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The displacement and attraction effects in interurban migration: an application of the input-output scheme to the case of large cities in Korea

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Abstract
In this paper, two migratory impact-assessment schemes are constructed within the framework of Ghoshian and Leontief input-output analysis. These schemes are designed to estimate the rural-to-urban migration-induced and the urban-to-rural migration-induced effects on interurban migration, where the former effect is termed the replacement effect, while the latter the attraction effect. The established input-output schemes are empirically applied to the 2012 data on interregional migration in Korea. The results show that an arrival of migrants to and/or a departure of residents from the 20 largest cities in Korea induce direct and indirect ripples of population flow between those cities. A combination of the displacement and the attraction effects yields a classification of cities by which the 20 largest cities are grouped into four different types.

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Keywords interregional migration; displacement effect; attraction effect; input-output schemes; classification of cities; largest cities in Korea

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1. Introduction

Inequality in regional development has attracted the attention of economists and policy-makers. By the way, it is contended that regional disparities in economic development are closely related with regional adjustment mechanisms. Incidentally, migration flows between different regions adjust the process through which the regional distribution of economic resources can be organized (OECD 2005). Where the balance of net migration is towards a surplus of inflow, migrants bring the benefits such as their skills and contribution to economic growth, or they might place demanding pressures on finite resources such as housing and services. On the other hand, where a surplus is towards a net outflow, different but no less important issues, such as the loss of human capital or the benefits accrued by remittances, may be of concern.

In line with the claim of the close relationship between migration and regional disparity, empirical evidence reveals that the persistence of regional disparities is attributed to the role of interregional migration as a regional adjustment mechanism (Kondo and Okubo 2015). Then, this conceivable relationship of migration with lasting regional disparities may constitute a most compelling reason for the pervasive concern of academia and policy analysists about the migration of people.

As the majority of intra-country regions throughout the world have undergone unemployment for a long period of time, reducing the intensity of uneven regional development has long been a major policy focus at national or regional governments (OECD 2005). Korea, with rapid economic growth and the consequential high rate of urbanization, is no exception of the countries which place higher policy priority on promoting balanced development between regions. During the past several decades, Korean governments have rigorously pursued a variety of policies to cope with population drain, industrial decline, and degrading quality of life in the lagging regions. Examples include the construction of various new cities, such as the new administrative city, innovative cities, and enterprise cities, and the relocation of public corporations into the underdeveloped regions (Jang 2015). Given the rigorous policy concern about persistent disparities in the levels of economic development between different regions in Korea, the proclaimed relationship between migration and regional disparities justifies investigating the consequences of residential migration between regions in the Korean context.

With its significant effect on the economic performance of the receiving as well as leaving regions of migrants, migration has been high on the academic subject for the past several decades. Indeed, the migration-related literature has proliferated such that up to 2014 since 1969, more than 12,000 articles in economics-related journals alone have been published (Cushing and Poot 2003).

A number of previous studies on migration have devoted on empirical analysis of the determinants of migration decisions. From the micro-economic perspective, the majority of the empirical literature investigate the migration decision through the interregional difference in wages and employment. Along the framework of Todaro (1969) and Harris and Todaro (1970), for example, several extensive studies identify real wage gaps and employment opportunities as the influential factors of migration. This strand of studies extends the argument into the prospective migrant's utility to incorporate diverse elements, such as, for example, employment and housing opportunities, environmental quality, cultural amenities, and so on.

Meanwhile, another stream of migration research centers on the impact of migration on labor market performance. Some migrants may take jobs or depress wages of existing resident workers, while others invest savings or add entrepreneurial talent to the economy. Whatever effects this stream of literature claims, the debate on labor market performance rarely takes place within a spatial context. The aspatial assessments of migration impact put prime emphasis on employment and wage effects at the migration destinations. In contrast to the aspatial assessment, some migration literature has paid attention to the potential effects that the exogenous arrival or departure of migrants can produce on the internal migration patterns between regions. The main focus of this literature is on assessing the impact of immigration or rural-to-urban migrants on interregional migration (Fernandez-Vazquez et al. 2011; Vinuela and Fernandez-Vazquez 2012).

This paper is in line with the stream of literature that assesses the effects that rural-urban or urban-rural migrants cause on internal migration between regions. The aim of this paper is to estimate the ripple effect that the rural-to-urban or urban-to-rural migrants bring on interurban migration in Korea. Specifically, using the Ghoshian and Leontief input-output schemes, estimated are the impacts of rural-urban and urban-rural movements on the interurban migration between the largest cities in Korea. The former is used for estimating the displacement effect, which represents the total number of migration outflows from a particular large city to other large cities as induced by a migrant moving into the relevant large city from non-large city areas. On the contrary, the latter is employed to measure the attraction effect, which represents the direct and indirect migration inducement that a resident departing a particular large city towards non-large city areas brings on the number of migration inflows into the relevant large city from other large cities. Next, based on the estimation of the two opposing effects, the largest cities in Korea are distinguished into different groups of cities.

This paper is organized as follows. The next section is devoted to a review of the related literature. The third section derives two contrasting input-output schemes with which the displacement and attraction effects can be estimated. The fourth section applies the established input-output schemes to the 20 largest cities in Korea and then, based on the results of empirical application, classifies the largest cities into four different groups. Finally, summary and conclusions are presented.

2. Literature Review

Research on migration was initially approached from the disequilibrium perspective, which suggests that interregional wage differentials and the probability of finding jobs are the major factors behind migration (Todaro 1969; Harris and Todaro 1970; Stark et al. 1991; Walker et al. 1992; Wright et al. 1997; Hatton and Tani 2005; Lim 2011). According to this view, an equilibrium of migration, at which no one has an incentive to move, is reached when real wages are equal in all regions. Some disequilibrium models depend on the perfect rationality assumption that migration decisions are made based on the risk-free deterministic expectation of income differentials (Todaro 1969; Harris and Todaro 1970), whereas others on the notion of imperfect information that uncertainty in the expectation of real income differentials prevails in migration decisions (Stark et al. 1991; Bonasia and Napolitano 2012).

Meanwhile, with Tiebout's (1956) contribution, the disequilibrium perspective of migration has been overridden by the equilibrium model: it is suggested that migration is possible even though wages are equal in all regions because of different levels of local public services. The idea implicit in the equilibrium perspective is that a migration imbalance between pairs of regions reveals the existence of difference in locational attributes. The locational quality-of-life attributes, which cause equilibrium in migration by offsetting the wage differentials, comprise natural amenities such as climate and scenery, as well as man-made amenities such as infrastructure, healthcare and public safety (Greenwood 1985; Knapp and Graves 1987; Greenwood at al. 1991; Greenwood 1997; Wall 2001; Krupka 2004; Plantinga et al. 2013). Besides the physical and man-made attributes, furthermore, other factors are incorporated as part of the local attributes into the equilibrium model. Examples include crime and pollution (Blomquist et al. 1988; Buch et al. 2014), institutional strength (Gyourko and Tracy 1991), and the activities of local and regional governments such as tax and government policies (Day 1992; Charney 1993).

It is noted that the disequilibrium or equilibrium perspective does not account for the spatial dimension in migration. Both perspectives do not consider spatial deterrence as a key determinant of interregional migration (Krugman 1995; Karlsson 2015). In contrast, the gravity model of spatial interaction explicitly employs spatial distances in migration analysis, assuming that the volume of migration interchange between regions is dependent on the mass and the distance deterrence (Plane and Rogerson 1994: 196-211; Molho 2013). As applied to migration analysis, the mass is measured by the population of regions, whereas the distance deterrence is represented by the geographical distances between destinations and origins. In this way, the spatial dimension is explicitly embedded into the model such that a longer distance between regions causes less migration to occur between them.

