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Does Job Creation Mitigate Regional Population Decline? Evidence from South Korea

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ABSTRACT: This study examines whether local job creation helps mitigate regional population decline in South Korea. Using annual data for 161 regions from 2008 to 2025, we estimate a panel vector autoregression (PVAR) model to investigate the dynamic relationship between resident population and workplace-based employment. The descriptive analysis shows that 81 regions (50.3%) experienced employment growth despite population decline. The PVAR results indicate that employment growth does not significantly predict subsequent population growth, whereas population growth positively predicts subsequent employment growth. These findings remain similar when metropolitan cities are excluded. Overall, the results provide stronger evidence that population growth precedes employment growth than that employment growth precedes population growth, suggesting that jobs tend to follow people rather than the reverse. Job creation alone may therefore be insufficient to reverse regional population decline.

Keywords: Regional depopulation; Local job creation; Panel vector autoregression

1. Introduction

Population decline poses a persistent challenge for rural areas and smaller cities, where a shrinking population can undermine local services, labor supply, and economic activity. Governments often respond by seeking to attract firms and create jobs, on the premise that new employment opportunities will encourage residents to stay and newcomers to settle. In South Korea, this approach is particularly salient as many regions outside the Seoul Capital Area face population decline and ageing amid low fertility and the continued migration of younger residents toward the capital region. Comparable place-based responses to regional shrinkage have been pursued elsewhere [1–4]. Yet an increase in jobs located in a municipality does not necessarily imply an increase in the number of people living there.

The relationship between local population and employment is inherently two-sided. New jobs may attract or retain residents, but a growing population can also attract firms by expanding the available workforce, consumer demand, and local markets. This question—whether people follow jobs or jobs follow people—has long been central to regional economics [5,6]. Models of jointly determined population and employment growth further emphasize the roles of amenities, initial regional conditions, and spatial

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interaction [7–9]. Consequently, the presence of local employment growth alone cannot establish that job creation has produced population growth.

The direction of adjustment may also depend on regional context. Mathur and Song [8] document regional differences in the direction of the population-employment relationship in the United States, finding that population growth tended to precede employment growth in the Snowbelt, whereas employment growth tended to precede population growth in the Sunbelt. Hicks and Faulk [10], examining 92 counties in Indiana, report a shift in the population–employment relationship over time: employment growth tended to precede population growth in the 1970s, whereas population growth tended to precede employment growth in the 2000s. More recent evidence highlights spatial and sectoral heterogeneity: Alamá-Sabater, Márquez, and Tortosa-Ausina [11] link population-employment dynamics in Spanish municipalities to the spatial and sectoral distribution of jobs, particularly services. These findings motivate an analysis that allows population and employment to respond to one another rather than imposing a single direction of adjustment.

This distinction is especially consequential in shrinking regions. Population decline may persist in these regions even when new businesses are established, or additional jobs are created. Delfmann and Koster [12] show that the employment effects of new business formation depend on local demographic conditions. The outmigration of younger residents and population ageing may weaken the local human capital base, thereby limiting the employment benefits of new business formation. Moreover, workers may commute into a municipality without residing there, so an increase in workplace-based employment need not translate into resident-population growth. Residential-location decisions may also depend on local amenities and quality-of-life considerations beyond employment opportunities [7,13]. These factors offer plausible explanations for divergent population and employment trajectories, although the empirical model in this study does not separately identify their effects.

Against this background, we examine the dynamic relationship between resident-population growth and workplace-based employment growth in South Korea from 2008 to 2025. We combine annual resident-registration population statistics and Regional Employment Survey data for 161 regions with consistent boundaries throughout the study period and estimate a panel vector autoregression (PVAR) model with demographic controls. By allowing population and employment growth to respond to their own past values and to each other's past values, the model captures their dynamic interdependence while accounting for time-invariant regional heterogeneity. Granger-causality Wald tests examine whether past growth in one variable helps predict growth in the other, while impulse-response functions trace how each variable responds over time to innovations in the other. Together, these analyses provide evidence on whether employment growth precedes population growth, population growth precedes employment growth, or the two exhibit a mutually reinforcing relationship.

The paper contributes in three respects. First, it provides evidence from 161 South Korean regions over 18 years, complementing previous studies focused on individual regions or specific regional policies. Second, it measures employment by workplace location rather than workers' place of residence. This distinction matters because a municipality can gain jobs even when the workers filling those jobs reside elsewhere [14]. Third, it examines both directions of the population-employment relationship within a dynamic panel framework and compares results for the full sample with those for a sample excluding metropolitan areas. The central empirical question is not whether job creation is valuable, but whether local employment growth reliably predicts subsequent growth in the resident population.

The descriptive and econometric results point to a divergence between local job growth and resident-population growth. Between 2008 and 2025, 81 of the 161 regions experienced rising workplace-based employment despite falling resident population. In the baseline PVAR(3), employment growth does not Granger-predict population growth ($p = 0.540$), whereas population growth significantly Granger-predicts employment growth ($p = 0.001$). The impulse-response analysis shows that the population response to an employment-growth innovation is sensitive to the contemporaneous ordering, whereas a population-growth

innovation is followed by a positive short-run employment response under both orderings. The directional pattern is similar outside metropolitan areas. These findings are consistent with jobs following people in a predictive sense, although they do not establish that employment growth has no causal effect on migration or population.

The findings suggest that job creation and population retention should be evaluated as distinct, though related, regional policy outcomes. Expanding a municipality's workplace-based employment may strengthen local economic activity without producing a comparable increase in its resident population, particularly where commuting across municipal boundaries is common. Policies aimed at mitigating population decline may therefore need to consider housing, education, healthcare, transportation, and other residential conditions alongside employment opportunities. More broadly, the findings highlight the importance of evaluating regional development policies in terms of both employment creation and their capacity to retain and attract residents.

The remainder of the paper is organized as follows. Section 2 reviews the literature and sets out the competing hypotheses. Section 3 describes regional population and employment changes in Korea. Section 4 presents the data and empirical approach. Section 5 reports the PVAR estimates, Granger-causality tests, impulse responses, and non-metropolitan results. Section 6 discusses policy implications, and Section 7 concludes.

2. Literature Review and Conceptual Framework

The relationship between population and employment has long been an important issue in regional economics because household and firm location decisions are closely interrelated. Employment opportunities may attract workers and their families to a region, while population growth may stimulate employment by expanding the available labor supply, consumer demand, and local markets. Consequently, population and employment may be jointly determined rather than linked through a strictly unidirectional relationship. Muth [5] examined whether migration primarily responds to employment growth or stimulates employment growth in destination regions, while Greenwood and Hunt [6] investigated the relationship between migration and the interregional redistribution of employment in the United States. Carlino and Mills [7] employed a simultaneous-equation framework to examine the interdependent growth of population and employment across U.S. counties.

Empirical studies have provided mixed evidence regarding the direction of the population-employment relationship. Mathur and Song [8], using a vector autoregressive model of population and employment growth across U.S. regions, found that the direction of adjustment varied geographically. Their Granger-causality tests indicated that population growth tended to precede employment growth in the Snowbelt, whereas employment growth tended to precede population growth in the Sunbelt. Boarnet et al. [9], using census-tract data from Orange County, California, demonstrated that the estimated relationships between population and employment growth were sensitive to the specification of spatial interactions. Hicks and Faulk [10], examining population and employment growth across 92 counties in Indiana, found that the relationship changed over time. While population growth tended to follow employment growth in the 1970s, employment growth tended to follow population growth in the 2000s. Taken together, these findings suggest that the direction of the population-employment relationship may vary across regions and over time.

