diversify housing pathways, and foster intergenerational support. Future research should move beyond census-based models to incorporate longitudinal and comparative analyses alongside qualitative perspectives on housing aspirations, thereby strengthening the paradigm and guiding strategies to promote equity and resilience in shrinking megacities worldwide.

## CRediT authorship contribution statement

**Qing Wang:** Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Chika Takatori:** Validation, Supervision, Methodology, Funding acquisition, Conceptualization. **Kenjiro Kito:** Writing – review & editing, Supervision, Formal analysis, Conceptualization.

## Declaration of competing interest

None.

## Acknowledgements

This work was supported by the China Scholarship Council [award to CSC NO. 202206510005 for 3 year's Phd study abroad at the Kyushu University in Japan].

This work was supported by the Japan Society for the Promotion of Science (JSPS) [grant number: 23H01584, 24016566].

This work was also supported by the Japan Society for the Promotion of Science (JSPS) [grant number: JPJS00124016566].

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cities.2025.106508.

## Data availability

The data that has been used is confidential.

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