Several variants of the gravity model are applied to migration research. The unconstrained and origin-constrained gravity models, among others, are most often used (Stillwell 1978; Plane 1984; Rogerson 1990; Plane and Rogerson 1994). Also, the attraction-constrained model is used to analyze movement patterns in the former Soviet Union (Mitchneck 1990). In addition, Plane (1981) experiments with a net-constrained version of gravity model. More recently, some extensions of the gravity model, in which the fixed vector decomposition estimator is applied, are used to investigate the main determinants of interregional migration flows (Greenwood 1997; Greenwood and Hunt 2003; Etzo 2011).

Besides the gravity model, the new economic geography (NEG) also provides another distance-embedded framework of migration analysis. The NEG literature implicitly address the question of migration between regions, showing how the interactions between transport costs and increasing returns at the firm level shape the location of economic activities and workers (Pfluger 2004; Karlsson 2015). The key aspect of the NEG is that regional differences in not only nominal wages but also the cost of living, by which workers migrate across different regions, are endogenously determined.[1] Then, incorporating the real wage difference as the determinant of migration decisions is a salient feature of the NEG models,

[1]When workers migrate into a location, the increased demand in this location attracts more firms. By reducing the price level, then, the more firms lead to the rise of real wages, which encourages the attraction of more workers. This influx of labor into the destination region again increases demand, prompting a new round of the process of cumulative causation (Krugman 1991; Krugman and Venables 1995; Venables 1996; Fujita et al. 2000; Baldwin 2001).

compared with other studies of equilibrium or disequilibrium perspective that take into account only nominal wages (Kondo and Okubo 2015). Although many studies in the NEG address the issue of interregional migration, most of them primarily focus on the development of theoretical models (Krugman 1991; Ottaviano et al. 2002; Camacho 2013).

In the meantime, a notable strand of migration research, which is much different from the literature examined so far, comes with the framework of input-output analysis. Developed initially by Leontief (1936, 1986), the economic input-output model has been applied to diverse areas, including energy analysis (Miller and Blair 2009; Su and Ang 2011), emergy analysis (Ukidwe and Bakshi 2007; Cho 2013), ecological footprint analysis (Wackernagel and Rees 1996), and natural disaster analysis (Kerschner and Hubacek 2009). However, it is rather recently that the input-output framework is extended to migration research.

Following the framework of Cabrer and Pavia (2003), Fernandez-Vazquez et al. (2011) investigate the impact of immigration on the internal migration pattern in Spain. Using the framework of Ghosh input-output analysis, they estimate the direct and indirect effects that the arrival of foreign immigrants can produce on the allocation of population among other regions. In a similar vein, Vinuela and Fernandez-Vazquez (2012) explore the chain of the effects of migrant flows from the periphery to the core in Spain. Based on the Spanish definition of core and periphery regions, they use the Ghoshian input-output scheme to assess the effects that the arrival of new workers from the periphery causes on the core. In a different context from these studies, Sastry (1992) applies the traditional input-output analysis to estimate the economic impacts of elderly migration in Florida in the U.S. Using the data of the consumption expenditures of elderly inmigrants who move into Florida, the study quantifies the impact of elderly inmigration on the output, earnings, and employment of the Florida economy.

As examined above, the migration studies based on the input-output scheme are mainly concerned with assessing the consequences of a migration inflow for the regions of destination. No attention is paid to estimating the impact of a migration outflow on the movement of people between regions. Then, the motivation of this paper is to fill this loophole in the migration-related literature.

3. The Input-Output Schemes of Migration Impact

3.1. The Measure of Displacement Effect

To analyze the displacement and attraction effects of migration, a set of geographical units, i.e. regions, provinces, cities, etc., between which interregional movements occur, should be posited. For this purpose, it is assumed that the economic space on which interregional migration takes place is composed of a set of N large cities and the remainder areas, i.e. non-large city areas, which comprise small and medium-sized cities and rural areas.

For a system of N large cities and non-large city areas, the following vectors and matrix can be defined: a $N \times 1$ column vector $\mathbf{x}$ to represent inflow or outflow totals of population for individual large cities; a $N \times 1$ column vector $\mathbf{n}$ of inflow totals into individual large cities migrating from other large cities; a $N \times 1$ column vector $\mathbf{s}$ of inflow totals into individual large cities from non-large city areas; and a $N \times N$ matrix $\mathbf{M}$ of interurban migrations between the large cities.

Then, the $N \times N$ matrix of direct displacement coefficients, $\mathbf{B}$, can be written as:

$$\mathbf{B} = (\hat{\mathbf{x}})^{-1}\mathbf{M} \tag{1}$$

where $\hat{\mathbf{x}}$ denotes the $N \times N$ diagonal matrix with the elements of the vector $\mathbf{x}$ along the main diagonal. Using $\mathbf{B}$, the inflows of population arriving into the N large cities can be expressed as:

$$\mathbf{x}' = \mathbf{s}'(\mathbf{I} - \mathbf{B})^{-1} \tag{2}$$

where $\mathbf{I}$ is the $N \times N$ identity matrix. The derivation of Eq. (2) is detailed in Appendix A.

Let $\mathbf{G} = (\mathbf{I} - \mathbf{B})^{-1}$ with elements g_{ij} 's, then, the matrix $\mathbf{G}$ can be called the displacement inverse. The element g_{ij} of $\mathbf{G}$ measures the direct and indirect displacement effects.[2] In other words, it represents the number of flows from large city i to large city j as caused by the arrival of one migrant into large city i from non-large city areas. Then, the value of this element depends on how many native residents are displaced from large city i to large city j when a new rural-urban migrant arrive in city i.

The quantity $g_{i\cdot} = \sum_{j \neq i}^{N} g_{ij}$ represents the total number of outmigrants from large city i

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[2]As the elements of $\mathbf{G}$ measure the outflow ripple effects caused by an inmigrant, the model in Eq. (2) can be considered a Ghoshian input-output scheme. The Ghosh model is designed to estimate the total output impact that a unit change in primary inputs (value-added) for a specific sector causes throughout all sectors of an economy (Oosterhaven, 1988; Dietzenbacher, 1997; Miller and Blair, 2009). Despite the occasional critique of the Ghosh model, strong counterarguments in vindication of the Ghoshian framework appear in the related literature (Gruver, 1989; Dietzenbacher, 1997). Consequently, in case of analyzing the effect of a small shock in exogenously specified input, the Ghosh model can be a useful tool.

moving towards the set of $(N-1)$ large cities, which are caused by an arrival of population into large city i from non-large city areas. Then, the large city i's displacement multiplier is defined as the sum of the elements in the i-th row of $\mathbf{G}$. Accordingly, the displacement effects for the set of N large cities is expressed with a $N \times 1$ column vector $\mathbf{p}$ as:

(3) $$\mathbf{p} = \mathbf{Gi}$$

where $\mathbf{i}$ is a $N \times 1$ column vector of ones. The element p_i of $\mathbf{p}$ presents the total number of migrants displaced from large city i to the rest of $(N-1)$ large cities as a resident arrives into large city i from non-large city areas.