The relationship between population and employment may be particularly complex in regions experiencing persistent population decline. Delfmann and Koster [12], examining the employment effects of new business formation across municipalities in the Netherlands, found that these effects varied between growing and shrinking regions. Although new business formation had a positive effect on employment even in municipalities experiencing population decline, its indirect employment effects were more limited in shrinking regions. Population decline may also be accompanied by selective outmigration of younger and more highly educated residents, population ageing, and reduced availability of skilled workers and potential entrepreneurs. Kim [15] examines regional disparities in human capital in South Korea with particular

attention to population ageing, highlighting the relevance of demographic composition to regional human capital differences. Under such circumstances, the capacity of new business formation to generate additional employment may be constrained by local demographic and economic conditions. Newsham and Rowe [16], examining population change across European regions, identify distinct trajectories of population decline that vary in their persistence and intensity across rural and urban areas. Taken together, these studies suggest that the relationship between population and employment may differ between growing and shrinking regions and that demographic conditions and population decline trajectories may vary considerably across regions.

Studies examining the relationship between population and employment in South Korea have also produced mixed results. Oh and An [17], using data for 15 metropolitan cities and provinces, found that employment changes preceded migration in metropolitan cities, whereas employment and migration exhibited a bidirectional relationship in provinces. In contrast, Lee [18], using metropolitan-city and provincial data, found that population growth generally preceded employment growth, but not vice versa. Lee [18] also examined employment relationships across industries and found that interindustry employment effects were weaker than conventionally expected, with some industries exhibiting negative employment relationships. Taken together, these findings suggest that the direction of the population–employment relationship in South Korea may vary across regional contexts and that employment dynamics may differ across industries.

Another consideration is that local employment growth does not necessarily translate into an increase in the resident population. New jobs may be filled by workers commuting from neighboring municipalities rather than by individuals relocating to the municipality where the jobs are created. Moreover, residential location decisions depend on factors beyond employment opportunities. Lee and Kim [19], examining daily activity spaces in South Korean regions experiencing population decline, document spatial variations in residents' and visitors' activity patterns and emphasize the importance of interregional cooperation in improving local living conditions. Deller et al. [13] demonstrated the importance of amenities and quality of life in regional economic growth, while Buch et al. [20] found that both local labor market conditions and amenities influenced migration across German cities. Consequently, a municipality may experience employment growth without a corresponding increase in its resident population, particularly when commuting across municipal boundaries is common or local residential conditions are less attractive. Although we do not separately estimate the effects of these factors, our distinction between workplace-based employment and resident population allows us to examine whether local employment growth is associated with subsequent population growth.

The preceding literature suggests that population and employment growth may influence each other, but the direction of their relationship remains an empirical question. Under the "people follow jobs" hypothesis, employment growth is expected to precede and positively predict subsequent population growth because additional employment opportunities may attract or retain residents. Under the "jobs follow people" hypothesis, population growth is expected to precede and positively predict subsequent employment growth because a larger population expands the local labor supply and consumer demand, thereby encouraging firms to expand or locate in the region. These two mechanisms are not necessarily mutually exclusive, and their relative importance may vary across regions and over time.

To examine these hypotheses, we employ a panel vector autoregression (PVAR) model using annual data on resident population and workplace-based employment across South Korean regions from 2008 to 2025. The PVAR framework allows population and employment growth to respond dynamically to their own past changes and to each other's past changes while accounting for time-invariant regional heterogeneity. We use Granger-causality Wald tests to examine whether past employment growth helps predict subsequent population growth and whether past population growth helps predict subsequent employment growth. We also examine the signs and statistical significance of the estimated coefficients to

assess whether the observed relationships are consistent with the positive associations anticipated by the two hypotheses.

3. Population and Employment Changes in South Korea, 2008–2025

South Korea has experienced a long-standing concentration of physical and human capital in the Seoul metropolitan area, which includes Seoul, Incheon, and Gyeonggi Province. Since the 2000s, this spatial concentration has interacted with sharply declining fertility and the continued migration of younger people toward the capital region. Many provincial and rural areas have consequently faced population decline and rapid ageing, raising concerns about their long-run growth potential and the sustainability of local communities. However, demographic changes have not been uniform across the country. While some municipalities have continued to attract residents, others have experienced sustained population losses, resulting in considerable geographical disparities in population growth. Previous studies have documented substantial spatial heterogeneity in population ageing and migration within South Korea. Choi and Yoon [21] examine the changing spatial distribution of population ageing across Korean municipalities, while Dörflinger [22] shows that internal migration has contributed differently to regional population ageing, slowing its progression in some regions while accelerating it in others. Sung [23] further demonstrates that the determinants of migration from Seoul to Gyeonggi Province and Incheon differ across generations. These contrasting demographic patterns provide an important context for examining the relationship between population and employment across South Korean regions.

Figure 1 illustrates the geographical distribution of changes in resident population across 161 harmonized regions in South Korea between 2008 and 2025. The regions are classified into four categories based on the magnitude and direction of population change. The figure reveals substantial geographical disparities, with population growth concentrated primarily in the Seoul metropolitan area and selected regional urban centers, while population decline is widespread across smaller cities and rural areas. In particular, many municipalities outside the major urban centers experienced population decreases exceeding 10%, whereas population increases of more than 10% were concentrated in a relatively limited number of regions. Nevertheless, population growth was not confined to the Seoul metropolitan area, as several municipalities elsewhere also experienced substantial increases. The coexistence of growing and declining municipalities within the same broader geographical areas further highlights the uneven spatial distribution of demographic change. Overall, the figure shows that population change in South Korea is characterized by concentrated growth in selected urban areas and widespread decline elsewhere, providing a basis for examining the relationship between population and employment changes at the regional level.

Figure 2 illustrates the geographical distribution of changes in workplace-based employment across the same 161 harmonized regions in South Korea between 2008 and 2025. As in Figure 1, regions are classified into four categories according to the magnitude and direction of employment change. In contrast to the population changes shown in Figure 1, employment growth was geographically widespread, with many regions experiencing increases exceeding 10%. Employment growth was observed not only in the Seoul metropolitan area and major regional urban centers but also in numerous smaller cities and rural areas. Although some regions, including parts of Gyeongbuk and Jeonnam, experienced employment declines, these were relatively limited in geographical extent compared with regions experiencing employment growth. A comparison of Figures 1 and 2 reveals a striking spatial contrast: while population decline was widespread, employment increased in many regions across the country. This divergence suggests that employment growth did not necessarily coincide with resident population growth during the study period, highlighting the importance of examining the dynamic relationship between population and employment at the regional level.

