Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

From Escalator Region to Escalator System: The Life-Course Division of Labor in South Korea's Internal Migration, 2006–2025

dongwoo kim

dwkim0302@gmail.com

Baekseok University https://orcid.org/0000-0003-2219-083X

Research Article

Keywords: internal migration, escalator region, life course, migration systems, functional roles, South Korea

Posted Date: August 3rd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10550342/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: The authors declare no competing interests.

From Escalator Region to Escalator System: The Life-Course Division of Labor in South Korea's Internal Migration, 2006–2025

Dongwoo Kim

Division of Advanced IT, Baekseok University, Cheonan-si 31065, Republic of Korea

Correspondence: dongwoo.kim@bu.ac.kr · ORCID 0000-0003-2219-083X

Abstract

Fielding's escalator region is an area that attracts young people and releases them during middle age. This study extends this definition to an escalator system: a life-course division of labor among complementary regional roles. Using harmonized register flows and 140 million household movement records for 229 Korean municipalities (2006–2025), this study identifies and validates six functional roles from age-specific schedules. Between 2006 and 2025, 105 of the 228 regions changed roles; significant shifts moved toward lower-mobility roles, and Seoul's escalator membership decreased by half. The escalator is positioned within a system, and Korea's system is reorganizing toward lower mobility.

Keywords: internal migration; escalator region; life course; migration systems; functional roles; South Korea

JEL classification: R23; J11; R12

1. Introduction

An escalator region is a fundamental concept in migration studies. Fielding's (1992) model suggests that South East England functions as an escalator, where young adults relocating at the beginning of their careers experience accelerated occupational advancement and subsequently migrate during their middle years. This model has been extensively examined for

London and applied to several metropolitan areas across Europe, North America, and Asia (e.g., Andersson, 1996; Newbold & Brown, 2012; Zhao, 2023). Its relevance has been revisited in recent studies (Champion & Gordon, 2019; Yu, 2022). Despite three decades of application, the concept retains its original grammatical form; it characterizes only a single region. One region is interpreted as an escalator, whereas the remainder of the migration system is an undifferentiated background.

This study contends that an escalator should be understood as one role within a system of complementary roles. An escalator cannot operate in isolation. It requires a source of young adults to board, destinations for departing households, and regions that provide stability to the system's core. If these roles exist, they should be measurable from age-specific migration schedules and validated by the subsequent behavior of arriving cohorts. Crucially, regions should be able to move between fixed roles over time. Otherwise, apparent changes may reflect changing role definitions rather than genuine system reconfigurations. We call this framework the life-course division of labor, and its measurement, validation, and observed transformation in South Korea from 2006 to 2025 constitute the core of this study.

Evaluating this framework requires a setting that combines complete migration registers with rapid demographic changes. Korea provides such a setting: a highly centralized urban system, one of the most rapid demographic declines among developed nations, and Sejong, a planned capital founded in 2012 whose entire migration cycle falls within the study period (Abel & Heo, 2018; Lee & Kim, 2025). The administrative records are exceptionally comprehensive, providing complete origin–destination flows by age for over two decades and detailed household migration data with single-year age specifics for 25 years. While escalator studies typically rely on linked census and panel samples (Champion, 2012; Champion & Gordon, 2019), these records permit population-scale analysis over 25 years—crucial for life-course questions.

This study investigates two research questions linked by a validation requirement. RQ1 (existence): Does Korea's internal migration system divide labor among functional roles defined by age-specific migration schedules? Validation: Are these roles merely cross-sectional artifacts, or do arriving cohorts subsequently exit? RQ2 (reconfiguration): Has the allocation of regions to roles shifted between 2006 and 2025 and, if so, how? The sequence is essential: The validation step is not an independent research question but a prerequisite for RQ1's answer to possess longitudinal significance, and the measurement design maintains fixed role definitions to ensure that reconfiguration is distinguishable from redefinition.

This study makes three main contributions to the literature. Conceptually, the escalator region was broadened to encompass the escalator system. The escalator is recast in relational terms as a limited set of complementary life-course roles that a national migration system distributes across regions. Methodologically, the study converted the escalator metaphor into a quantifiable and longitudinally validated framework: roles are measured from age-specific migration schedules against a constant reference space. Their longitudinal content was verified at the population level through a diagonal cohort design involving 140 million household records. This design can be replicated by country using age-disaggregated register data. This study identified a system-wide transition consistently shifting from roles characterized by high mobility to those with lower mobility, halving the strength of the original escalator geography. This finding is directly pertinent to discussions on the decline of the escalator concept (Champion & Gordon, 2019) and reduction in internal migration in developed countries (Champion et al., 2017).

2. Theoretical Background

2.1 Age and the life course in internal migration

Age is the most regular dimension of migration behavior (Bernard et al., 2014; Rogers & Castro,

1981). Ravenstein's (1885) laws noted that migrants are predominantly adults, an observation later formalized by Rogers and Castro (1981) in the model migration schedule. This model delineates a peak in migration during young adulthood, reflects parental relocations during childhood, and, in some systems, indicates an increase in migration at retirement age. This regularity holds true across countries and decades (Bernard et al., 2014, 2017). The life-course literature explains this consistency: migration accompanies major life events—completing education, entering the workforce, family formation, and retirement—so the age schedule mirrors an institutionalized sequence of life events (Bernard et al., 2014). Cross-national variation in the young-adult peak reflects the timing of adulthood transitions more than the propensity to move (Bernard et al., 2016). Specific transitions map onto distinct schedule components from education peaks (Wilson, 2010, 2014) to retirement moves (Sander & Bell, 2013). Schedule shape and migration intensity vary independently across countries and are distinct aspects of migration regimes (Bell et al., 2015).

However, the geographical implications of these regularities have received far less attention. Migration during specific life stages results in regions that differ in attraction, retention, and release stages. University areas, commuter towns, and established industrial cities may show similar volumes, but distinct age patterns. Thus, the geographical dimension of life-course regularity lies in its demographic function, not in its magnitude. Plane et al. (2005) approached this concept by illustrating that movements within the U.S. urban hierarchy are organized by life stage: individuals ascend the hierarchy in early adulthood and descend later. However, their study regarded age selectivity as a feature of flows between size categories rather than the regions themselves. A shift in interpretative focus is necessary; if the age schedule signifies the demographic signature of life course transitions, then consistent differences in regional schedules indicate consistent differences in the roles that regions play within a national migration framework. We term these functional roles complementary life-course functions that

regions collectively employ to manage the redistribution of a national population. This is distinct from the functional region concept in commuting studies, which pertains to a spatial unit defined by interaction intensity (e.g., Coombes et al., 1986). To date, research has predominantly focused on a single role, typically analyzing one region at a time (Champion et al., 2013; Fielding, 1992).

2.2 The escalator region

Fielding (1992) characterized the age dynamics in South East England as analogous to an escalator: young adults initiate their careers by relocating to the region, experience above-average occupational progression, and subsequently depart from middle age (see also Fielding, 1993). Metaphors link spatial and social mobility through entry, advancement, and exit. Subsequent research expanded this concept in three ways. The first examines the components of the exit and return phases (Champion, 2012; Findlay et al., 2008) and occupational ascent (Gordon et al., 2015; McCollum et al., 2018; Reuschke, 2013). The second applies the concept to various contexts, including Sweden (Andersson, 1996), Toronto (Newbold & Brown, 2012), secondary cities in England (Champion et al., 2013), international migrants in London (King et al., 2017), major Chinese cities (Zhang & Wang, 2025; Zhao, 2023), and Australia's Northern Territory (Martel et al., 2013), showing that the escalator is a portable interpretive tool. The third examines its continuity, questioning whether London's escalator remains effective (Champion & Gordon, 2019) and its applicability to millennials (Yu, 2022), underscored by the evidence of declining internal migration in many developed countries (Alvarez et al., 2021; Champion et al., 2017; Cooke, 2013; Molloy et al., 2011).

Despite this broad empirical development, two aspects of the original concept remain. The first concerns the unit of analysis. Since the initial study, the escalator has been treated as a feature of a single candidate region (Fielding, 1992). Comparative studies have individually evaluated

secondary cities against London (Champion et al., 2013), leaving regions that supply young entrants and receive mid-life leavers as undifferentiated external areas. The second pertains to validation; the escalator's core claim is longitudinal—the same individuals who enter later exit (Fielding, 1992). However, the evidence relies on linked census and panel samples that are small relative to the populations involved (Champion, 2012; Champion & Gordon, 2019), or on repeated cross-sections that cannot substantiate a cohort claim. Consequently, the complete entering-advancing-exiting sequence has seldom been demonstrated at the population level. These two constraints delineate the measurement and validation challenges that the system-level reformulations must address.

2.3 Migration systems

Mabogunje (1970) initially proposed the notion of migration flow from interconnected systems. He viewed rural to urban migration as origins and destinations linked by people and information and altered through feedback. Subsequent work, largely on international migration, emphasized organized exchanges sustained through networks (Fawcett, 1989; Massey et al., 1993) and development feedback at origins (de Haas, 2010). The fundamental principle is that no location can be comprehensively understood in isolation and each location is defined by its role within a broader system.