Meanwhile, in terms of the changes in $\mathbf{s}$, Eq. (2) can be expressed as:

(4) $$\Delta\mathbf{x}' = \Delta\mathbf{s}'\mathbf{G}$$

Eq. (4) shows the changes in the gross displacement, $\Delta\mathbf{x}'$, that the changes in the number of rural-urban migrants, $\Delta\mathbf{s}'$, trigger. This means that, under the assumption that $\mathbf{G}$ remains fixed, the change in $\mathbf{x}'$ can be realized only by the exogenous change in $\mathbf{s}'$.

3.2. The Measure of Attraction Effect

In addition to the matrices and vectors defined before, let define the $N \times 1$ column vector $\mathbf{r}$ to represent the outflow totals from individual large cities to non-large city areas and the $N \times 1$ column vector $\mathbf{nm}$ to represent the factors that ensure the equivalence of the outflow and the inflow for the individual large cities.

Given the matrices and vectors defined above, the N x N matrix of direct-attraction coefficients, $\mathbf{A}$, can be expressed as:

(5) $$\mathbf{A} = \mathbf{M}(\hat{\mathbf{x}})^{-1}$$

Then, using the $\mathbf{A}$ matrix, the number of outflows from the N large cities can be expressed as:

(6) $$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}[\mathbf{r} + \mathbf{nm}]$$

Appendix B presents the derivation of Eq. (6). Let define $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$, the element l_{ij}

measures the direct plus indirect attraction effect, which indicates the number of population migrating from large city i to large city j when a resident relocates from large city j to non-large city areas. Then, the quantity of $l_{\cdot j} = \sum_{i \neq j}^{N} l_{ij}$ represents the total number of outflows that a departure from large city j to non-large city areas generates across the set of $(N-1)$ large cities.

We define the attraction multiplier for large city j as the sum of inflows to city j from the rest of $(N-1)$ large cities, which are generated by a resident relocating from large city j to non-large city areas. Then, the attraction multipliers for N individual large cities can be represented by the $1 \times N$ row vector $\mathbf{q}'$ as:

(7) $$\mathbf{q}' = \mathbf{i}'\mathbf{L}$$

Stated from the standpoint of large city i, the element q_i of $\mathbf{q}$ means the attraction multiplier of large city i, which indicates the sum of inflows migrating into large city i from other $(N-1)$ large cities, which occurs when one resident moves from large city i to non-large city areas. Thus, it represents the number of migrants that large city i attract from other $(N-1)$ large cities as prompted by a resident relocating from large city i to non-large city areas.

Meanwhile, set aside the vector $\mathbf{nm}$ whose elements are fixed, the outflow vector $\mathbf{x}$ in Eq. (6) can be expressed in terms of the change in $\mathbf{r}$ as:

(8) $$\Delta\mathbf{x} = \mathbf{L}\Delta\mathbf{r}$$

Eq. (8) calculates the change in the gross attraction, $\Delta\mathbf{x}$, as caused by the change in the amount of relocation from large cities to non-large city areas $\Delta\mathbf{r}$. This means that because the attraction coefficient matrix, $\mathbf{L}$, is considered constant, the change in $\mathbf{x}$ can be realized by the exogenous change in $\mathbf{r}$.

4. Empirical Application

4.1. Interurban Migration in Korea

This paper applies the input-output schemes to analyzing migration effects in Korean. The point of departure in the empirical application is to distinguish Korean cities by their sizes. For this, the national territory of Korea is split into two segments: the 20 largest cities with greater than 500,000 inhabitants and the rest of the territory, which comprises cities with less than 500,000 residents and counties. It is noted that the segment of the Korean territory comprising cities with less than 500,000 residents and counties is referred to as non-large city areas in this paper.

Based on the 2012 data on population of local governments, which is offered by the Korean Statistical Information Service (KOSIS), all 84 cities are listed in descending order of population size, and then the 20 most populous cities of at least 500,000 inhabitants are selected as the largest cities.[3] Figure 1 shows the locations and population sizes of the 20 largest cities in Korean.

[Figure 1 about here]

With the largest cities vs. non-large city areas divide, Figure 2 shows the changes of population concentration for the 20 largest cities, which are contrasted with those for all 88 Korean cities. As shown in the upper panel of Figure 2, the overall rate of urbanization steadily increases from 88.5% to 92.1% for the period 2000-2012. In contrast, when confined to the 20 largest cities, the concentration rate of population varies within a narrow margin substantially below the overall urbanization rate, ranging between 64.9% and 65.8% for the same period (see the lower panel of Figure 2). Obviously, the shares of population concentrated in the 20 largest cities relative to those of the rest of the cities appear to decline throughout the period. This trend suggests that the 20 largest cities have continually lost their population.

[Figure 2 about here]

On the other hand, the mobility of population appears quite different across the 20 largest cities. Figure 3 presents the net migration rates for the 20 largest cities for the years 2004, 2008, and 2012.[4] According to Figure 3, the majority of the largest cities in the capital region,

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[3]In Korea, a locale with more than 50,000 inhabitants is incorporated as a city, with the status of municipality granted by the central government. There are 84 cities in Korea as of 2012. This total comprises 20 largest cities with greater than 500,000 residents and 64 small and medium-sized cities. The average population for all 84 cities is 558,767, while the standard deviation is 1,216,216. On the other hand, for the 20 largest cities, the average city size and the standard deviation are 1,675,666 and 2,165,917, respectively,

[4]The net migration rate is defined as the difference between the inmigration rate and the outmigration rate. It is calculated as $[(IM_{it} - OM_{it})/P_{it}] \times 100$, where IM_{it} is the number of incoming populations into city i at time t and OM_{it} is the number of outgoing populations from city i at time t.

including Seoul, have negative net migration rates, whereas four cities located in the outskirts of the capital region, including Incheon, Goyang, Namyangju, and Youngin, attract substantial migrants over the years. This pattern of net migration for the largest cities within the capital region suggests a strong implication that substantial migration streams from the core cities adjacent to Seoul to the cities in the peripheral areas in the capital region.

Figure 3 also reveals an additional salient characteristic of the migration pattern for the largest cities. Specifically, most of the top five populous cities in Korea, i.e. Seoul, Busan, Daegu, Gwangju, and Daejeon, have lost their population over the period. This pattern implies that as the large cities grow, the agglomeration benefits are weaker than the diseconomies from congestion. This effect, combined with the impact of the geographical dispersion of firms and industries, would stimulate the populations of the top largest cities to migrate to other cities or rural areas.

[Figure 3 about here]

4.2. Data Set

As mentioned earlier, this paper applies the input-output schemes established in the previous section to estimating the migratory attraction and displacement effects in Korea. For the empirical application of the schemes, a proper data set should be constructed. Based on the 2012 raw data on migration obtained from the KOSIS, a table in input-output format is constructed that contains the interregional flows of migrants occurring across the largest cities and non-large city areas. Table 1 shows the matrix of interurban migrant flows between the 20 largest cities, on the one hand, and the vectors of total inflows and outflows for the cities, on the other.[5]

Table 1 demonstrates that, when intra-urban mobility is excluded, Seoul is ranked first in the numbers of inmigrants from and outmigrants to other largest cities and non-large city areas. Seoul is followed, but with a large margin, by two metropolitan cities, Busan and Incheon. These three largest cities appear extraordinarily high in the share of interregional

[5]The diagonal elements of the portion of interurban migrations, which is equivalent to $\mathbf{M}$ in Eq. (A5) in Appendix A, represent the internal migration within the 20 largest cities. Because the intra-city flows are less to nothing at all to do with increasing or decreasing outmigration, they should not be considered in calculating the migration multiplier results, i.e. the displacement and attraction effects. On the other hand, according to the 2012 KOSIS data, the share of immigration and emigration in total migrations in Korea is extremely low to account for only 0.04% in 2012. Reflecting the insignificance of international mobility, both immigration and emigration are excluded from constructing Table 1.

migrations compared to the rest of the largest cities in Korean, including four metropolitan cities, i.e. Daegu, Gwangju, Daejeon and Ulsan, and 13 non-metropolitan large cities. Thus, the data of interregional migration presents the asymmetrical feature of interregional migration with the distribution of migrants skewed heavily to a few largest metropolitan cities.