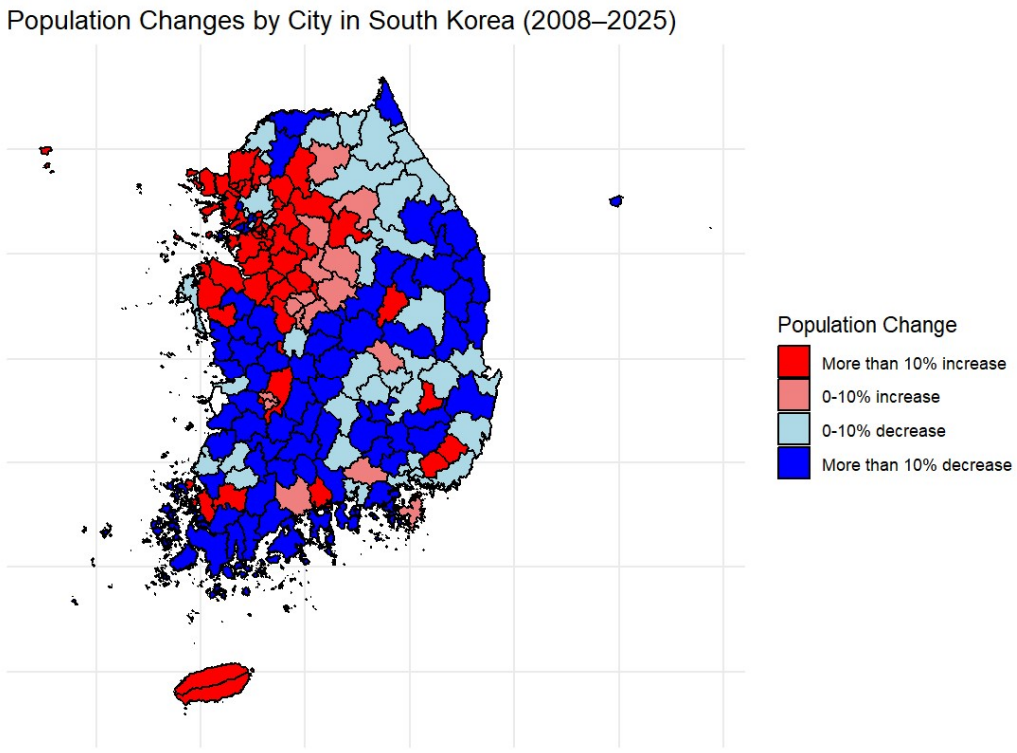


Figure 1. Population Change across South Korean Municipalities, 2008–2025.

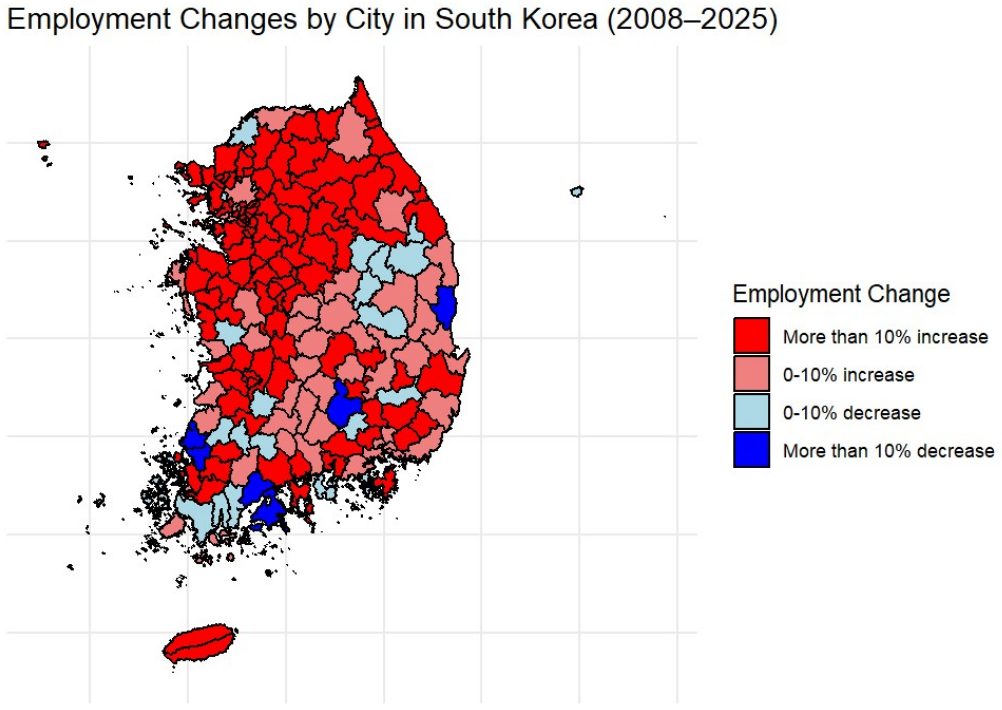


Figure 2. Change in Workplace-Based Employment across South Korean Municipalities, 2008–2025.

Figure 3 provides a more detailed comparison of population and employment changes by classifying the 161 regions into four groups according to the direction of change in the two variables between 2008 and 2025. Of the 161 regions, 81 (50.3%) experienced population decline accompanied by employment growth, while 51 (31.7%) recorded increases in both population and employment. In contrast, 28 regions (17.4%) experienced declines in both variables, and only one region (0.6%) recorded population growth accompanied by employment decline.

The most notable finding is that half of the regions experienced employment growth despite a decline in their resident populations. As shown in Figure 3, this pattern was widespread across the country, particularly in many municipalities outside the Seoul metropolitan area, including parts of Gyeongnam and Jeonnam. This finding indicates that increases in workplace-based employment did not necessarily coincide with increases in the resident population. At the same time, 51 regions experienced growth in both population and employment, suggesting that the two variables followed similar directions in some municipalities but diverged in others. The geographical distribution of these four groups highlights considerable regional variation in the correspondence between population and employment changes.

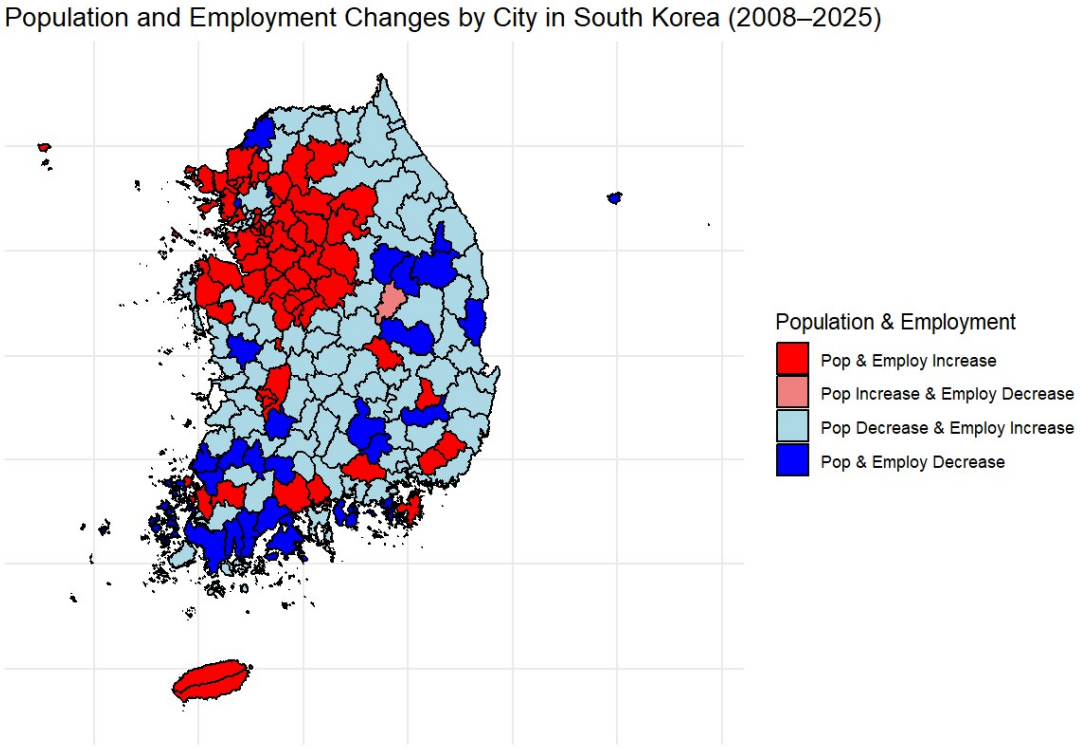


Figure 3. Joint Changes in Population and Workplace-Based Employment, 2008–2025.