In the study of internal migration, the systems perspective has been adopted more often in terminology than in analytical design; national systems are often labelled as such while being examined in one region, one corridor, or one net-flow map at a time, even in studies that quantify entire flow matrices (Abel & Sander, 2014) or document national redistribution (Fan, 2005). A recent trend in network analysis emphasizes the entire structure, identifying communities and hubs and their development from national flow matrices in Croatia (Pitoski et al., 2021), Turkey (Gürsoy & Badur, 2022), China (Wu & Liu, 2022), Italy (Sarra et al.,

2025), and the United States (Xu et al., 2025) using tensor partitioning (Almquist et al., 2024). These analyses define positions by connectivity—who exchanges with whom and how intensely—while an age schedule captures what exchanges do; which life stages a region absorbs and releases. These two dimensions are analytically distinct; regions with similar network positions may fulfil different, even contrasting, life-course roles, and the same role can be fulfilled in disparate parts of the network. Consequently, a national migration system has a relational structure defined by the topology of exchanges and a functional structure defined by age-specific roles. While the former has been measured with increasing precision, the latter remains largely unaddressed at the national level. Thus, the tool required complements the network description, defining the system's components by life-course function rather than exchange intensity.

2.4 A life-course division of labor: framework and research gap

This study posits that a national internal migration system can be conceptualized as a life-course division of labor between regions. Migration assigns distinct life course roles to different locations, and the interaction of these roles constituting the system. This perspective expands the foundational view of regional science from focusing solely on production to including population dynamics. Historically, cities have been analyzed as components of larger systems of cities (Berry, 1964), where specialization is based on function rather than merely a sector (Duranton & Puga, 2005). While the spatial division of labor in production is a well-established concept, its demographic counterpart has been vaguely described as regions exporting and importing young people or as life-stage flows organized by hierarchy (Plane et al., 2005). The three studies reviewed earlier each supply one element: life-course research as the signature, escalator literature as the archetypal role, and systems traditions as the relational framework. Previous studies have addressed each of these elements separately; however, their

integration remains limited.

Addressing this gap requires a framework rather than an empirical study. This framework is based on the following three requirements. First, age-specific migration schedules are used as indicators of regional functions. Second, the role structure is established once and held fixed so that changes over time reflect regional shifts between roles, rather than roles being redefined. Third, roles' longitudinal significance is confirmed using independent cohort data rather than the cross-sectional data that generated them. The separation of measurement, validation, and reconfiguration is the core design principle of this study.

The data requirements, comprehensive age-disaggregated flow matrices over decades, along with event-level microdata for independent cohort tracking, explain why this framework has not been previously implemented. Currently, only countries with full registers are beginning to provide both (Lichner et al., 2024). South Korea fulfils both requirements; complete age-disaggregated flows for all municipalities over 25 years plus single-age household microdata (Section 3). The rapid sequence of urbanization, planned new-town and capital development, and demographic decline makes functional differentiation particularly clear. Korean research has extensively documented the system's concentration and evolving flows (Abel & Heo, 2018; Kim et al., 2024; Lee & Kim, 2025; Lee et al., 2025), but its role structure has not been measured there or, to the best of our knowledge, anywhere else. Consequently, the research questions align with the framework's logic in a fixed sequence: existence (RQ1), validation as the condition under which existence holds longitudinal significance, and reconfiguration (RQ2) from the system's structure to its meaning to its transformation.

3. Data and Methods

The analytical framework is illustrated in Figure 1. It aligns the three register sources to a consistent geographical scope, develops migration schedules, and evaluates them against a role

space that is calibrated once. The resulting memberships enable the analyses of existence and reconfiguration, whereas single-age microdata provide independent longitudinal validation.

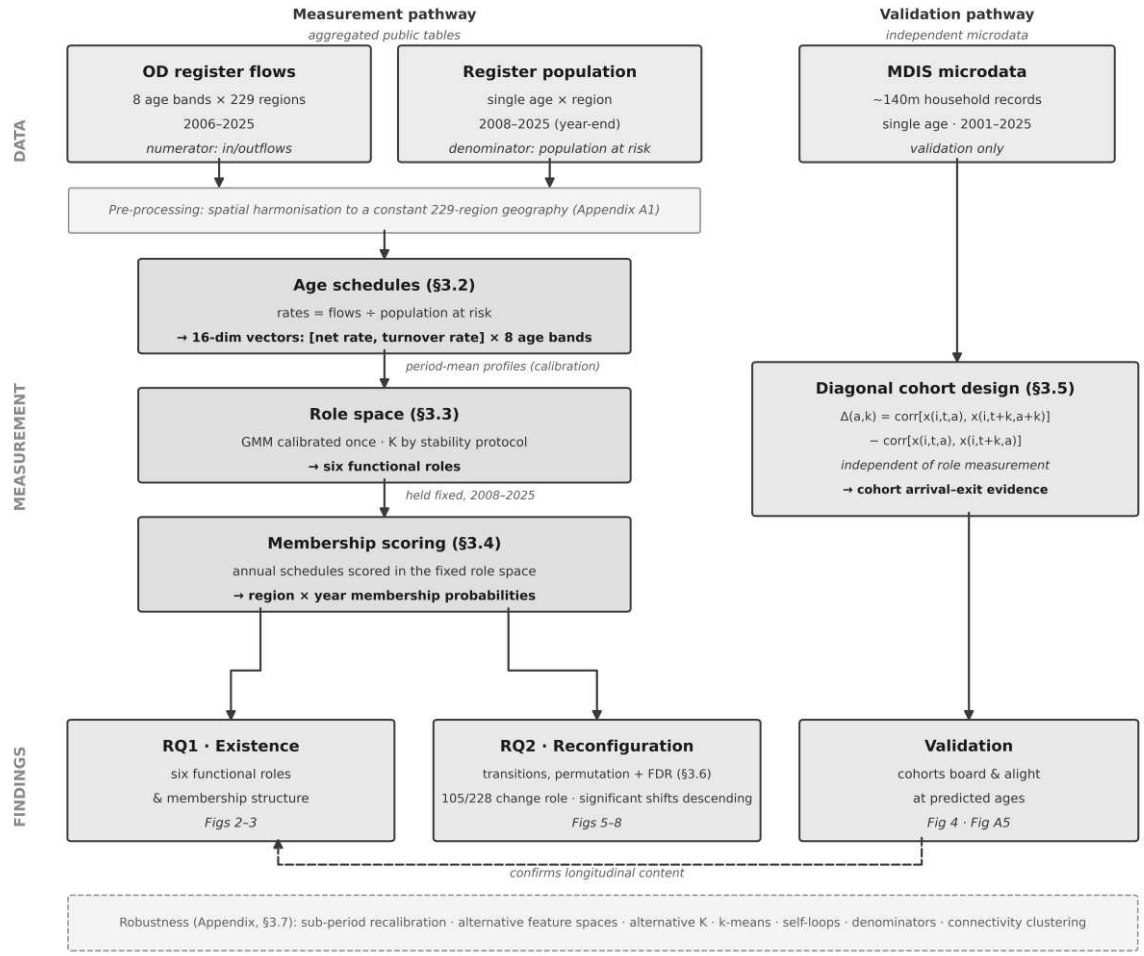


Figure 1. Analytical design: from population registers to role measurement, longitudinal validation, and reconfiguration.

Note: OD = origin–destination; MDIS = household microdata of the Domestic Migration Statistics, used only for validation.

3.1 Data sources and harmonization

The three complementary register-based sources are integrated in Table 1. First, origin–destination migration registers offer comprehensive counts of intermunicipal residential moves for 229 municipalities, categorized by eight ten-year age groups, annually from 2006 to 2025.

Residential registration is mandatory, and these are population-wide administrative records (Statistics Korea, 2024). Second, annual resident registration statistics provide single-year-of-age population counts (year-end, 2008–2025) aggregated into the same age groups as the denominators for rate calculations. Consequently, rate-based analyses cover 2008–2025, whereas flow-based analyses utilize the entire period. Third, the household-level microdata of the Domestic Migration Statistics (MDIS, 2001–2025; approximately 140 million movement records with a single year of age for each household member) are employed solely for longitudinal validation and did not contribute to role estimation. The earlier starting year relative to the flow panel extends the range of arrival–exit lags observable in cohort validation.

Table 1. Data sources.

Source	Official statistic	Period	Resolution	Function
OD register flows	Domestic Migration Statistics (aggregated OD tables)	2006–2025	229 municipalities × 8 age bands, annual	Numerator: age-specific in/outflows
Register population	Resident Registration Population	2008–2025 (year-end)	Single year of age × municipality	Denominator: population at risk
MDIS microdata	Domestic Migration Statistics (household microdata)	2001–2025	Move-level records; single age & sex of all members	Longitudinal validation; processing cross-check

Note: MDIS = household microdata of the Domestic Migration Statistics; rate-based analyses cover 2008–2025 (single-age denominators begin in 2008); microdata used only for validation. Source: Statistics Korea.