[Table 1 about here]

4.3. The Displacement Effect

As defined earlier, the displacement effect means a rural-to-urban migration-initiated shock. Empirically, the displacement effect with respect to a particular largest city is calculated by horizontal summation of the elements in the row of $\mathbf{G}$ in Eq. (3) which corresponds to the relevant largest city. Then, the index of displacement effect for the individual 20 largest cities is represented by the 20×1 column vector, $\mathbf{p}$, as expressed by Eq. (3). Table 2 shows the results of the estimated displacement effect for the 20 largest cities.[6]

According to Table 2, Bucheon has a highest displacement effect, with the value of 2.6124. This means that the arrival of one migrant to Bucheon from non-large city areas generates 2.6124 outmigrants moving from Bucheon to the rest of the 20 largest cities. Bucheon is followed by Seongnam, which shows the value of 2.4995. Other three largest cities, i.e. Youngin, Seoul, and Anyang, appear to have the displacement effect larger than 2.0. The magnitudes of their displacement effect are 2.3420 for Youngin, 2.3323 for Seoul, and 2.3309 for Anyang, respectively. These large cities with a highest level of displacement effect are located in the capital region. These findings indicate that, if a largest city is within the capital region, more residents would be induced to migrate outside the city's boundaries.

On the other hand, five of the 20 largest cities, including Daegu, Cheongju, Cheonan, Gwangju, and Jeonju, constitute a group of large cities at the bottom level of displacement effect. These cities have the magnitudes of displacement effect less than 2.0, say, 1.9832 for Daegu, 1.9445 for Cheongju, 1.8823 for Cheonan, 1.8619 for Gwangju, and 1.8485 for Jeonju, respectively. Regarding the geographical location of these cities, none of these cities are located within the capital region. But it is evident that the magnitudes of displacement effect rise as the cities are located closer to the capital region.

[6]The numbers in the second column in Table 2 represent the displacement effect in original scale, while those in the third column are the standardized z-scores for the values of displacement effect, which are scaled to the mean of 0.0 and the standard deviation of 1.0.

[Table 2 about here]

Overall, the distribution of displacement effect across the 20 largest cities examined above casts a strong implication that, for a specific largest city, the intensity of displacement effect is associated with its physical distance to the capital region. That is, it can be said that the closer a largest city to the capital region, the more intense its displacement effect. As the largest cities adjacent to and within the capital region have a higher level of chain effect as initiated by the arrival of a migrant into them, that is, the intense forward waves of migration rippling across the whole set of the 20 largest cities, a specific interplay between the labor skills or job classes of migrants and those of native residents is implied. Specifically, it seems that, for the largest cities within or close to the capital region, skill or job similarities exist between emigrants and native residents, and consequently, the inflowing migration shock leads to a higher level of direct and indirect displacement (Walker et al. 1992; Hatton and Tani 2005).

In the circumstance of the similar skill grade, some policies can be justified if they could reduce the adverse economic effect originating from the replacement relationship between emigrants and native residents. For instance, by adjusting the wage of inmigrants, the largest cities exposed to a higher level of displacement can generate production complementarity with an improvement of profit potential, by which the economic distress of resident's displacement in the cities could be ameliorated (Walker et al. 1992; Wright et al. 1997).[7]

On the other hand, there exists no apparent relationship between the population sizes of cities and the intensities of displacement effect. That is, there is no indication that a largest city's population size is associated with the intensity of its displacement effect, i.e. the number of migrants moving from a largest city to other largest cities, which is spurted when a migrant arrives in the largest city from non-large city areas.[8] Then, regarding the 20 largest cities, other relevant variables would be responsible for the varying degrees of displacement effect between them. This issue is not further addressed here because the main purpose of this

[7]If the inmigrants from non-large city areas are adjusted to receive lower than equilibrium wage, labor is substituted for capital and consequently, profit opportunities at inmigrant destination cities are enhanced. By attracting high-skilled workers into these inmigrant destinations, then, the improved profit potential generates production complementarity between skilled white-collar professionals and low-skilled workers, Thus, the production complementarity with an improvement of profit potential at migrant destination cities can be a condition under which the inflows of skilled migrants into these places are fostered.

[8]The correlation coefficient between the city size and the displacement effect is 0.1547. This value is too low to claim the substantial relationship between the two variables.

study is to measure the aggregated migratory effect rather than to identify plausible factors that account for migration.

4.4. The Attraction Effect

In contrast to the rural-to-urban migration shock, the attraction effect for a specific largest city represents the urban-to-rural migrant-triggered effect as measured by the total number of inflows to a specific largest city from other largest cities, which is prompted when a resident in the largest city migrates to non-large city areas. The measure of migratory attraction is conceptually parallel to the vector of output multipliers constructed to capture both direct and indirect backward linkages in ordinary economic input-output analysis (Miller and Blair 2009, 556-558). As defined in Eq. (7), then, the column sums of $\mathbf{L}$, represented by the 20×1 row vector $\boldsymbol{q}'$, contain the magnitudes of attraction effect for the individual largest cities. Table 3 shows the results of the estimated attraction effect for the top 20 largest cities in Korea.[9]

As shown in Table 3, the city with the highest attraction effect is Bucheon. The intensity of attraction effect for the city is 2.6221. This means that, if a resident living in Bucheon migrates into non-large city areas, this outgoing migrant generates a total of 2.6221 additional migrants, who relocate into Bucheon from the rest of the largest cities. Youngin has the next highest value of attraction, 2.6136. Besides these two cities, four other largest cities, including Seongnam, Goyang, Namyangju, and Incheon, appear to have relatively higher attraction effect, with their magnitudes of greater than 2.4. The attraction indices for these cities are 2.5885, 2.5114, 2.4623, and 2.4007, respectively.

It is notable that all these six largest cities with a higher value of attraction effect are located in the capital region. This finding implies that, as per a resident relocating to non-large city areas, the largest cities in the capital region tend to attract more migrants from other largest cities across the nation. The tendency of the largest cities in the capital region to have stronger attraction effect is similar to the case of displacement effect examined previously, even though the cities are not exactly identical for the two opposing migratory effect.

In the meantime, Jeonju is the lowest in the generation of urban-to-rural migrant-initiated migration, with the amount of 1.7216. Jeonju is one of the five large cities that have lower levels of attraction. In addition to Jeonju, other four cities with weak attraction effect are

[9]The entries in the second column in Table 3 represent the attraction effect in original scale, while the numbers in the third column are the standardized z-scores for the original scale of attraction effect. For the standardized z-scores, the original values of attraction are scaled to the mean of 0.0 and the standard deviation of 1.0.

Busan, Cheongju, Daegu, and Gwangju. These cities constitute the bottom five in the order of attraction effect, all of which have the attraction index less than 2.0. Of these five cities with least attraction, three cities, i.e. Daegu (1.7579), Gwangju (1.7389), and Jeonju (1.7216), are very close in the strength of migratory attraction. Here, excluding Busan, the remaining four cities also represent the ones with the weakest displacement effect, which are readily identified in Table 2. In addition, Table 3 shows that, excluding the large cities with the top highest and bottom lowest levels of attraction, the rest of the largest cities in the middle strata of attraction intensity have the magnitudes of 2.0 to 2.4.