Another notable feature is the asymmetry between employment growth and employment decline in their association with population changes. Among the 29 regions that experienced employment decline, 28 also recorded population decline, while only one experienced population growth. In contrast, among the 132 regions that experienced employment growth, 81 recorded population decline and 51 experienced population growth. Thus, employment decline was almost always accompanied by population decline, whereas employment growth was more frequently accompanied by population decline than by population growth. These descriptive patterns suggest that the relationship between population and employment changes is not symmetric and that employment growth alone does not necessarily coincide with population growth.

Several mechanisms may help explain why employment growth and population growth do not always occur together. First, because employment is measured by workplace location, workers may fill additional jobs by commuting from neighboring municipalities rather than relocating to the municipality where the jobs are created. The average share of interregional commuters across the 161 regions increased from 17.5% in 2008 to 22.5% in 2025. A panel regression controlling for region and year fixed effects also reveals a statistically significant negative association between changes in commuting shares and population changes. Furthermore, logit estimates indicate that regions experiencing larger increases in commuting shares were significantly more likely to exhibit employment growth alongside population decline between 2008 and 2025, even after controlling for changes in demographic characteristics ($p < 0.01$). These findings are

consistent with commuting as a potential mechanism underlying the divergence between employment and population growth, although they do not establish causality. Second, residential location decisions may depend on factors beyond local employment opportunities, including housing, education, healthcare, transportation, and other amenities. Third, in municipalities experiencing population ageing and natural population decrease, employment growth may coexist with continued population decline.

Taken together, Figures 1–3 reveal a substantial geographical divergence between changes in workplace-based employment and resident population across South Korean municipalities. The fact that half of the regions experienced employment growth alongside population decline highlights the importance of examining the two variables separately rather than assuming that an expansion of local employment necessarily translates into population growth. However, the figures describe cumulative changes over the study period and do not establish the direction of the dynamic relationship between the two variables. Whether employment growth precedes population growth, population growth precedes employment growth, or the two variables exhibit a bidirectional relationship remains an empirical question, which we investigate using the PVAR framework in the following sections.

4. Data and Empirical Methodology

4.1. Data and Variable Construction

The analysis combines annual resident-registration population statistics and the Regional Employment Survey for the period 2008–2025. The variables constructed for each region and year include total population, workplace-based employment, the female share of the population, manufacturing employment share, and the share of university graduates.

A key measurement choice concerns the definition of employment. Previous regional analyses often measure employment by the number of employed residents. However, this measure may differ substantially from the number of jobs located within a region because workers frequently commute across municipal boundaries. In 2023, for example, Seoul had approximately 4.99 million employed residents, compared with approximately 5.85 million workers whose workplaces were located in the city. Gyeonggi Province exhibited the opposite pattern, with residence-based employment exceeding workplace-based employment. By using workplace information from the Regional Employment Survey, this study measures employment according to the location of jobs rather than workers' residence, thereby distinguishing local employment opportunities from the residential distribution of workers.

The analysis covers 161 regions with consistent geographical boundaries throughout the study period. This geographical classification reflects the structure of the Regional Employment Survey, which, until 2020, treated metropolitan cities as single regional units for the residence and workplace information used in this study. Consequently, the number of regions included in the analysis is smaller than the current number of basic local-government units in South Korea. The use of harmonized geographical units ensures that changes in population and employment over time are not confounded by changes in regional boundaries or classification.

The use of administrative municipalities as the unit of analysis is motivated by the policy focus of this study. In South Korea, local governments play a central role in implementing policies to create jobs, attract residents, and mitigate population decline. Administrative municipalities therefore represent policy-relevant decision-making units for examining whether local employment growth is associated with subsequent resident population growth. Nevertheless, administrative boundaries do not necessarily coincide with functional labor markets, as workers frequently commute across municipal boundaries. Employment growth in one municipality may therefore benefit residents of neighboring municipalities without increasing its own resident population. Moreover, population and employment changes in neighboring municipalities may be spatially interdependent, potentially influencing the estimated PVAR relationships. Accordingly,

the findings should be interpreted as municipality-level predictive relationships rather than as estimates of population-employment dynamics within integrated functional labor markets.

4.2. Panel VAR Framework

To examine whether people follow jobs or jobs follow people, population and employment are treated as mutually interacting variables. A conventional vector autoregression (VAR) provides a framework for analyzing such dynamic relationships, but the regional panel structure of the data also requires accounting for unobserved, time-invariant regional heterogeneity. We therefore employ a panel vector autoregression (PVAR), which allows population and employment to respond dynamically to their own past values and to changes in each other while controlling for region-specific effects. The PVAR framework builds on the dynamic panel approach of Holtz-Eakin et al. [24], and forward orthogonal deviations eliminate region-specific effects [25]. Estimation and dynamic analysis follow the PVAR methodology presented by Abrigo and Love [26].

Let P_{it} denote the population of region i in year t, and E_{it} the number of workers whose workplaces are located in region i in year t. The empirical PVAR system is specified as follows:

$$\Delta \ln P_{it} = \alpha_i + \sum_{p=1}^{\tau} \gamma_p \Delta \ln P_{i,t-p} + \sum_{p=1}^{\tau} \delta_p \Delta \ln E_{i,t-p} + X_{it}\beta + \varepsilon_{it} \quad (1)$$

$$\Delta \ln E_{it} = \mu_i + \sum_{p=1}^{\tau} \theta_p \Delta \ln E_{i,t-p} + \sum_{p=1}^{\tau} \varphi_p \Delta \ln P_{i,t-p} + X_{it}\lambda + \nu_{it} \quad (2)$$

where $\Delta \ln P_{it}$ and $\Delta \ln E_{it}$ represent annual population and employment growth, respectively. The parameters α_i and μ_i capture unobserved region-specific effects, while X_{it} contains the changes in the female share of the population, the share of manufacturing employment, and the share of university graduates. The lag order is denoted by τ, and ε_{it} and ν_{it} are the respective error terms.

The main specification employs a third-order panel vector autoregressive model, PVAR(3), and uses forward orthogonal deviations (FOD) to remove region-specific effects. The PVAR(3) estimation for 2008–2025 includes 2093 observations from 161 regional panels, with 13 effective time observations per panel. The instrument specification and lag-selection diagnostics are reported below.

The estimated PVAR system is used to examine the dynamic relationship between population and employment in three complementary ways. First, the estimated coefficients describe how lagged employment growth is associated with subsequent population growth and how lagged population growth is associated with subsequent employment growth, conditional on the other variables included in the system. Second, Granger-causality Wald tests assess the joint significance of the lagged employment-growth terms in the population-growth equation and the lagged population-growth terms in the employment-growth equation. Third, impulse-response functions trace the magnitude and persistence of population-growth and employment-growth responses to innovations in the system.

Together, these analyses provide evidence on the predictive direction and dynamic responses characterizing the relationship between population and employment growth. The findings are interpreted as conditional predictive relationships and responses within the estimated PVAR system, rather than as structural causal effects of exogenous changes in population or employment.

4.3. Panel Unit-Root Tests and Lag Selection

Before estimating the PVAR, we examine the time-series properties of the variables using the Im-Pesaran-Shin (IPS) panel unit-root test [27], which allows the autoregressive processes to differ across regions. The null hypothesis is that all regional series contain a unit root, while the alternative is that at least some regional series are stationary.

Table 1 reports the IPS panel unit-root tests for the endogenous variables and controls. The unit-root null cannot be rejected for log resident population or log workplace-based employment in levels. For

employment growth, the null is consistently rejected across Augmented Dickey–Fuller (ADF) lag specifications (0–2). For population growth, however, the null is rejected with one lag but not with zero or two lags. This sensitivity may partly reflect the short time dimension of the panel (T = 17 after differencing), which limits the power of unit-root tests as additional lags are included. Supplementary Fisher-type ADF tests exhibit similar sensitivity, whereas LLC tests consistently reject the unit-root null across all lag specifications. The null is also rejected for the first differences of all control variables. Although the evidence for population-growth stationarity remains mixed, the main Granger-causality findings are robust across alternative PVAR lag specifications, providing some reassurance regarding the results while warranting cautious interpretation.