Boundary changes—83 superseded codes across ten event types—were standardized to a consistent 229-region geography using many-to-one correspondence rules. In the transition years, both code sets were aggregated to preserve flow totals. Sejong, founded as a planned administrative capital in 2012, entered the panel that year. The harmonized panel was verified by reconstructing the aggregated tables from the MDIS microdata, matching all 36,592 region–year–age cells. Two changes in registration coverage (2010 and 2015) adjusted the national denominators by +1.5% and +0.4%, respectively, and are highlighted where relevant. Appendix A1 provides details of the correspondence table and verification process. Annual inter-municipal migration ranged from 5.70 million (2006) to 3.97 million (2023); people in their twenties and thirties averaged 46.6% of all moves. The analysis panel included 4,118 region–year schedule observations, with annual totals by year detailed in Appendix Table A1.

3.2 Construction of migration schedules

Each region–year observation is a sixteen-dimensional migration schedule: for each of eight age bands, the net migration rate (I−O)/P and the turnover rate (I+O)/P. Here, I and O denote the inflows and outflows across municipal borders, respectively, while P represents the population at risk. This schedule is expressed as follows:

$$s_{it} = [\, n_{it}(1), \ldots, n_{it}(8), \tau_{it}(1), \ldots, \tau_{it}(8) \,]'$$

$$n_{it}(a) = \frac{I_{ita} - O_{ita}}{P_{ita}}, \quad \tau_{it}(a) = \frac{I_{ita} + O_{ita}}{P_{ita}} \qquad (1)$$

Net rates capture the directional balance of movement at each age, whereas turnover rates capture their volume, irrespective of direction. This separates regions with similar net balances but different volumes; high-traffic escalator versus a low-mobility residential area (Bell et al., 2015; Fielding, 1992). The pair constitutes an invertible transformation of the in-rate/out-rate pair and is preferred because of the high collinearity of age-specific in- and out-rates across regions. Thus, the clustering of the untransformed pair primarily highlights overall mobility levels rather than directional roles (see Appendix A2). Therefore, the transformation changes the representation of the schedules and not their information content. The term "schedule" is used descriptively, as the parametric model by Rogers and Castro (1981) necessitates more detailed age data than the eight ten-year groups provide (Yeung et al., 2023) and is thus not employed in the main analysis.

3.3 Measuring functional roles

Functional roles were identified using a Gaussian mixture model following a model-based clustering methodology (Fraley & Raftery, 2002; McLachlan & Peel, 2000). Clustering itself was not the objective; the fitted mixture served as the measurement instrument. The estimated role space was calibrated once and then fixed such that every region-year observation could be evaluated against the same reference. The calibration process employed the 229 period-average schedules s̄i, standardized by dimension, with diagonal component covariances:

$$f(\bar{s}) = \sum_{k=1}^{K} \pi_k \, N(\bar{s};\, \mu_k, \Sigma_k), \quad \Sigma_k \; diagonal \qquad (2)$$

As annual observations from the same region are serially dependent, calibrating period averages avoids pseudo-replication and yields components that represent enduring profiles

rather than short-term fluctuations. The number of components K was determined using a predefined protocol that integrated the bootstrap stability of the partition, a minimum component size of ten regions, and consistency with the archetypal schedule shapes identified in a pre-specified design-stage audit. The information criteria are provided alongside the diagnostics in Appendix A3. The calibrated role space then remained fixed, and the potential drift in role definitions was examined as a robustness issue (Section 3.7).

3.4 Membership scoring

All annual observations were scored in the fixed role space. Because single-year observations fluctuate more than the period averages, the scoring covariances add a within-region interannual variance component W, and the posterior membership follows the Bayes' rule:

$$p_k(s_{it}) = \frac{\pi_k \, N(s_{it};\, \mu_k, \Sigma_k + W)}{\Sigma_j \, \pi_j \, N(s_{it};\, \mu_j, \Sigma_j + W)} \qquad (3)$$

where W is a diagonal covariance matrix whose entries are the across-region averages of the within-region variances of the annual standardized schedules around their period means. Without W, the posteriors would concentrate artificially near zero or one, destabilizing the yearly assignments. Corrected memberships are interpreted as continuous indicators of role affiliation; discrete (modal) assignments, the role with the highest average corrected membership over a period, are used only for categorical summaries, such as maps and transition matrices.

3.5 Longitudinal validation

The longitudinal contents of these roles were evaluated independently using single-age microdata. The validation employed a diagonal cohort design, reflecting the concept of the

cohort as a driver of social change (Glenn, 2005; Ryder, 1965). In this context, x(i,t,a) represents the net inflow for region i at a specific age in year t, adjusted by the region's mean annual gross flow (removing scale differences) and normalized within the region (removing fixed regional attractiveness). The diagonal correlation connects x(i,t,a) with x(i,t+k,a+k), tracking the same birth cohort k years later. The placebo correlation links x(i,t,a) with x(i,t+k,a), maintaining the same region, lag, and age but involving a different cohort. Both terms incorporate common regional conditions identically, so their differences highlight cohort-specific behavior.

$$\Delta(a,k) = corr[\, x(i,t,a), x(i,t+k,a+k)\,] - corr[\, x(i,t,a), x(i,t+k,a)\,] \quad (4)$$

The escalator prediction is selective by age: Δ is expected to be negative at ages corresponding to labor-market entry—cohorts that arrive in excess subsequently leave in excess, reversing the sign of their later net flows—and neutral at settlement ages. Inference was conducted using a regional-level cluster bootstrap (B = 400), and regions with mean annual gross flows of less than 500 persons were excluded to minimize noise from small denominators.

3.6 Role reconfiguration

To mitigate snapshot uncertainty, reconfiguration was examined over the full annual membership trajectories of 2008–2025, rather than endpoint classifications alone. Transition matrices, which employed the modal roles defined in Section 3.4, encapsulated the shifts between the initial period (2008–2011) and final period (2022–2025). The significance of these changes was assessed through within-region permutation tests (B = 1,000), which randomized the sequence of years while preserving each region's marginal membership distribution, thereby eliminating the temporal ordering. The null hypothesis is that observed transitions

reflect only window noise under a random ordering of years. Cell-level results were adjusted using the Benjamini–Hochberg false discovery rate (Benjamini & Hochberg, 1995) and a directional statistic, the number of regions moving into low-mobility roles (specified in Table 3) minus the number moving out, was tested against the same null hypothesis.

3.7 Robustness and reproducibility

Robustness analyses were conducted to exclude alternative explanations. First, to test whether the observed change reflects shifting role definitions rather than shifting assignments, the model was recalibrated on sub-periods (Appendix A2). Second, to test the dependence on measurement choices, the roles were re-estimated in the untransformed [in-rate, out-rate] representation of Section 3.2, with a scale-free net-to-turnover specification, intra-municipality moves included, alternative denominators, alternative values of K, and k-means instead of the mixture model (Appendices A2–A3). Third, to test whether the roles merely reproduced the spatial structure, role partitioning was compared to connectivity-based clustering (Appendix A4.2). All analyses were derived from a single fixed specification using seeded estimations.

4. Results

4.1 Six functional roles

The selection protocol identified six functional roles (Figure 2). Within the stability plateau of five to eight components, the six-component solution was the only solution that satisfied all three predefined criteria: the five-component solution merged the landing zone and reception profiles, larger solutions added outlier components below the minimum size, and the information criteria decreased monotonically without an internal optimum (Section 3.3; full diagnostics in Appendix A3).

Figure 2 shows the calibrated schedules, and Table 2 details the composition. The three roles

were characterized by net population gain, each operating at a different life-course stage. The escalator role exhibited net gains during teenage and young adult years, followed by net losses after approximately age thirty, with the second highest turnover in the system. Its 17 municipalities comprise 12 central and Han River districts of Seoul and the historic cores of Busan and Daegu. The landing-zone role (27 municipalities) showed net gains at all ages, peaking in the thirties, was concentrated in the metropolitan new town belt, and expanded to industrial municipalities such as Asan and Yangsan. The high turnover reception role (17 municipalities) combined the highest turnover in the system with mid-life net gains. Its members include planned administrative settlements (Sejong, Gyeryong, Gwacheon, Wanju, and Muan) and island and military service counties where institutional rotation produces similar schedules. The other three roles are characterized by population release or low mobility. The supplier–return role (69 mainly rural municipalities) lost approximately 6.1% of its population in their twenties annually while regaining residents aged 50 and above. The gradual outflow (56 municipalities) spanned mature residential districts on Seoul's outskirts and metropolitan cities, with minor net losses throughout adulthood. The low-mobility anchor role (43 municipalities) included self-contained regional centers such as Cheongju, Changwon, and Pohang, with the lowest turnover in the system and losses limited to those in their twenties. These two roles encompassed 125 of the 229 municipalities.