[Table 3 about here]

Incidentally, regarding the geographic locations of the largest cities with the weakest attraction, none of them are located within the capital region. This implies that the physical distances that the largest cities are away from the capital region affect the intensity of attraction effect. All told, the findings that the largest cities in the capital region have the relatively strong effect of attraction, whereas the cities with lower attraction effect are distant from the capital region, indicate that the locations of the largest cities with respect to the capital region would influence the intensity of attraction effect. The crucial role of the capital region is also claimed in the previous analysis of the displacement effect.

Like the case of the displacement effect, the tendency that the largest cities located near to or inside the capital region have a stronger effect on attraction implies a certain labor-skill relationship between migrants and native inhabitants. As far as the largest cities within or near to the capital region are concerned, there exist similarities in labor or job skill between the migrants departing these cities and the native residents. Given this property of labor markets, the migrants who leave these cities for non-large city areas would induce high volumes of migration originating from other largest cities (Hatton and Tani 2005; Giulietti 2009; Docquier et al. 2014).

The differences in the condition of labor markets between the cities suggest that, if urban-to-rural migration is left alone to thrive in the largest cities near to or within the capital region, it renders the cities remote from the capital region at higher risk of population drain. In this respect, some policies can be recommended to ameliorate the adverse effect afflicting the largest cities distant from the capital region. For example, various forms of welfare and wage subsidies, which are provided to the would-be outmigrants from the largest cities near to or within the capital region, would contribute to preventing the likelihood of population drain in the largest cities distant from the capital region.

On the other hand, just like the case of displacement effect examined earlier, the results of the analysis of attraction effect suggest no identifiable relationship between the city size and the attraction effect.[10] That is, the there is no indication that a bigger city is more likely to have a stronger attraction effect. Then, other variables except for the city size may account for the difference in the attraction effect between the largest cities. Again, because this paper aims to assess the aggregate impacts of a unit migration, the issue of identifying the determinants of attraction effect is not addressed.

4.5. The Classification of Korean Largest Cities

So far in this section, two forms of migration effect, namely, the displacement effect and the attraction effect, are estimated within the input-output framework. Given the intercity variances in the two types of migration effect, then, the 20 largest cities can be classified according to their intensities. By combining the z-scores for both types of migration effect, which are shown in Tables 2 and 3, respectively, the 20 largest cities can be distinguished into four different groups of cities.

To construct the migration effect-dependent classification of cities, each pair of z-scores for the two types of migration effect is plotted on two axes: z-scores for the displacement effect are plotted on the horizontal axis, while z-scores for the attraction effect are plotted on the vertical axis. Figure 4 shows the resultant scattered plots, which represent the 20 sets of z-scores corresponding to the 20 pairs of migration effect for the 20 largest cities.

[Figure 4 about here]

By combining the relative strength of the displacement effect and that of the attraction effect, the scattergram in Figure 4 identifies four groups of large cities in Korea. First, the type 1 group of cities, which are plotted in the northeast quadrant of the graph, comprises the largest cities with a positive z-score in both types of effect. Put differently, the type 1 cities are those in which the values of both displacement and attraction effects are greater than their mean values. Of the 20 largest cities, eight cities, i.e. Seoul, Bucheon, Seongnam, Youngin, Goyang, Namyangju, Anyang, and Ansan, are included in the group of type 1 cities.

[10]The correlation coefficient between the city size and the attraction effect is -0.0458. With such tiny magnitude of correlation, a claim of the relationship between the two variables is not justified.

It is noticed that all the cities of type 1 are located within the capital region. Then, it is argued that the largest cities in the region are quite intense not only in pushing out more residents to other largest cities when the arrival of residents from non-large city areas to them occurs, but also in pulling population from other largest cities into them when the residents depart from them to non-large city areas. This means that the migration impact imposed on or originating from the largest cities in the capital region is highly probable to provoke reallocations of residence between the largest cities across Korea.

Next, the type 2 group of cities in the northwest quadrant are formed with combination of the negative displacement effect and the positive attraction effect. The cities in this quadrant are relatively extensive in the displacement effect, whereas weak in the attraction effect. The former effect is above its average value, while the latter effect falls short of its average. Figure 4 shows that, of the 20 largest cities, only two cities, i.e. Incheon and Suwon, are included in this category.

Third, the southwest quadrant in Figure 4 represents the type 3 group of cities, which are shown to be weak in the intensities of both types of migration effect. The cities included in this category fall below the average values in the strength of both migration effects. Then, it can be argued that the cities in this quadrant are in the opposite direction to the type 1 group of cities in the northeast quadrant, which are relatively strong in both displacement and attraction effects. In contrast to the cities of type 1, therefore, the cities of this category are least in pushing out residents to other largest cities when residents arrive from non-large city areas, and also in pulling population from other largest cities when their residents move migrate to non-large city areas. Then, it is argued that, when the migration impact takes place, these cities might cause a weak level of reallocations of residence between the largest cities across Korea. Of the 20 largest cities, eight cities are classified as the group of type 3 cities. They include four metropolitan cities, i.e. Daejeon, Ulsan, Daegu, and Gwangju, and four non-metropolitan large cities, i.e. Changwon, Cheongju, Cheonan, and Jeonju.

Finally, the southeast quadrant presents the group of type 4 cities, which is established by the combination of a higher displacement effect and a lower attraction effect. As combined with these two odd values of effect, the cities in this category are placed diagonal to type 2 cities. In contrast to type 2 cities, therefore, the cities in this group are represented by a positive z-score of attraction effect and a negative score of displacement effect. This means that the cities in the southeast quadrant are relatively strong in the attraction effect, whereas weak in the displacement effect. Like the case of the group of type 2 cities, two cities, one of which is metropolitan city (Busan) and the other is non-metropolitan large city (Pohang), are included in this group.

So far, the four different types of cities into which the 20 largest cities are classified are explained. A glance at the four-quadrant diagram in Figure 4 suggests that the two types of migration effect are correlated. That is, the plots of the 20 largest cities indicate that the effect of migratory attraction varies with the intensity of displacement effect. The strength of association between the two opposing effects can be measured by a correlation coefficient, which represents whether the two types of migration effect tend to move in the same or opposite directions when they change. In this case, the magnitude of correlation coefficient is 0.7886, reflecting a substantial level of positive relationship between the two effects. Then, it is apparent that, as far as the 20 largest cities in Korea are concerned, the more intense their attraction effect, the stronger the level of displacement effect, and vice versa.

5. Conclusions

This paper aims to extend the input-output model framework for the assessment of migratory effects. Within the Ghoshian and Leontief input-output schemes, two contrasting versions of migratory impact-assessment model are constructed: one is for estimating the inmigration-initiated displacement effect and the other for calculating the outmigration-triggered attraction effect. For a given large city, the former effect represents the number of residents displaced from that largest city, which is invoked by an arrival of inmigrant from non-large city areas to that large city, while the latter effect means the chain effect of migrant attraction that a migrant outflowing from the large city in question to non-large city areas brings about.

The two input-output schemes are applied to a set of 2012 data that contains interregional migration in Kore. The results of empirical application show that an arrival of migrant to and a departure of resident from the 20 largest cities generate the substantial ripples of direct and indirect interurban migration between them. However, the intensities of migration effect, whether the displacement or attraction effect, are various between the largest cities. The physical distances that the cities are away from the capital region impinge on the intercity variations in the strengths of migration effect.