Table 1. IPS Panel Unit-Root Tests.

Variable	Transformation Tested	ADF Lags	W-t-Bar	*p*-Value
Resident population	Log level	0	24.579	1.000
Workplace-based employment	Log level	0	0.579	0.719
Resident population	First difference of log (growth)	0	−1.390	0.082
Resident population	First difference of log (growth)	1	−8.587	0.000
Resident population	First difference of log (growth)	2	0.013	0.505
Workplace-based employment	First difference of log (growth)	0	−41.718	0.000
Workplace-based employment	First difference of log (growth)	1	−25.419	0.000
Workplace-based employment	First difference of log (growth)	2	−14.198	0.000
Female share	First difference	0	−7.690	0.000
University-graduate share	First difference	0	−35.624	0.000
Manufacturing employment share	First difference	0	−42.746	0.000

Note: The IPS tests include panel-specific intercepts but no deterministic time trend. The ADF lag order is shown separately for each test. The null hypothesis is that all regional series contain a unit root. A reported *p*-value of 0.000 indicates a value below the displayed precision, not an exact probability of zero.

The lag order is examined using the modified Bayesian information criterion (MBIC), modified Akaike information criterion (MAIC), and modified Hannan-Quinn information criterion (MQIC). All three criteria attain their minimum values at lag 3 (MBIC = −15.701, MAIC = 6.570, and MQIC = −1.621), supporting the selection of a third-order panel vector autoregression, PVAR(3). The lag-selection procedure is estimated for the two endogenous variables without the exogenous controls used in the baseline specification. Accordingly, PVAR specifications with one, two, and three annual lags are compared, and the three-lag specification is adopted as the baseline for the subsequent dynamic analysis. The stability of the baseline model and the robustness of the results to alternative lag specifications are assessed using the corresponding PVAR diagnostic tests.

4.4. Instrument Set, Stability, and Impulse-Response Identification

The baseline PVAR(3) is estimated using the generalized method of moments (GMM) with forward orthogonal deviations to remove region-specific effects. The instrument set includes the first through third lags of population growth and workplace-based employment growth, together with three exogenous control variables: the changes in female share, manufacturing employment share, and university-graduate share. Lagged values of the endogenous variables serve as instruments for the transformed equations, while the controls account for changes in regional demographic composition, industrial structure, and educational attainment. The three-lag specification allows population and employment growth in each year to depend on their own past values and on the past values of the other variable over the preceding three years.

The baseline GMM specification is exactly identified, as indicated by the Hansen J test with zero degrees of freedom. Consequently, the Hansen overidentification test is not informative for this specification.

Although the use of lagged endogenous variables follows the standard PVAR-GMM approach, exact identification does not establish instrument validity or rule out concerns about weak instruments.

The stability of the estimated system is assessed using the eigenvalues of its companion matrix. The baseline PVAR(3) satisfies the stability condition, with all eigenvalues lying within the unit circle. The alternative PVAR(1) and PVAR(2) specifications also satisfy this condition. These alternative lag specifications are estimated to examine whether the main findings are sensitive to the number of lags included. Stability indicates that the effects of innovations diminish over time rather than generating an explosive dynamic path. It does not, however, establish the validity of the instruments or identify the innovations as exogenous structural shocks.

Orthogonalized impulse-response functions are used to examine how an innovation in one variable is followed by changes in population growth and employment growth over subsequent years. The baseline responses are computed with population growth ordered before employment growth. Under this ordering, a contemporaneous population-growth innovation may affect employment growth within the same year, whereas a contemporaneous employment-growth innovation is restricted from affecting population growth within that year. Because this contemporaneous restriction is imposed by the ordering rather than established independently by the data, the responses are also computed with employment growth ordered first as a sensitivity check. The impulse-response results are interpreted as dynamic responses to orthogonalized innovations within the estimated PVAR system, rather than as structural causal effects of externally identified changes in population or employment.

The PVAR framework captures dynamic relationships between population and employment growth within individual regions but does not explicitly model spatial dependence or cross-regional spillovers. Given the substantial commuting flows and economic linkages across municipal boundaries, changes in population or employment in one region may influence outcomes in neighboring regions. Consequently, interpret the estimated dynamic relationships with caution, as they may partly reflect spatial interactions not explicitly captured by the model. Incorporating spatial dependence into the PVAR framework represents an important direction for future research.

5. Empirical Results

5.1. PVAR Estimates

Table 2 reports the baseline three-lag PVAR estimates for resident population growth and workplace-based employment growth, conditional on the changes in female share, manufacturing employment share, and university-graduate share.

In the population-growth equation, the coefficients on the first, second, and third lags of employment growth are 0.019 (p = 0.190), 0.006 (p = 0.395), and 0.006 (p = 0.351), respectively. None of these coefficients is statistically significant at conventional levels. Thus, the individual lag estimates provide no evidence that past workplace-based employment growth predicts subsequent resident population growth, conditional on the other variables in the model. The coefficients on the first, second, and third lags of population growth are positive (1.319, $p < 0.001$), negative (−0.704, $p < 0.001$), and positive (0.303, $p < 0.001$), respectively. All three coefficients are statistically significant, indicating a dynamic pattern of persistence and adjustment in population growth over the preceding three years.

Table 2. PVAR Estimates for Population and Employment Growth.

Regressor	Population: Coef.	SE	*p*-Value	Employment: Coef.	SE	*p*-Value
Population growth, lag 1	1.319	0.095	<0.001	0.957	0.256	<0.001
Population growth, lag 2	−0.704	0.089	<0.001	−0.516	0.242	0.033
Population growth, lag 3	0.303	0.061	<0.001	0.244	0.187	0.192
Employment growth, lag 1	0.019	0.014	0.190	−0.213	0.054	<0.001
Employment growth, lag 2	0.006	0.007	0.395	−0.141	0.040	<0.001
Employment growth, lag 3	0.006	0.006	0.351	−0.035	0.027	0.198
Change in female share	−0.384	0.589	0.515	0.668	4.780	0.889
Change in manufacturing employment share	0.018	0.018	0.334	−0.031	0.096	0.751
Change in university-graduate share	0.018	0.028	0.518	−0.110	0.1856	0.553

Note: Full sample, 2008–2025; 161 regional panels and 2093 estimation observations. The model includes three annual lags and uses forward orthogonal deviations. Population and workplace-based employment growth are measured as first differences of their natural logarithms. Changes in female share, manufacturing employment share, and university-graduate share enter as exogenous controls. Coefficients, robust standard errors (SE), and two-sided *p*-values are reported.

In the employment-growth equation, the first lag of population growth has a positive coefficient of 0.957 ($p < 0.001$), while the second lag has a negative coefficient of −0.516 ($p = 0.033$). The third-lag coefficient is positive (0.244, $p = 0.192$) but is not statistically significant. These estimates indicate that higher population growth in the preceding year is associated with higher current employment growth, whereas population growth two years earlier is negatively associated with current employment growth, conditional on the other variables in the system. The coefficients on the first and second lags of employment growth are negative and statistically significant (−0.213 and −0.141, respectively; both $p < 0.001$), while the third-lag coefficient is negative but statistically insignificant (−0.035, $p = 0.198$). These estimates indicate that higher employment growth in the preceding two years is associated with lower current employment growth, conditional on the other variables in the model. This pattern suggests moderation in the rate of employment expansion rather than a decline in employment levels.