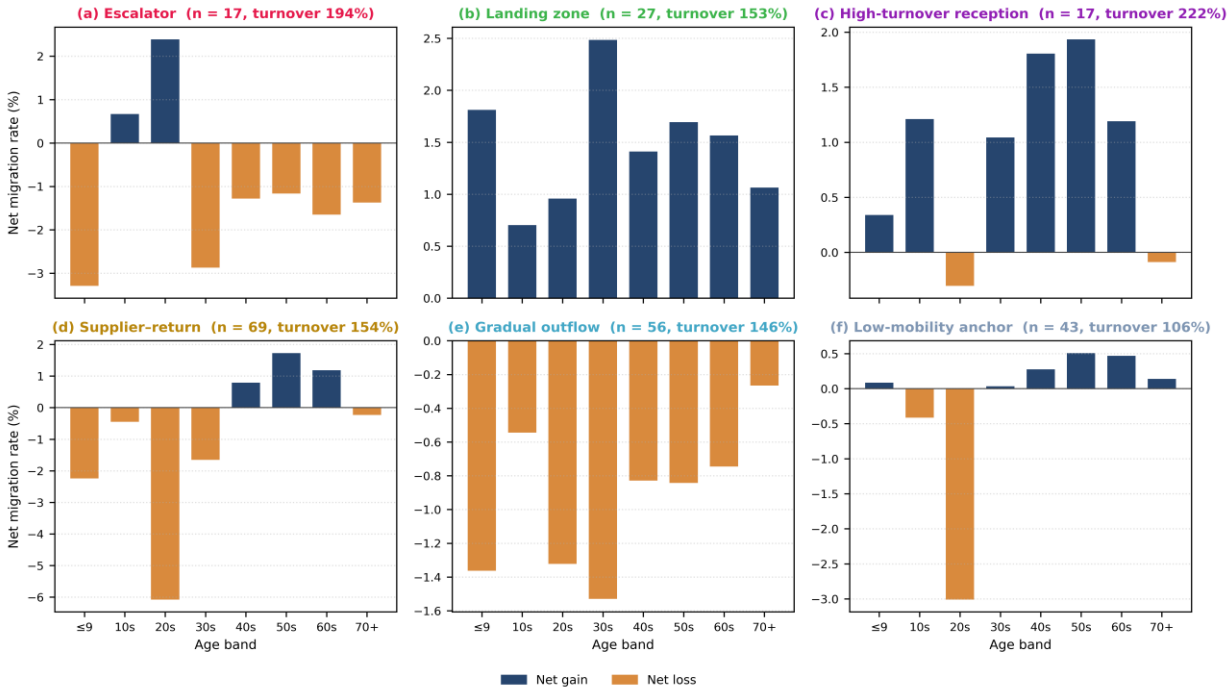


Figure 2. Six functional roles: calibrated age-specific migration schedules (period means, 2008–2025).

Note: Age-specific net migration rates (percent of population at risk); blue = net gain, vermilion = net loss; panel headings indicate member count and age-summed turnover.

Source: Authors' calculations from Statistics Korea registers.

Table 2. Functional roles: composition and profile summary.

Role	n	Profile signature	Marker regions	Mean membership
Escalator	17	Net gains at 10s–20s; losses at 30+; turnover 194%	Gwanak, Gangnam; Busan/Daegu cores	0.82
Landing zone	27	Net gains at all ages, peak 30s	Hwaseong; new-town belt	0.58
High-turnover reception	17	Mid-life gains; turnover 222%	Sejong; planned & special territories	0.71
Supplier–return	69	20s −6.1%; 50–60s return	Uiseong; rural counties	0.81

Gradual outflow	56	Weak losses at all ages	Nowon; mature suburbs	0.71
Low-mobility anchor	43	Only 20s leave; turnover 106%	Cheongju, Changwon, Pohang	0.87

Note: n = municipalities under modal assignment; turnover = age-summed gross migration relative to population (period mean); and mean membership = average corrected membership in the assigned role. Source: Authors' calculations.

Figure 3 maps the modal assignments: escalators in metropolitan centers; landing zones and reception areas around the capital and planned communities; supplier–return municipalities in rural regions; and gradual outflow and anchor roles in mature suburbs and established regional cities. The roles were persistent; decade-separated average schedules were correlated at r = 0.89. Similar structures were identified using various specifications and algorithms (Appendix A2).

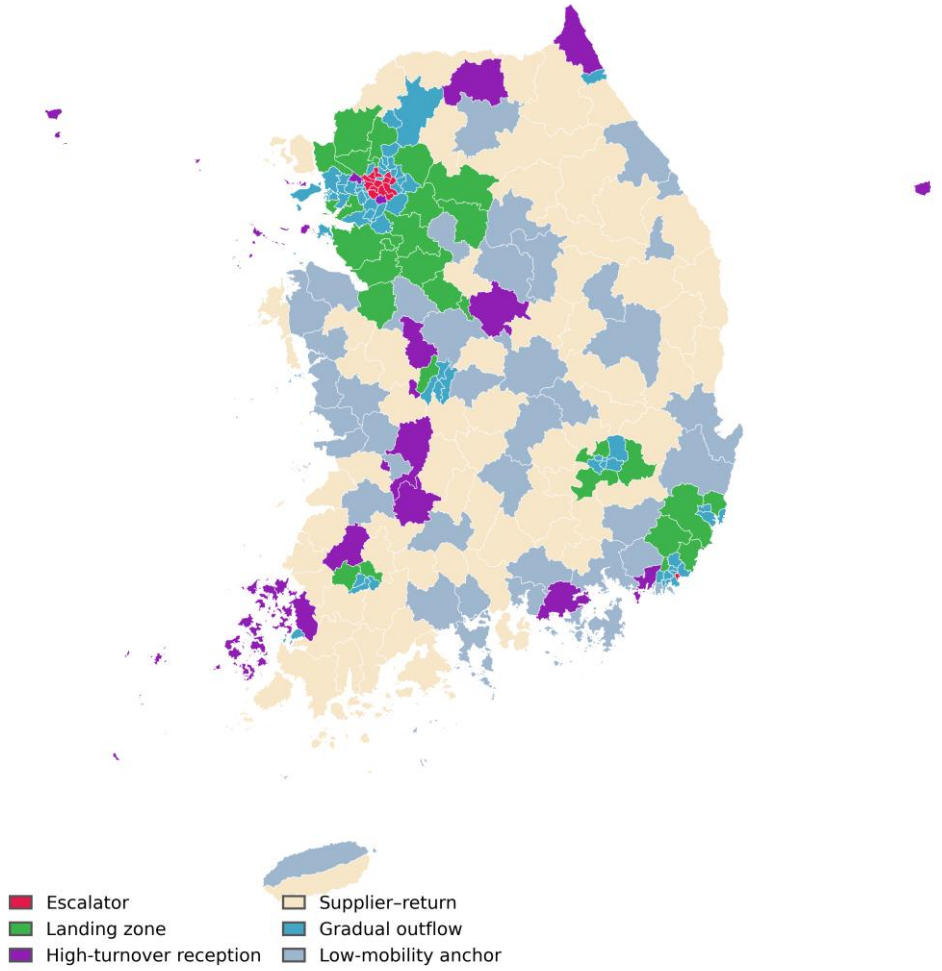


Figure 3. Spatial distribution of modal role assignments, 2008–2025 average.

Note: Modal role = highest average corrected membership, 2008–2025 (Sejong: 2012–2025). Escalator-like assignments in island and border counties reflect institutional rotation rather than labor market migration. Source: Authors' calculations.

Nevertheless, the posterior membership probabilities revealed a substantial boundary structure. The average maximum membership was 0.76, with 51 municipalities (22%) exhibiting a maximum membership below 0.60 and indicating gradual transitions between neighboring roles rather than distinct clusters, which motivates the use of membership probabilities rather than discrete labels in the analyses (Appendix A4). In summary, six stable roles that vary systematically in the direction and intensity of age-specific migration frame the validation and

reconfiguration analyses.

4.2 Longitudinal validation

Longitudinal validity was evaluated using the diagonal cohort design described in Section 3.5. We first asked whether aggregate methods could replicate cohort dynamics. Lagged correlations from age-band net migration declined over five- to seven-year horizons for nearly all age pairings, including placebo pairings with no cohort mechanism, such as inflows over 60 against later outflows in the thirties (Appendix A5), so aggregate lagged correlations mainly register common regional cycles rather than cohort behavior. In the diagonal analysis of single-age microdata (Figure 4), the same-cohort correlation for arrival ages 25 and 28 was significantly more negative than the same-age placebo at every horizon: $\Delta(a,k)$ ranged from -0.09 to -0.15 over follow-ups of 3, 5, 7, and 10 years, with all eight region-cluster bootstrap intervals excluding zero (Table A5), matching the predicted sign. Across the full arrival age grid at the five-year horizon, the cohort effect was confined to a narrow segment of the life course (Figure A5). Differences were significantly negative for arrival ages 23–30, peaking at 26–27 ($\Delta = -0.22$ and -0.20); positive but not significant at ages 20–22 (+0.07 to +0.09), consistent with initial retention; and indistinguishable from placebo from age 31 onward in a stable pattern. The validation thus provides independent evidence that the schedules identified in Section 4.1 represent persistent cohort trajectories that are significant precisely at the labor market entry ages that define the escalator profile and absent at the settlement ages that define the landing zone.