The results of the estimation of migration effect reveal that the largest cities near to or within the capital region are more likely to have the stronger displacement and attraction effects. This finding suggests a plausible policy recommendation that would contribute to curtailing consistent population drain in the largest cities located remote from the capital region. Policies of adjusting the wages of inmigrants moving to these peripheral cities and/or providing welfare and wage subsidies to outmigrants from the largest cities near to or within the capital region would slow down the decline of population in the largest cities in the peripheral regions, most of which experience significant economic decline and consequently a diminished quality of their residents' lives.

On the other hand, combining the displacement and attraction effects produces a classification of cities, in which the 20 largest cities can be distinguished into four different groups of cities. The classification reveals the existence of a substantial level of positive relationship between the displacement and attraction effects, which implies that a large city with higher attraction is more likely to have a higher level of displacement effect, or vice versa.

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Appendices

Appendix A: Derivation of Eq. (2)

Suppose the economic space that is composed of a set of N large cities and non-large city areas. For the system of N large cities and non-large city areas, the following vectors and matrix can be defined: A $N \times 1$ column vector $\mathbf{x}$ to represent the inflow or outflow totals of population for the individual large cities; a $N \times 1$ column vector $\mathbf{n}$ of inflow totals into the individual large cities originating from other large cities; a $N \times 1$ column vector $\mathbf{s}$ of inflow totals into the individual large cities originating from non-large city areas; and a $N \times N$ matrix $\mathbf{M}$ of interurban migrations between the N large cities.

To specify the migration input-output scheme in the above-defined economic space, some notations for a specific large city i are defined as follows: o_i the total number of outmigration from large city i to other large cities; n_i the inflow total to large city i migrating from other large cities; r_i the number of residents relocating from large city i to non-large city areas; s_i the number of inmigrants into large city i from non-large city areas; and nm_i the balancing factor for large city i that ensures the inflow total and the outflow total of large city i to be identical.

In fact, the balancing factor nm_i means the net flow of migrants for large city i. Using the balancing factor nm_i, we can establish a simple equation that accounts for the outflow total of population from large city i, x_i^{out}, which can be written as:

(A1) $$x_i^{out} = o_i + r_i + nm_i$$

On the other hand, the inflow total of population into large city i, x_i^{in} is expressed as the following equation:

(A2) $$x_i^{in} = n_i + s_i$$

For the large city i in question, then, the outflow total from and the inflow total into that city, respectively, should be equivalent. Therefore, the demographic identity for large city i can be written as follows:

(A3) $$o_i + r_i + nm_i = n_i + s_i$$

Eq. (A3) represents the equivalence of the outflow from and the inflow into large city i. Then, from Eq. (A3), the balancing factor nm_i is derived as:

(A4) $$nm_i = [n_i + s_i] - [o_i + r_i]$$

As mentioned earlier, the balancing factor in Eq. (A4) is set to ensure that the raw sum of the migration input-output table is equal to the inflow total for the relevant large city i. To construct the measure of displacement effect, define the following vectors and matrix for the system of N large cities and non-large city areas:

(A5) $$\mathbf{x} = \begin{bmatrix} x_1 \\ \vdots \\ x_N \end{bmatrix} \quad \mathbf{n} = \begin{bmatrix} n_1 \\ \vdots \\ n_N \end{bmatrix} \quad \mathbf{s} = \begin{bmatrix} s_1 \\ \vdots \\ s_N \end{bmatrix} \quad \text{and} \quad \mathbf{M} = \begin{bmatrix} m_{11} & \cdots & m_{1N} \\ \vdots & \ddots & \vdots \\ m_{N1} & \cdots & m_{NN} \end{bmatrix}$$

where $\mathbf{x}$ represent the vector of inflow or outflow totals of population for individual large cities; $\mathbf{n}$ the vector of inflow totals into individual large cities migrating from other large cities; and $\mathbf{s}$ the vector of inflow totals into individual large cities from non-large city areas. In addition, $\mathbf{M}$ represents the matrix of interurban migrations whose element m_{ij} denotes the number of population migrating from large city i to large city j.

With these vectors and matrix, the vector that shows the inflows arriving to each of N large cities can be expressed as:

(A6) $$\begin{aligned} \mathbf{x}' &= [x_1 \quad \cdots \quad x_N] \\ &= \mathbf{n}' + \mathbf{s}' \\ &= \mathbf{i}'\mathbf{M} + \mathbf{s}' \end{aligned}$$

where $\mathbf{i}$ is the $N \times 1$ summation column vector whose elements are 1's. When $\hat{\mathbf{x}}$ denotes the $N \times N$ diagonal matrix with the elements of the vector $\mathbf{x}$ along the main diagonal, the $N \times N$ matrix of direct-displacement coefficients, $\mathbf{B}$, can be represented as:

(A7) $$\mathbf{B} = (\hat{\mathbf{x}})^{-1}\mathbf{M}$$

Using the direct-displacement matrix in Eq. (A7), the inflows of population arriving into the N large cities shown in Eq. (A6) can be rewritten as:

(A8) $$\mathbf{x}' = \mathbf{i}'\mathbf{M} + \mathbf{s}'$$

$$= \mathbf{i}'\hat{\mathbf{x}}\mathbf{B} + \mathbf{s}'$$
$$= \mathbf{x}'\mathbf{B} + \mathbf{s}'$$

since $\mathbf{i}'\hat{\mathbf{x}} = \mathbf{x}'$. Let $\mathbf{I}$ be the $N \times N$ identity matrix, then the inflow total in Eq. (A8) can be expressed just as:

(A9) $$\mathbf{x}' = \mathbf{s}'(\mathbf{I} - \mathbf{B})^{-1}$$

which is equal to Eq. (2) in Section 3.

Appendix B: Derivation of Eq. (6)

In addition to the vectors and matrices used for constructing the measure of displacement effect in Appendix A, we can define the following three column vectors:

(B1) $$\mathbf{o} = \begin{bmatrix} o_1 \\ \vdots \\ o_N \end{bmatrix} \quad \mathbf{r} = \begin{bmatrix} r_1 \\ \vdots \\ r_N \end{bmatrix} \quad \text{and} \quad \mathbf{nm} = \begin{bmatrix} nm_1 \\ \vdots \\ nm_N \end{bmatrix}$$

where $\mathbf{o}$ represents the vector of outflow totals for individual large cities moving to other large cities; $\mathbf{r}$ the vector of outflow totals for the N individual large cities moving toward non-large city areas; and $\mathbf{nm}$ the vector of balancing factors that ensure the balance equation in Eq. (A3) to hold for the N individual large cities.