Among the controls, the change in manufacturing employment share is not statistically significant in either the population-growth equation (coefficient 0.018, $p = 0.334$) or the employment-growth equation (coefficient −0.031, $p = 0.751$). The change in female share is also statistically insignificant in both equations ($p = 0.515$ and $p = 0.889$, respectively). Similarly, the change in university-graduate share is not statistically significant in either the population-growth equation ($p = 0.518$) or the employment-growth equation ($p = 0.553$). Thus, none of the three control variables exhibits a statistically significant conditional association with population or employment growth in the baseline PVAR(3) specification.

5.2. Granger-Causality Tests

Table 3 presents the Granger-causality Wald tests from the three-lag PVAR model. The null hypothesis that employment growth does not Granger-cause population growth cannot be rejected (Wald $\chi^2 = 2.162$, df = 3, $p = 0.540$). In contrast, the null hypothesis that population growth does not Granger-cause employment growth is rejected at the 1% significance level (Wald $\chi^2 = 16.009$, df = 3, $p = 0.001$).

Table 3. PVAR Granger-Causality Wald Tests.

Dependent Variable	Excluded Variable	Wald χ^2 (df = 3)	*p*-Value
Population growth	Employment growth	2.162	0.540
Employment growth	Population growth	16.009	0.001

Note: The null hypothesis is that the excluded variable does not Granger-cause the dependent variable. Tests are based on the three-lag PVAR specification.

These results indicate an asymmetric predictive relationship between population and employment growth. Past population growth contains statistically significant information for predicting subsequent employment growth, whereas past employment growth does not provide statistically significant additional information for predicting subsequent population growth. This asymmetry is consistent with the view that local employment growth alone may not reliably translate into subsequent population growth. At the same time, the results should be interpreted as evidence of predictive precedence rather than structural causality, since Granger-causality tests do not by themselves identify causal effects.

5.3. Impulse-Response Functions

Figures 4 and 5 present the orthogonalized impulse-response functions (IRFs) from the baseline PVAR(3) model under two alternative recursive orderings: population growth ordered first, and employment growth ordered first, respectively. The shaded areas represent 95% confidence intervals obtained from 500 Monte Carlo replications. Comparing the two orderings provides a robustness check on the sensitivity of the estimated responses to the contemporaneous identifying restrictions.

Under the population-first ordering (Figure 4), a positive employment-growth shock does not generate a statistically significant response in population growth over the response horizon, as the 95% confidence interval includes zero throughout. Thus, there is no statistically significant evidence under this ordering that an employment-growth shock leads to subsequent population growth. In contrast, a positive population-growth shock generates a positive response in employment growth. The response is strongest in the initial periods and then gradually declines, although the confidence bands widen at longer horizons.

Under the employment-first ordering (Figure 5), an employment-growth shock generates a positive short-run response in population growth. The response increases initially and then gradually declines, with the confidence interval widening and eventually including zero at longer horizons. A positive population-growth shock produces no contemporaneous employment response by construction, but is followed by a positive employment response in subsequent periods. This response reaches its maximum in the early periods and then gradually diminishes, with statistical significance weakening at longer horizons.

The own-variable responses are broadly similar under the two orderings. Employment growth responds strongly to its own innovation on impact, followed by a negative adjustment in the next period and rapid convergence toward zero. Population growth displays greater persistence: its response to its own innovation remains positive for several periods and declines more gradually over the response horizon.

Overall, the impulse-response analysis indicates that positive population-growth shocks are followed by positive employment responses under both recursive orderings. By contrast, the estimated population response to employment-growth shocks is more sensitive to the contemporaneous ordering. Under the population-first ordering, the response is not statistically significant, whereas under the employment-first ordering, a positive response emerges in the short run but weakens over time. This pattern is broadly consistent with the Granger-causality results from the baseline PVAR(3), which show that population growth Granger-causes employment growth, while employment growth does not Granger-cause population growth. Taken together, the results provide more consistent evidence that population growth precedes subsequent employment growth than that employment growth precedes subsequent population growth, although the short-run population response to employment shocks varies with the contemporaneous identification scheme.

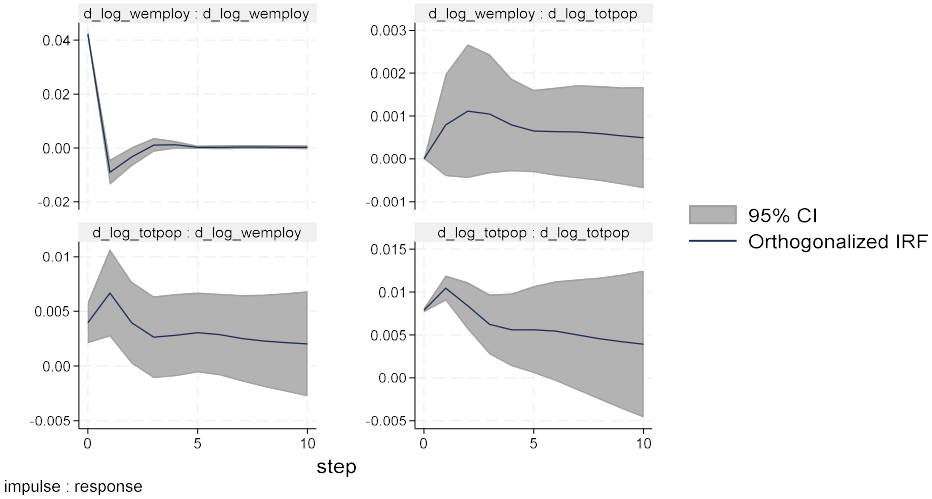


Figure 4. Impulse-Response Functions for Population and Employment Growth: Population Growth Ordered First.

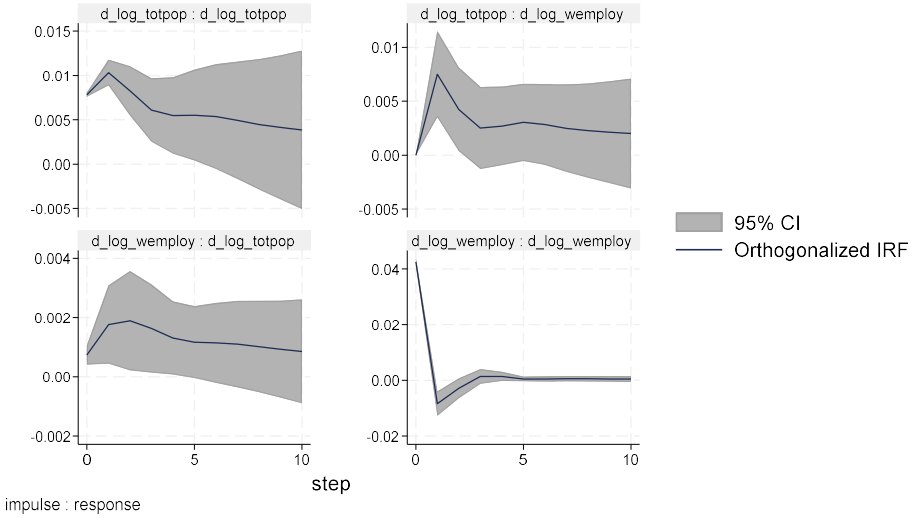


Figure 5. Impulse-Response Functions for Population and Employment Growth: Employment Growth Ordered First.

5.4. Robustness Checks

To assess the robustness of the main findings, two sets of additional analyses are conducted. First, the full-sample PVAR model is re-estimated under alternative lag structures and model specifications. Second, the baseline PVAR(3) model is re-estimated after excluding metropolitan cities to examine whether the main findings persist outside these regions.