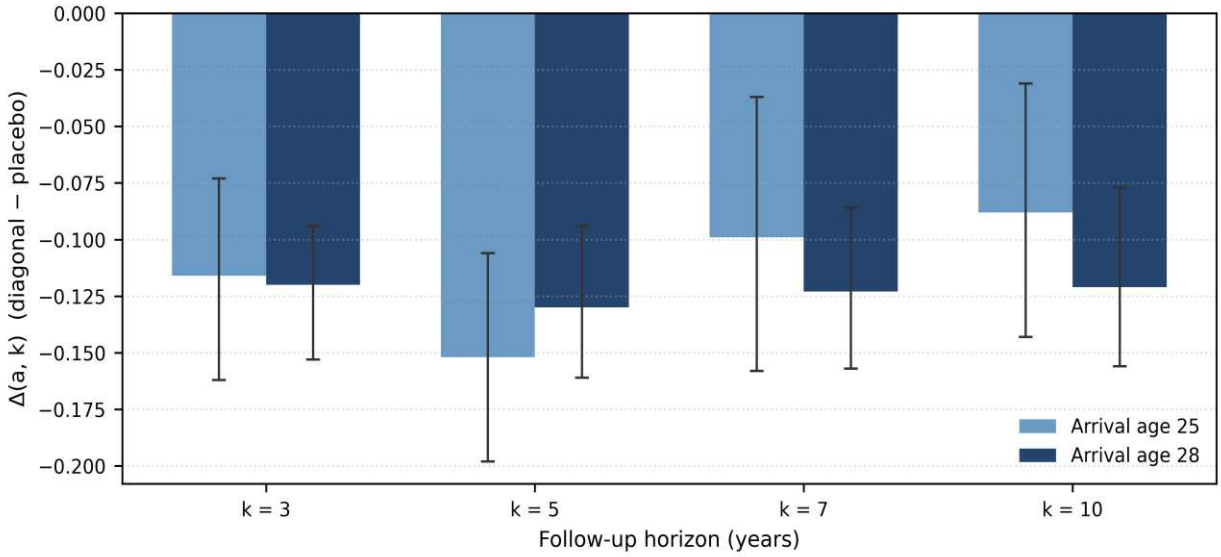


Figure 4. Diagonal cohort validation: same-cohort versus same-age placebo correlations by arrival age and follow-up horizon.

Note: Δ(a,k) = same-cohort minus same-age placebo correlation (equation 4), arrival ages 25 and 28, horizons k = 3, 5, 7, 10; whiskers = 95% region-cluster bootstrap intervals (B = 400); regions with mean annual gross flows below 500 excluded. Source: MDIS microdata.

4.3 Reconfiguration, 2006–2025

Figure 5 illustrates the corrected membership trajectories for the four municipalities chosen to span the principal trajectory types: planned capital completing a full role sequence (Sejong), new town maturation (Hwaseong), an escalator core in recent flux (Gangnam), and a persistently stable escalator (Gwanak). Sejong showed the fullest sequence; reception membership near one from 2012 to 2019, a rapid transition to the landing zone by 2021, and a drift toward the anchor profile by 2025. Hwaseong alternated between reception and landing-zone roles through successive waves of new-town intake before stabilizing as a landing zone. Gwanak sustained an escalator membership of close to one for 18 consecutive years. Gangnam predominantly held escalator membership, with posterior probabilities briefly diffusing from 2023 to 2024, before returning by 2025.

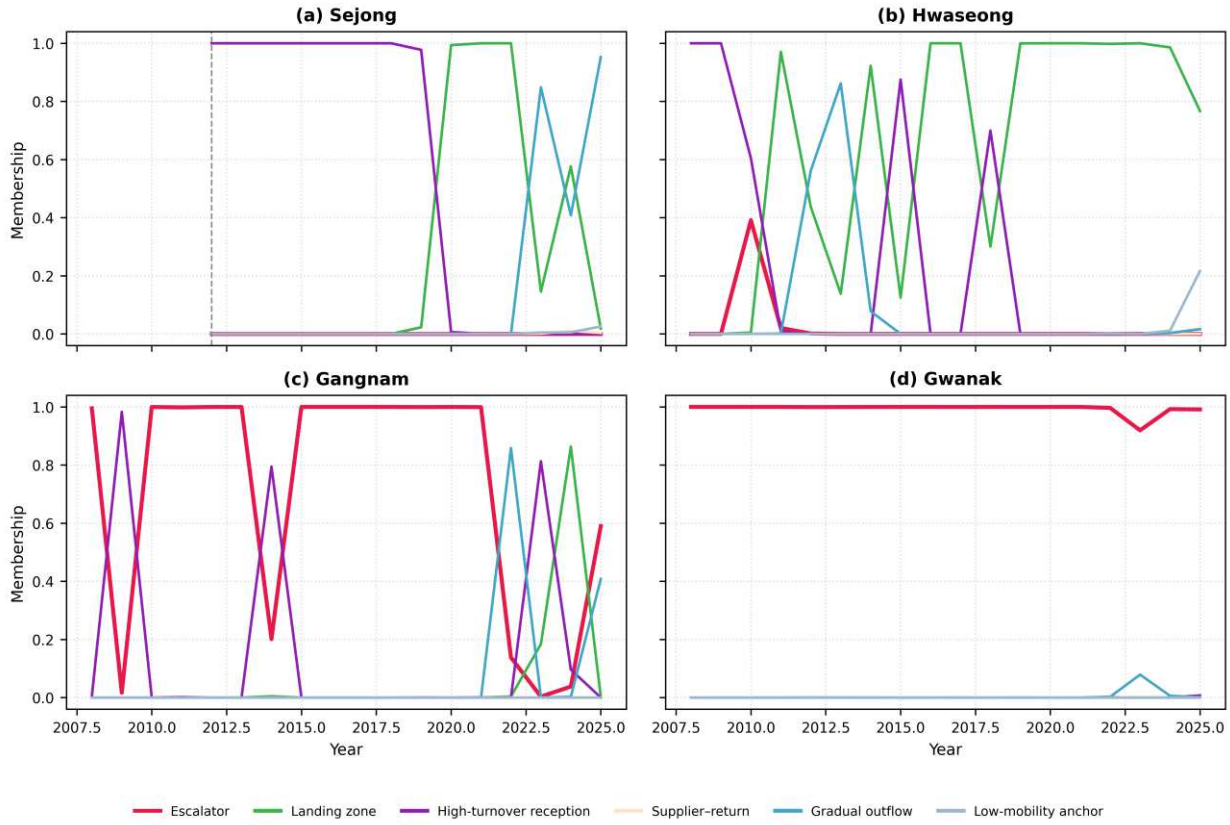


Figure 5. Corrected membership trajectories: Sejong, Hwaseong, Gangnam, Gwanak.

Note: Annual corrected membership probabilities (Equation 3), 2008–2025; dashed line = Sejong's 2012 foundation. Source: Authors' calculations.

A common trend across the system underlies these varied trajectories (Figure 6): high-mobility roles declined, whereas low-mobility roles increased. The average escalator membership across Seoul's twenty-five districts decreased from 0.62–0.69 2008–2011 0.27–0.39 2022–2025. The shift extended beyond the capital: the mean escalator membership across all municipalities fell from 0.115 to 0.051 and reception membership from 0.137 to 0.056, while anchor membership rose from 0.165 to 0.304 and supplier membership rose from 0.237 to 0.328.



Figure 6. Mean escalator membership, Seoul's twenty-five districts, 2008–2025.

Note: Annual mean corrected escalator membership across the twenty-five districts; band = interquartile range; gray = analysis window. Source: Authors' calculations.

Figure 7 and Table 3 summarize the transitions between the early (2008–2011) and late (2022–2025) periods and Figure 8 spatially maps these transitions. Of the 228 municipalities, 105 (46.1%) changed their modal roles well above the permutation expectations (Table 3). The direction of change was asymmetric: net movement into the low-mobility roles amounted to +43 municipalities (Table 3), and of the 19 transition types, the 11 that remained significant after false discovery rate correction all followed the descending mobility gradient—most prominently gradual outflow to anchor, escalator to gradual outflow, and landing zone to anchor–together with the stepwise decline of the reception role—while no upward or reverse transition was distinguishable from the permutation null. These transitions reflected changes in role membership rather than role definitions; recalibration within sub-periods reproduced the role profiles with component mean correlations of 0.88–0.94 (Appendix A2). Thus, the reconfiguration consisted of municipalities systematically moving within a stable role space

from high- to low-mobility roles.