With these definitions, the matrix form of Eq. (A1), in which the elements of the $N \times 1$ column vector $\mathbf{x}$ show the outflows originating from the N large cities, is expressed as:

(B2) $$\mathbf{x} = \mathbf{o} + \mathbf{r} + \mathbf{nm}$$
$$= \mathbf{Mi} + \mathbf{r} + \mathbf{nm}$$

As before, let $\hat{\mathbf{x}}$ denotes the $N \times N$ diagonal matrix with the elements of the vector $\mathbf{x}$ along the main diagonal. Then, the $N \times N$ matrix of direct-attraction coefficients, $\mathbf{A}$, can be calculated by the following equation:

(B3) $$\mathbf{A} = \mathbf{M}(\hat{\mathbf{x}})^{-1}$$

Substituting Eq. (B3) into Eq. (B2) yields the following equation that shows the number of people outflowing from the N large cities:

(B4)
$$\begin{aligned}\mathbf{x} &= \mathbf{A}\hat{\mathbf{x}}\mathbf{i} + [\mathbf{r} + \mathbf{nm}] \\ &= \mathbf{Ax} + [\mathbf{r} + \mathbf{nm}]\end{aligned}$$

since $\hat{\mathbf{x}}\mathbf{i} = \mathbf{x}$. Then, solving Eq. (B4) in terms of $\mathbf{x}$ gives the flowing expression as shown in Eq. (B5):

(B5)
$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}[\mathbf{r} + \mathbf{nm}]$$

which is correspond to Eq. (6) in Section 3.

Table 1. Matrix of interregional migration among the largest cities and non-large city areas

	Seoul	Busan	Daegu	Incheon	Gwangju	Daejeon	Ulsan	Suwon	Seongnam	Anyang	Bucheon
Seoul	0	12,766	7,938	32,504	8,071	10,375	4,564	13,008	21,087	9,408	15,104
Busan	17,965	0	3,939	2,391	1,072	1,755	8,815	1,706	1,207	539	696
Daegu	11,495	3,897	0	1,490	512	1,476	3,017	1,454	854	417	432
Incheon	23,732	1,985	1,253	0	1,416	2,042	839	2,544	1,697	1,228	8,771
Gwangju	9,824	1,069	464	1,639	0	1,107	467	1,145	768	384	541
Daejeon	11,460	1,430	1,188	2,073	838	0	669	1,357	910	458	584
Ulsan	5,624	7,052	2,276	795	296	642	0	591	356	165	174
Suwon	10,326	1,147	904	2,319	927	1,246	497	0	1,517	1,342	729
Seongnam	16,286	942	678	1,949	696	912	296	2,246	0	774	598
Anyang	7,918	427	327	1,676	412	562	162	2,023	820	0	560
Bucheon	12,305	555	391	11,437	523	652	253	985	654	491	0
Ansan	6,622	609	459	2,790	563	687	258	2,296	637	1,314	778
Goyang	17,825	894	532	2,975	557	761	279	987	936	426	909
Namyangju	12,875	415	268	1,195	308	377	168	554	680	269	327
Youngin	12,593	1,037	820	1,991	759	911	451	6,626	5,541	772	609
Cheongju	4,134	403	436	801	251	2,160	219	683	378	208	234
Cheonan	4,741	595	439	1,170	350	1,849	270	948	481	301	386
Jeonju	4,913	304	223	795	1,129	1,017	176	624	404	201	258
Pohang	3,003	1,733	2,412	744	99	418	970	362	222	111	152
Changwon	5,258	7,333	1,542	866	327	588	1,395	582	343	152	231
$n_j \left(= \sum_i m_{ij}\right)$	198,899	44,953	26,489	71,600	19,106	29,537	23,765	40,721	39,492	18,960	32,703
Non-large city areas	166,625	51,795	49,316	44,793	38,208	32,127	24,581	29,354	16,794	13,376	12,737
Inflow Total	365,524	96,388	75,805	166,393	57,314	61,644	48,346	70,075	56,286	32,336	44,810

(continued)

Table 1 (continued)

	Ansan	Goyang	Namyangju	Youngin	Cheongju	Cheonan	Jeonju	Pohang	Changwon	$o_i \left(= \sum_j m_{ij}\right)$	nm_i	Outflow total
Seoul	7,121	23,943	18,744	16,778	3,673	5,106	3,995	2,253	3,750	220,188	145,336	365,524
Busan	737	1,123	446	1,325	460	963	339	1,751	8,322	55,551	40,837	96,388
Daegu	506	754	289	1,028	558	790	194	2,632	1,728	33,523	42,282	75,805
Incheon	2,213	2,638	959	1,854	788	1,449	658	758	734	57,558	58,835	116,393
Gwangju	633	620	297	857	269	538	1,047	134	317	22,120	35,194	57,314
Daejeon	593	711	338	1,074	2,056	2,037	843	335	509	29,463	32,201	61,664
Ulsan	261	277	171	493	202	326	135	941	1,225	22,002	26,344	48,346
Suwon	1,625	811	428	5,045	567	941	434	268	405	31,478	38,597	70,075
Seongnam	648	944	790	7,947	348	535	361	157	248	37,355	18,931	56,286
Anyang	1,575	524	294	975	212	347	222	94	127	19,257	13,079	32,336
Bucheon	813	1,144	393	695	281	485	265	138	184	32,644	12,166	44,810
Ansan	0	546	302	809	273	519	286	142	200	20,090	16,751	36,841
Goyang	522	0	641	1,073	250	338	298	162	248	30,613	24,083	54,696
Namyangju	331	658	0	693	148	214	156	109	148	19,893	19,050	38,943
Youngin	701	946	656	0	424	560	381	239	334	36,351	24,233	60,584
Cheongju	271	284	111	491	0	835	162	126	164	12,351	16,256	28,607
Cheonan	359	279	166	590	723	0	225	111	190	14,173	21,212	35,385
Jeonju	298	304	127	410	192	339	0	66	141	11,921	19,051	30,972
Pohang	141	173	103	297	172	197	51	0	423	11,783	7,929	19,712
Changwon	215	283	126	422	180	250	135	470	0	20,698	19,224	39,992
$n_j \left(= \sum_i m_{ij}\right)$	19,563	36,962	25,381	42,856	11,776	16,769	10,187	10,886	19,397			
Non-large city areas	17,278	17,734	13,562	17,728	16,831	18,616	20,785	8,826	20,525			
Inflow total	36,841	54,696	38,943	60,584	28,607	35,385	30,972	19,712	39,992			

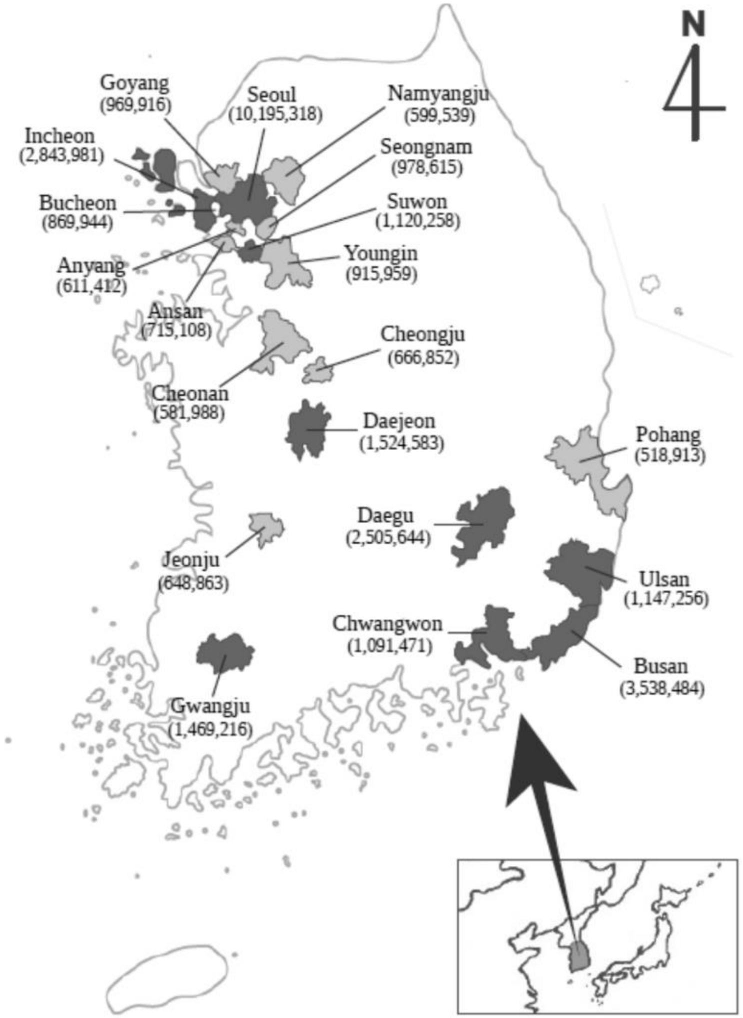
Table 2. Displacement effects and z-scores