5.4.1. Robustness to Alternative Model Specifications

The robustness of the full-sample results is first examined by varying the lag structure and the set of control variables. Table 4 reports the Granger-causality Wald tests for these alternative specifications. To examine sensitivity to lag length, the model is re-estimated with one and two annual lags and compared with the baseline PVAR(3) specification. In the baseline PVAR(3) model, employment growth does not significantly Granger-predict population growth (χ^2 = 2.162, p = 0.540), whereas population growth significantly Granger-predicts employment growth (χ^2 = 16.009, p = 0.001). The PVAR(2) specification yields the same qualitative pattern: employment growth does not significantly Granger-predict population growth (χ^2 = 2.650, p = 0.266), while population growth significantly Granger-predicts employment growth

(χ^2 = 14.654, p = 0.001). The PVAR(1) specification also produces the same directional result. The null hypothesis that employment growth does not Granger-cause population growth cannot be rejected (χ^2 = 2.690, p = 0.101), whereas the null hypothesis that population growth does not Granger-cause employment growth is rejected (χ^2 = 12.064, p = 0.001).

As an additional robustness check, the model is estimated without the demographic and industrial controls. In this specification, employment growth does not Granger-predict population growth at the 5% significance level (χ^2 = 2.940, p = 0.086), whereas population growth significantly Granger-predicts employment growth (χ^2 = 13.752, p < 0.001). Although the former relationship is marginally significant at the 10% level, it remains statistically insignificant at the conventional 5% level.

Table 4. Granger-Causality Tests under Alternative Model Specifications: Full Sample.

Specification	Employment→Population χ^2 (p-Value)	Population→Employment χ^2 (p-Value)
Baseline PVAR(3)	2.162 (0.540)	16.009 (0.001)
PVAR(2)	2.650 (0.266)	14.654 (0.001)
PVAR(1)	2.690 (0.101)	12.064 (0.001)
PVAR(1), no controls	2.940 (0.086)	13.752 (<0.001)

Note: The null hypothesis is that the excluded variable does not Granger-cause the dependent variable. Wald-test degrees of freedom correspond to the number of lags in each specification: 3 for PVAR(3), 2 for PVAR(2), and 1 for PVAR(1). All models use forward orthogonal deviations.

Overall, the robustness checks yield a consistent pattern across alternative lag lengths and control specifications. Employment growth does not significantly Granger-predict population growth at the 5% level in any of the specifications, although the relationship becomes marginally significant at the 10% level when the controls are excluded. In contrast, population growth significantly Granger-predicts employment growth in every specification. Thus, the main finding—that the predictive relationship runs from population growth to employment growth rather than from employment growth to population growth—is robust to changes in lag length and the inclusion of demographic and industrial controls.

5.4.2. Excluding Metropolitan Cities

To examine whether the full-sample findings are driven by metropolitan regions, the baseline PVAR(3) model is re-estimated after excluding metropolitan cities. The same endogenous variables, demographic and industrial controls, three-lag structure, and forward orthogonal deviations are used to maintain comparability with the full-sample specification.

The non-metropolitan sample consists of 154 regional units and 2002 estimation observations, compared with 161 regional units and 2093 observations in the full sample. The subsample excludes metropolitan cities but is not restricted to municipalities experiencing population decline.

Table 5 compares the Granger-causality results from the baseline PVAR(3) model across three samples: the full sample, the non-metropolitan sample, and a further restricted sample excluding both metropolitan cities and Gyeonggi Province. The results reveal a consistent asymmetric predictive relationship across all three specifications. In the full sample, employment growth does not significantly Granger-cause population growth (Wald χ^2 = 2.162, p = 0.540), whereas population growth significantly Granger-causes employment growth (Wald χ^2 = 16.009, p = 0.001). Similar results are obtained for the non-metropolitan sample, with corresponding Wald statistics of 2.353 (p = 0.502) and 16.112 (p = 0.001), respectively. When both metropolitan cities and Gyeonggi Province are excluded, employment growth remains statistically insignificant in predicting population growth (Wald χ^2 = 5.413, p = 0.144), while population growth remains marginally significant in predicting employment growth (Wald χ^2 = 7.785, p = 0.051). Although the statistical significance of the latter relationship weakens in the most restricted sample, the overall pattern

remains qualitatively unchanged. These findings suggest that the asymmetric predictive relationship between population and employment growth is not driven solely by metropolitan cities or the broader capital region, although heterogeneity across regions with different demographic and industrial characteristics may still exist.

Table 5. Granger-Causality Tests: Full and Non-Metropolitan Samples.

Specification	Regions	Observations	Employment→Population χ^2 (*p*-Value)	Population→Employment χ^2 (*p*-Value)
Full sample PVAR(3)	161	2093	2.162 (0.540)	16.009 (0.001)
Non-metropolitan PVAR(3)	154	2002	2.353 (0.502)	16.112 (0.001)
Excluding Metropolitan Cities and Gyeonggi Province PVAR(3)	123	1599	5.413 (0.144)	7.785 (0.051)

Note: All three specifications include three annual lags and the same demographic and industrial controls and use forward orthogonal deviations. The null hypothesis is that the excluded variable does not Granger-cause the dependent variable. All Wald tests have 3 degrees of freedom.

Figure 6 presents the orthogonalized impulse-response functions for the non-metropolitan sample under the population-first ordering. A positive employment-growth shock does not produce a statistically significant response in population growth over the response horizon, as the 95% confidence interval includes zero throughout. In contrast, a positive population-growth shock generates a positive short-run response in employment growth, which subsequently declines and becomes statistically insignificant at later horizons.

Because orthogonalized impulse responses depend on the recursive ordering of the variables, the impulse-response functions are also examined under the alternative employment-first ordering, although the corresponding figure is omitted to conserve space. Under this alternative ordering, a positive population-growth shock again generates a statistically significant positive short-run response in employment growth. A positive employment-growth shock also produces a statistically significant positive response in population growth contemporaneously and in the first subsequent period, but the effect becomes statistically insignificant thereafter. Thus, the population response to an employment-growth shock is sensitive to the Cholesky ordering and, when statistically significant, is confined to the short run. By contrast, the positive short-run response of employment growth to a population-growth shock is observed under both orderings.

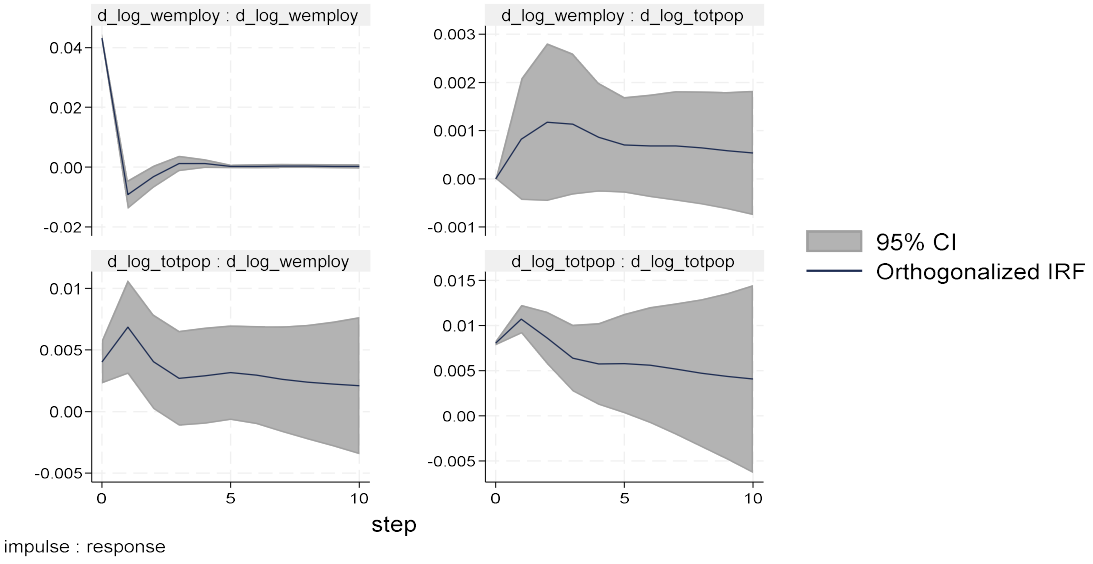


Figure 6. Impulse-Response Functions for Non-Metropolitan Regions: Population Growth Ordered First.