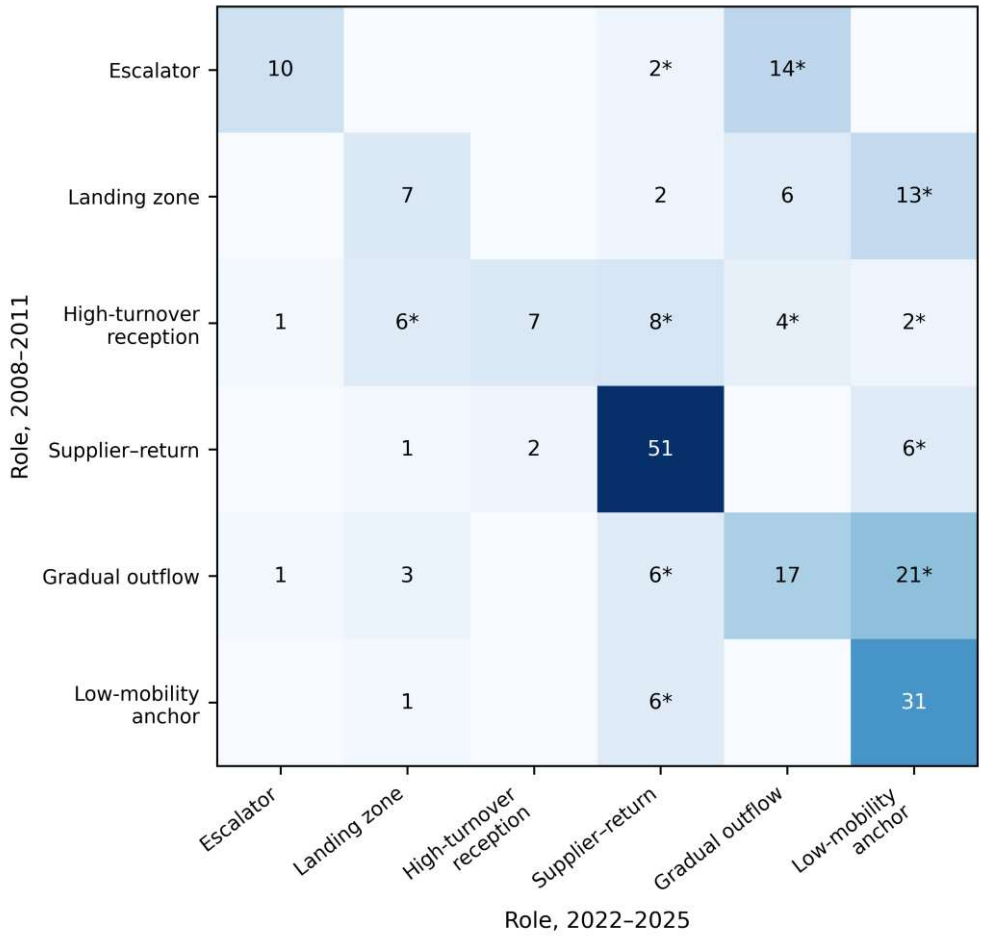


Figure 7. Role transitions between early and late windows.

Note: Cells count municipalities moving from row (2008–2011) to column (2022–2025); asterisks = significant at the 5% level after false discovery rate correction (within-region permutation, B = 1,000). Source: Authors' calculations.

Table 3. Transition inference (within-region permutation, B = 1,000).

Statistic	**Observed**	**Null mean**	**p**
Regions changing modal role	105 / 228	40.3	< 0.001
Net movement into low-mobility roles	+43	−0.2	< 0.001

FDR-significant transition types (5%)	11 of 19	—	all descending
Largest flows: Gradual→Anchor / Escalator→Gradual / Landing→Anchor	21 / 14 / 13	2.7 / 1.7 / 2.4	< 0.01 each

Note: Windows 2008–2011 and 2022–2025: 228 municipalities were observed in both (Sejong was excluded early). Null distributions from within-region permutation of year order; FDR = Benjamini–Hochberg at 5%. Low mobility roles = supplier–return, gradual outflow, anchoring. Source: Authors' calculations.

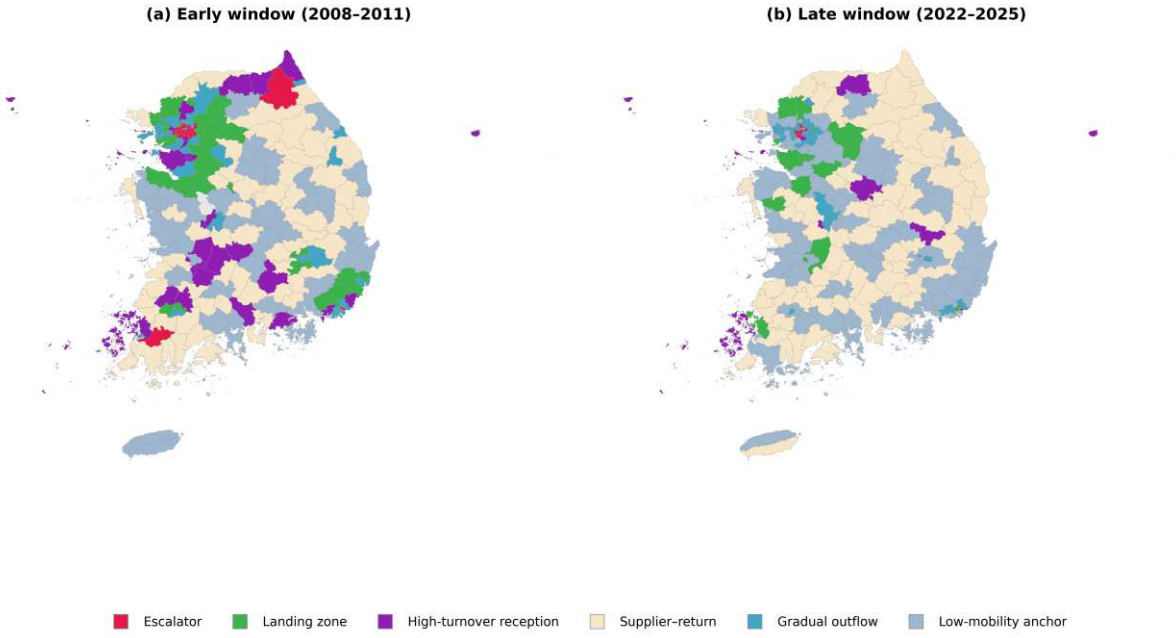


Figure 8. Spatial distribution of modal role assignments, early (2008–2011) and late (2022–2025) windows.

Note: Modal role = highest average corrected membership within each window. Gray = unclassified (Sejong enters 2012). Institutional-rotation caveat as in Figure 3. Source: Authors' calculations.

5. Discussion

The escalator region concept implies that for a region to attract young individuals while losing middle-aged individuals, other regions must exhibit opposite trends: losing young individuals and gaining middle-aged individuals. Fielding's analysis of South East England implicitly commented on the rest of Britain (Fielding, 1992). The framework developed in this study quantifies this implication, modifying the concept. The escalator is a position rather than a location, and the profile characterizing Seoul's central districts also applies to the historic centers of Busan and Daegu, cities with declining total populations, which are not typically identified as escalators in candidate-focused single-region designs (Champion et al., 2013). The releasing side is an equal part of the system: supplier–return counties and gradual-outflow districts—most Korean municipalities—are not background but complementary positions that demographically enable escalators. Because the roles were held fixed, Korea's roles remained constant even as its regions shifted, addressing the unit-of-analysis issue in Section 2: the escalator is a position within a measured structure of complements.

The validation results address the second longitudinal issue. The diagonal cohort design demonstrates that at the population level, the measured escalator profiles align with the actual cohort behavior: cohorts entering the labor market later exit in greater numbers, with the signal appearing precisely at the ages defining the escalator profile and disappearing at those defining the landing zone. Thus, the roles carry the longitudinal content of the concept claims (Fielding, 1992), and not merely a cross-sectional form. The robustness analyses relate to Section 2's other proposition that the relational and functional structures of a migration system are analytically distinct. Clustering the same regions based on connectivity results in a partition largely unrelated to the role structure (ARI = 0.11), functional roles are not disguised spatial communities, and information absent from the flow topology is added.

The reconfiguration findings connect Korea with two global discussions. In the debate on whether metropolitan escalators still operate (Champion & Gordon, 2019; Yu, 2022), Seoul's

escalator membership has roughly halved over two decades, with exits and no significant new entries, showing an escalator decline across an entire system rather than a single area. For the mobility-decline debate (Alvarez et al., 2021; Champion et al., 2017; Cooke, 2013; Molloy et al., 2011), transition analysis adds a structural reading: Korea's decline is not merely less movement but a targeted reallocation of roles—all 11 transitions surviving multiple-testing correction shifts toward lower-mobility roles. The division of labor persists, but its membership is reassigned. This targeted demobilization also provides a system-level counterpart to city-specific shrinkage accounts (Khavarian-Garmsir, 2023; Martinez-Fernandez et al., 2012).