Overall, the non-metropolitan results are qualitatively consistent with the full-sample findings. Population growth significantly Granger-predicts employment growth, whereas employment growth does not significantly Granger-predict population growth. The impulse-response analysis provides a somewhat more nuanced picture: employment-growth shocks do not produce a statistically significant population response under the population-first ordering, while the employment-first ordering produces only a short-lived positive response. In neither ordering is there evidence of a sustained statistically significant increase in population growth following an employment-growth shock. These results indicate that the main empirical patterns are not driven by the inclusion of metropolitan regions.

6. Discussion and Policy Implications

The combined evidence suggests that the relationship between population and employment is asymmetric across South Korean regions. This does not mean that local employment opportunities are irrelevant to household location decisions. Rather, growth in workplace-based employment does not necessarily coincide with, or significantly predict, subsequent growth in the resident population. The descriptive maps show that employment can expand even while the resident population contracts, and the dynamic estimates provide no statistically significant evidence that employment growth Granger-predicts population growth.

One explanation is that households evaluate a bundle of place-specific attributes rather than employment alone. Schools, hospitals, housing affordability and quality, transportation connections, cultural services, and recreational amenities can all affect the attractiveness of a region. Lee and Yoon [28], examining the relationship between population decline and healthcare provision in South Korea, find evidence of a dynamic relationship in which declining population and the contraction of healthcare services may reinforce one another. Their findings suggest that maintaining essential healthcare services is an important consideration in policies aimed at mitigating regional population decline. The role of such amenities is well established in the rural and regional development literature [13,20]. When these conditions remain weak, new jobs may be filled by commuters from neighboring municipalities or by existing residents without producing substantial net in-migration.

The workplace-based employment measure used in this study is especially important in this regard. It allows employment growth to be recorded where jobs are located even when some workers reside elsewhere. In integrated metropolitan labor markets, employment creation can therefore raise local job counts without generating equivalent local population growth. For policy evaluation, this means that job creation and resident retention should be treated as related but distinct outcomes.

The results also have implications for regional industrial policy. Firm-attraction subsidies, industrial parks, and other job-creation programs may raise employment and local production, but their demographic effects depend on whether workers can or want to live in the same locality. Where housing, schools, medical services, or urban amenities are insufficient, the demographic payoff from economic-development policy may be weak. This helps explain why employment gains can coexist with continued population decline.

For shrinking regions, the policy challenge is therefore not to abandon employment policy, but to integrate it with population and quality-of-place policy. A region that creates jobs but fails to retain young households may face continuing ageing, weakening consumer demand, and a shrinking future labor force. Conversely, policies that improve residential attractiveness may strengthen the local labor supply and consumer base, thereby making the region more attractive to firms. This two-sided mechanism is consistent with the study's finding that population growth predicts subsequent employment growth.

7. Conclusions

This study investigates whether local job creation contributes to mitigating population decline across South Korean municipalities. Using annual data for 2008–2025 and a PVAR framework, the analysis treats population and employment as jointly dynamic variables and measures local employment by workplace location rather than residence.

Across the 161 harmonized regions, employment increased while population declined in 81 regions (50.3%) between 2008 and 2025. Both population and employment increased in 51 regions (31.7%), while both declined in 28 regions (17.4%). Only one region (0.6%) experienced population growth accompanied by employment decline. These descriptive findings indicate that employment growth frequently coexists with population decline. The PVAR results further reveal an asymmetric predictive relationship between population and employment growth. Employment growth does not significantly Granger-predict population growth, whereas population growth significantly Granger-predicts employment growth in both the full and non-metropolitan samples. The robustness checks support this asymmetric relationship across alternative lag lengths and control specifications. The impulse-response analysis also shows that employment-growth shocks do not generate a sustained statistically significant increase in population growth under either Cholesky ordering, while population-growth shocks are followed by positive short-run employment responses under both orderings.

These results have an important policy implication. Although employment growth does not significantly predict subsequent population growth in the estimated PVAR, this does not rule out positive population effects of job creation under particular regional conditions. Firm-attraction policies, industrial parks, and employment subsidies may increase local employment and potentially attract residents, but their demographic outcomes may depend on housing, amenities, and other local characteristics. A broader regional development strategy that integrates employment creation with improvements in residential attractiveness may therefore be more effective in addressing population decline.

For younger households in particular, stable housing, educational opportunities, medical services, convenient transportation, cultural and recreational amenities, and the quality of local public services can be central to long-term residential decisions. Regional policy should therefore integrate employment creation with investment in these dimensions of quality of life. In this sense, population retention and attraction should be treated as part of economic-development policy rather than as a separate demographic objective.

The study has several limitations that suggest directions for future research. First, although the PVAR identifies dynamic predictive relationships, it does not isolate the structural causal effect of an exogenous employment shock. The impulse-response results are also sensitive to the Cholesky ordering, particularly regarding the short-run population response to employment-growth shocks. Future research could exploit plausibly exogenous plant openings, closures, public-sector relocations, or policy discontinuities to identify causal effects more directly. Second, the unit-root evidence for population growth is sensitive to the ADF lag specification, which should be considered when interpreting the dynamic results. Third, the effects of job creation may vary by job quality, industry, age group, education, commuting accessibility, and the initial degree of population decline. Finally, this study does not explicitly account for spatial dependence and cross-regional spillovers. Given the substantial commuting flows and economic linkages across municipal boundaries, population and employment dynamics in one region may influence those in neighboring regions. Future research could extend the present analysis by incorporating spatial interactions into the PVAR framework to understand better how employment growth and population changes are transmitted across regions. Despite these limitations, this study provides important empirical evidence on the dynamic relationship between population and employment growth in South Korea. By examining 161 harmonized regions over an 18-year period, distinguishing workplace-based employment from resident

population, and comparing the full sample with non-metropolitan regions, the study contributes to understanding why local employment growth does not necessarily translate into population growth.

Overall, the evidence points to an asymmetry in the dynamic relationship between population and employment. Population growth contains significant predictive information for subsequent employment growth in both the full and non-metropolitan samples, whereas employment growth does not significantly Granger-predict population growth in either sample. These findings provide new empirical evidence from South Korea that is consistent with the view that jobs tend to follow people rather than people following jobs, at least in a predictive sense. The appropriate conclusion is therefore not that jobs never attract people, but that job creation alone cannot be relied upon to reverse local population decline. By demonstrating the importance of distinguishing between employment creation and population retention, this study provides an empirical basis for a more comprehensive approach to regional development policy. For regional policy, the practical implication is to evaluate job creation together with residential retention, migration, commuting, and quality-of-place outcomes.

Statement of the Use of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this manuscript, the author used ChatGPT-6 (OpenAI) to assist with language editing, improve clarity and readability, and refine the manuscript's presentation. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

Ethics Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The data used in this study are publicly available from the Korean Statistical Information Service (KOSIS). The dataset constructed for the analysis is also available from the author upon reasonable request. Resident-registration population: Statistics Korea/Korean administrative population statistics, annual municipal population, 2008–2025. Employment and worker characteristics: Regional Employment Survey, workplace-location based employment measures, 2008–2025.

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Declaration of Competing Interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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