Two findings further support this scenario. The age at which individuals board is decreasing: the intensification of Seoul's most active escalator district is driven by teenage in-migration, aligned with education-related schedule components (Wilson, 2010), indicating that escalator entry is increasingly linked to educational rather than labor market transitions. The planned capital experiment completes a full role life cycle within 13 years—pulse, absorption, subsidence—a trajectory relevant to other planned capitals (Moser, 2010) and caution for policies assuming planned in-migration leads to permanent attraction.

However, the study design did not address the underlying reasons. Factors such as population aging, the narrowing of migratory age ranges, housing-cost exclusion from escalator cores, and the maturation of a landing-zone belt developed in earlier decades are potential mechanisms familiar with the mobility-decline debate (Champion et al., 2017; Cooke, 2013); each aligns with parts of the pattern, yet none is pinpointed by our measurements. The association structure documented here—which roles exist, which regions moved, and in which direction—is the phenomenon that determinant-focused research must explain; under one constraint, any proposed mechanism must reproduce the observed directionality of transitions.

This framework is adaptable. To evaluate this, age-specific origin–destination register flows are essential and can be obtained from population registers in Northern Europe, municipal

registration systems such as Spain's padrón, and resident registration systems across East Asia, noted for their cross-national comparability (Bell et al., 2015). For validation purposes, event-level microdata, which are increasingly accessible from countries with comprehensive registers, are required (Lichner et al., 2024). The diagonal design is optimal for registers such as Korea's, which document movements without continuous personal identifiers, because it extracts cohort data from anonymous event records. The reference-role-space logic—calibrate once, score always—generalizes equally, opening comparative questions about whether national systems allocate roles differently. Thus, Korea demonstrates a framework with data requirements that more countries are beginning to fulfil.

This study has several limitations. Fielding's (1992) initial association of migration with occupational ascent captures the migratory aspect that this framework generalizes, while occupational tradition (Gordon et al., 2015) remains a complementary source of evidence that aggregate registers cannot address. Validation occurs at the cohort level, demonstrating that arrival cohorts eventually exit in greater numbers, not that specific individuals embark and disembark. Institutional rotation, such as military services or island administration, can mimic high-turnover patterns, which is why the interpretation of the reception role differentiates between planned-city and special-territory groups. Age-specific denominators were introduced in 2008 and included two registration category breaks, which are noted where applicable. Finally, the measured roles were defined according to the age composition. Whether the system's flows link roles from a division-of-labor perspective suggests whether those leaving escalators predominantly end up in landing zones and those leaving suppliers on escalators, and how the division of labor varies by gender, are pertinent questions for future research.

6. Conclusion

Transforming the escalator region into an escalator system turns a three-decade-old analysis of

a single area into an account of how the national migration system allocates life stages among complementary roles. Applied to Korea, the framework answers each question in turn: six functional roles encompass all 229 municipalities (RQ1); boarding, riding, alighting, and settling appear in household registers at the expected ages (validation); and between 2006 and 2025, regions moved between fixed roles, consistent toward lower mobility, halving Seoul's escalator geography (RQ2). Requiring only age-specific register flows for measurements and event-level microdata for validation, the framework can travel to any system that records these flows. For policy, escalator functions should not be treated as permanent; planned in-migration can complete its cycle within a decade, and mobility declines by reallocating regions toward lower mobility roles, a distinction relevant to regional and housing policies aimed at young adults' entry points. The escalator was not merely a location; in Korea, it is at least a position within a system reorganizing toward lower mobility.

Funding details

This study was supported by the Academic Research Funding of Baekseok University in 2026.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Declaration of generative AI use

Generative AI tools were used to assist with language editing and manuscript formatting. All research design, analyses, interpretations, and conclusions are the authors' own, and the authors reviewed and take full responsibility for all content.

Data availability statement

The aggregated origin–destination flow tables and resident registration population counts are

publicly available from Statistics Korea (KOSIS). The household-level microdata of the Domestic Migration Statistics are available through the Microdata Integrated Service of Statistics Korea under its access procedures. Processing and analysis code, the harmonization correspondence table, and derived datasets sufficient to reproduce all results are available at https://github.com/dongwoo2022008/From-escalator-region-to-escalator-system.

References

Abel, G. J., & Heo, N. (2018). Changing internal migration flows patterns in South Korea. *Regional Studies, Regional Science*, *5*(1), 78–80. https://doi.org/10.1080/21681376.2018.1431149

Abel, G. J., & Sander, N. (2014). Quantifying global international migration flows. *Science*, *343*(6178), 1520–1522. https://doi.org/10.1126/science.1248676

Almquist, Z. W., Nguyen, T. D., Sorensen, M., Fu, X., & Sidiropoulos, N. D. (2024). Uncovering migration systems through spatio-temporal tensor co-clustering. *Scientific Reports*, *14*(1), 26861. https://doi.org/10.1038/s41598-024-78112-z

Alvarez, M., Bernard, A., & Lieske, S. N. (2021). Understanding internal migration trends in OECD countries. *Population, Space and Place*, *27*(7). https://doi.org/10.1002/psp.2451

Andersson, R. (1996). The geographical and social mobility of immigrants: Escalator regions in Sweden from an ethnic perspective. *Geografiska Annaler: Series B, Human Geography*, *78*(1), 3–25. https://doi.org/10.1080/04353684.1996.11879693

Bell, M., Charles-Edwards, E., Ueffing, P., Stillwell, J., Kupiszewski, M., & Kupiszewska, D. (2015). Internal migration and development: Comparing migration intensities around the world. *Population and Development Review*, *41*(1), 33–58. https://doi.org/10.1111/j.1728-4457.2015.00025.x

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and

powerful approach to multiple testing. *Journal of the Royal Statistical Society Series B*, *57*(1), 289–300. https://doi.org/10.1111/j.2517-6161.1995.tb02031.x

Bernard, A., Bell, M., & Charles-Edwards, E. (2014). Life-course transitions and the age profile of internal migration. *Population and Development Review*, *40*(2), 213–239. https://doi.org/10.1111/j.1728-4457.2014.00671.x

Bernard, A., Bell, M., & Charles-Edwards, E. (2016). Internal migration age patterns and the transition to adulthood: Australia and Great Britain compared. *Journal of Population Research*, *33*(2), 123–146. https://doi.org/10.1007/s12546-016-9157-0

Bernard, A., Rowe, F., Bell, M., Ueffing, P., & Charles-Edwards, E. (2017). Comparing internal migration across the countries of Latin America: A multidimensional approach. *PLOS One*, *12*(3), e0173895. https://doi.org/10.1371/journal.pone.0173895

Berry, B. J. L. (1964). Cities as systems within systems of cities. *Papers in Regional Science*, *13*(1), 147–163. https://doi.org/10.1111/j.1435-5597.1964.tb01283.x

Champion, T. (2012). Testing the return migration element of the "escalator region" model: An analysis of migration into and out of south-east England, 1966–2001. *Cambridge Journal of Regions, Economy and Society*, *5*(2), 255–270. https://doi.org/10.1093/cjres/rsr045

Champion, T., Cooke, T., & Shuttleworth, I. (Eds.). (2017). *Internal migration in the developed world*. Routledge. https://doi.org/10.4324/9781315589282

Champion, T., Coombes, M., & Gordon, I. (2013). How far do England's second-order cities emulate London as human-capital 'escalators'? *Population, Space and Place*, *20*(5), 421–433. https://doi.org/10.1002/psp.1806

Champion, T., & Gordon, I. (2019). Linking spatial and social mobility: Is London's "escalator" as strong as it was? *Population, Space and Place*, *27*(7). https://doi.org/10.1002/psp.2306

Cooke, T. J. (2013). Internal migration in decline. *Professional Geographer*, *65*(4), 664–675. https://doi.org/10.1080/00330124.2012.724343

Coombes, M. G., Green, A. E., & Openshaw, S. (1986). An efficient algorithm to generate official statistical reporting areas: The case of the 1984 travel-to-work areas revision in Britain. *Journal of the Operational Research Society*, *37*(10), 943–953. https://doi.org/10.1057/jors.1986.163

de Haas, H. (2010). Migration and development: A theoretical perspective. *International Migration Review*, *44*(1), 227–264. https://doi.org/10.1111/j.1747-7379.2009.00804.x

Duranton, G., & Puga, D. (2005). From sectoral to functional urban specialisation. *Journal of Urban Economics*, *57*(2), 343–370. https://doi.org/10.1016/j.jue.2004.12.002

Fan, C. C. (2005). Interprovincial migration, population redistribution, and regional development in China: 1990 and 2000 census comparisons. *Professional Geographer*, *57*(2), 295–311. https://doi.org/10.1111/j.0033-0124.2005.00479.x

Fawcett, J. T. (1989). Networks, linkages, and migration systems. *International Migration Review*, *23*(3), 671–680. https://doi.org/10.1177/019791838902300314

Fielding, A. J. (1992). Migration and social mobility: South East England as an escalator region. *Regional Studies*, *26*(1), 1–15. https://doi.org/10.1080/00343409212331346741

Fielding, T. (1993). Migration and the metropolis: An empirical and theoretical analysis of inter-regional migration to and from South East England. *Progress in Planning*, *39*, 75–166. https://doi.org/10.1016/0305-9006(93)90006-f

Findlay, A., Mason, C., Harrison, R., Houston, D., & McCollum, D. (2008). Getting off the escalator? A study of scots out-migration from a global city region. *Environment and Planning A*, *40*(9), 2169–2185. https://doi.org/10.1068/a39256

Fraley, C., & Raftery, A. E. (2002). Model-based clustering, discriminant analysis, and density estimation. *Journal of the American Statistical Association*, *97*(458), 611–631. https://doi.org/10.1198/016214502760047131

Glenn, N. (2005). *Cohort analysis*. Sage Publications, Inc.

https://doi.org/10.4135/9781412983662

Gordon, I., Champion, T., & Coombes, M. (2015). Urban escalators and interregional elevators: The difference that location, mobility, and sectoral specialisation make to occupational progression. *Environment and Planning A*, *47*(3), 588–606. https://doi.org/10.1068/a130125p

Gürsoy, F., & Badur, B. (2022). Investigating internal migration with network analysis and latent space representations: An application to Turkey. *Social Network Analysis and Mining*, *12*(1), 150. https://doi.org/10.1007/s13278-022-00974-w

Khavarian-Garmsir, A. R. (2023). A systematic review of shrinking cities literature: Lessons from the past and directions for the future. *International Planning Studies*, *28*(3–4), 219–238. https://doi.org/10.1080/13563475.2023.2205030

Kim, W., Jeong, J., & Yoon, D. K. (2024). Analysis of multiple gravitational influences on interregional population migration in South Korea. *Regional Studies*, *59*(1). https://doi.org/10.1080/00343404.2024.2385560

King, R., Lulle, A., Parutis, V., & Saar, M. (2017). From peripheral region to escalator region in Europe: Young Baltic graduates in London. *European Urban and Regional Studies*, *25*(3), 284–299. https://doi.org/10.1177/0969776417702690

Lee, C., & Kim, D. (2025). Exploring the characteristics shaping internal migration type of young adults in South Korea: A focus on the primary, onward, short-return, and return migration. *International Journal of Urban Sciences*, 1–33. https://doi.org/10.1080/12265934.2025.2574925

Lee, S., Jeon, J., Yeon, S., & Im, J. (2025). Disaggregating multifaceted destination effects on residential mobility by regional and age groups in South Korea. *Land*, *14*(9), 1833. https://doi.org/10.3390/land14091833

Lichner, I., Baláž, V., & Jeck, T. (2024). Between spaces: Unravelling motives and distances in internal migration. *Population, Space and Place*, *30*(8). https://doi.org/10.1002/psp.2818

Mabogunje, A. L. (1970). Systems approach to a theory of rural-urban migration. *Geographical Analysis*, *2*(1), 1–18. https://doi.org/10.1111/j.1538-4632.1970.tb00140.x

Martel, C., Taylor, A., & Carson, D. (2013). Changing patterns of migration to Australia's Northern Territory: Evidence of new forms of escalator migration to frontier regions? *Migration Letters*, *10*(1), 101–114. https://doi.org/10.33182/ml.v10i1.115

Martinez-Fernandez, C., Audirac, I., Fol, S., & Cunningham-Sabot, E. (2012). Shrinking cities: Urban challenges of globalization. *International Journal of Urban and Regional Research*, *36*(2), 213–225. https://doi.org/10.1111/j.1468-2427.2011.01092.x

Massey, D. S., Arango, J., Hugo, G., Kouaouci, A., Pellegrino, A., & Taylor, J. E. (1993). Theories of international migration: A review and appraisal. *Population and Development Review*, *19*(3), 431. https://doi.org/10.2307/2938462

McCollum, D., Liu, Y., Findlay, A., Feng, Z., & Nightingale, G. (2018). Determinants of occupational mobility: The importance of place of work. *Regional Studies*, *52*(12), 1612–1623. https://doi.org/10.1080/00343404.2018.1424993

McLachlan, G., & Peel, D. (2000). *Finite mixture models*. In Wiley Series in Probability and Statistics. John Wiley & Sons. https://doi.org/10.1002/0471721182

Molloy, R., Smith, C. L., & Wozniak, A. (2011). Internal migration in the United States. *Journal of Economic Perspectives*, *25*(3), 173–196. https://doi.org/10.1257/jep.25.3.173

Moser, S. (2010). Putrajaya: Malaysia's new federal administrative capital. *Cities*, *27*(4), 285–297. https://doi.org/10.1016/j.cities.2009.11.002

Newbold, K. B., & Brown, W. M. (2012). Testing and extending the escalator hypothesis: Does the pattern of post-migration income gains in Toronto suggest productivity and/or learning effects? *Urban Studies*, *49*(15), 3447–3465. https://doi.org/10.1177/0042098012443859

Pitoski, D., Lampoltshammer, T. J., & Parycek, P. (2021). Network analysis of internal migration in Croatia. *Computational Social Networks*, *8*(1). https://doi.org/10.1186/s40649-

021-00093-0

Plane, D. A., Henrie, C. J., & Perry, M. J. (2005). Migration up and down the urban hierarchy and across the life course. *Proceedings of the National Academy of Sciences of the United States of America*, *102*(43), 15313–15318. https://doi.org/10.1073/pnas.0507312102

Ravenstein, E. G. (1885). The laws of migration. *Journal of the Statistical Society of London*, *48*(2), 167–235. https://doi.org/10.2307/2979181

Reuschke, D. (2013). Self-employment as a route in and out of Britain's South East. *Regional Studies*, *49*(4), 665–680. https://doi.org/10.1080/00343404.2013.799764

Rogers, A., & Castro, L. J. (1981). Model migration schedules (RR-81-030). International Institute for Applied Systems Analysis. https://pure.iiasa.ac.at/1543

Ryder, N. B. (1965). The cohort as a concept in the study of social change. *American Sociological Review*, *30*(6), 843–861. https://doi.org/10.2307/2090964

Sander, N., & Bell, M. (2013). Migration and retirement in the life course: An event history approach. *Journal of Population Research*, *31*(1), 1–27. https://doi.org/10.1007/s12546-013-9121-1

Sarra, A., D'Ingiullo, D., Evangelista, A., Nissi, E., Quaglione, D., & Di Battista, T. (2025). A network analysis of skill-specific internal migration flows in Italy. *Socio-Economic Planning Sciences*, *100*, 102225. https://doi.org/10.1016/j.seps.2025.102225

Statistics Korea. (2024). *Internal migration statistics 2023*. Statistics Korea. [in Korean].

Wilson, T. (2010). Model migration schedules incorporating student migration peaks. *Demographic Research*, *23*, 191–222. https://doi.org/10.4054/demres.2010.23.8

Wilson, T. (2014). The impact of education-bound mobility on inter-regional migration age profiles in Australia. *Applied Spatial Analysis and Policy*, *8*(4), 371–391. https://doi.org/10.1007/s12061-014-9124-0

Wu, S., & Liu, T. (2022). Stability and change in China's geography of intercity migration: A

network analysis. *Population, Space and Place*, *28*(7). https://doi.org/10.1002/psp.2570

Xu, A., Hu, Y., & Wang, J. (2025). Unraveling the COVID-19 impact on spatiotemporal dynamics of U.S. domestic migration: A network perspective. *Professional Geographer*, *77*(2), 104–120. https://doi.org/10.1080/00330124.2025.2455188

Yeung, J., Alexander, M., & Riffe, T. (2023). Bayesian implementation of Rogers–Castro model migration schedules: An alternative technique for parameter estimation. *Demographic Research*, *49*, 1201–1228. https://doi.org/10.4054/demres.2023.49.42

Yu, Y. (2022). Spatial and social mobility in England: The persistence of the 'Escalator' effect for the millennial generation. *Population, Space and Place*, *29*(3). https://doi.org/10.1002/psp.2625

Zhang, Y., & Wang, J. (2025). Bidirectional spatial mobility and intergenerational social mobility in contemporary China: The role of escalator regions. *Eurasian Geography and Economics*, 1–27. https://doi.org/10.1080/15387216.2025.2451878

Zhao, M. (2023). Moving to 'Bei–Shang–Guang'? Internal migration, local hukou barriers and labour market outcomes among college graduates in China. *Population, Space and Place*, *29*(5). https://doi.org/10.1002/psp.2651

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Appendix.docx