	Displacement effect	Standardized z-score
Seoul	2.3323	0.8160
Busan	2.2566	0.4588
Daegu	1.9832	-0.8315
Incheon	2.1345	-0.1175
Gwangju	1.8619	-1.4040
Daejeon	2.0486	-0.5229
Ulsan	2.0095	-0.7074
Suwon	2.0111	-0.6998
Seongnam	2.4995	1.6051
Anyang	2.3309	0.8094
Bucheon	2.6124	2.1379
Ansan	2.2091	0.2346
Goyang	2.2702	0.5229
Namyangju	2.1663	0.0326
Youngin	2.3420	0.8618
Cheongju	1.9445	-1.0141
Cheonan	1.8823	-1.3077
Jeonju	1.8485	-1.4672
Pohang	2.2960	0.6447
Changwon	2.1484	-0.0519
Total	43.1878	0.0000
Average	2.1594	0.0000
Standard deviation	0.2119	1.0000

Table 3. Attraction effects and z-scores

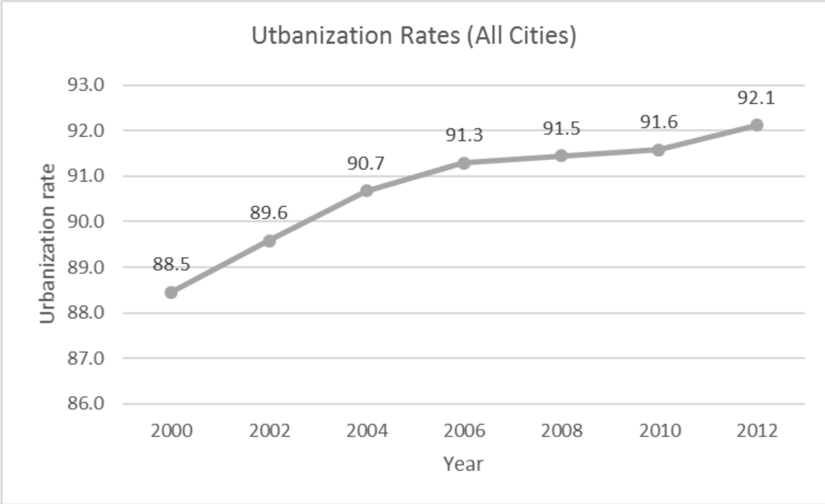
	Attraction effect	Standardized z-score
Seoul	2.2260	0.1585
Busan	1.9836	-0.6692
Daegu	1.7579	-1.4399
Incheon	2.4007	0.7550
Gwangju	1.7389	-1.5047
Daejeon	2.0374	-0.4855
Ulsan	2.0156	-0.5599
Suwon	2.3197	0.4785
Seongnam	2.5885	1.3963
Anyang	2.3162	0.4665
Bucheon	2.6221	1.5110
Ansan	2.1950	0.0527
Goyang	2.5114	1.1330
Namyangju	2.4623	0.9654
Youngin	2.6136	1.4820
Cheongju	1.8984	-0.9601
Cheonan	2.0344	-0.4957
Jeonju	1.7216	-1.5638
Pohang	2.1409	-0.1321
Changwon	2.0074	-0.5879
Total	43.5916	0.0000
Average	2.1796	0.0000
Standard deviation	0.2929	1.0000

Figure 1. Locations of the 20 largest cities in Korea



Note: Numbers in parenthesis are population sizes of the cities.

Figure 2. Urbanization Rates



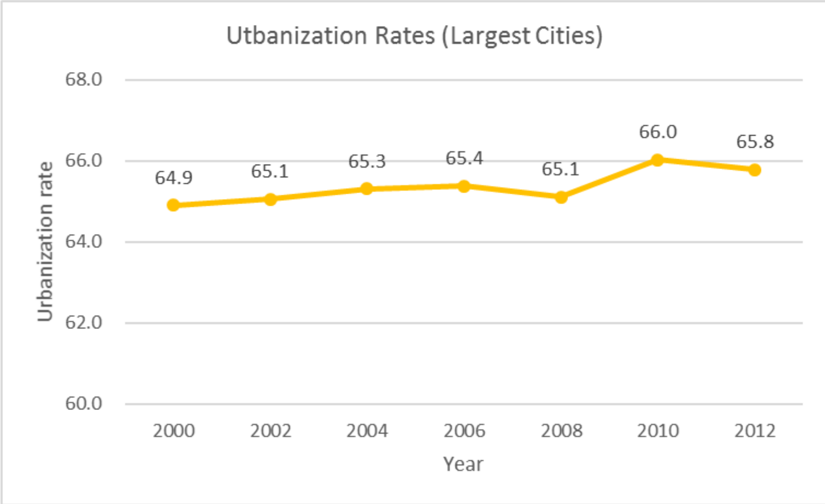
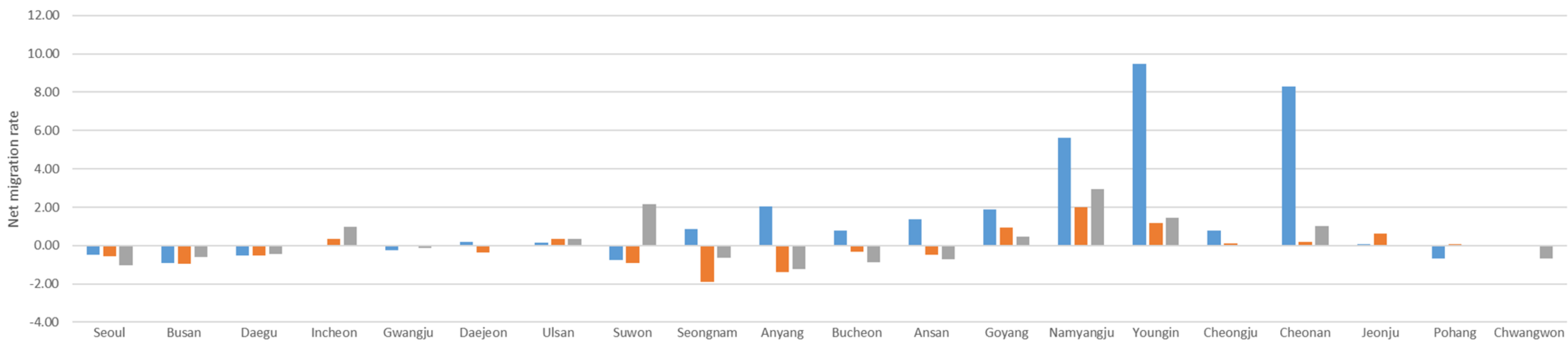


Figure 3. Net Migration Rates for 20 Largest Cities



	Seoul	Busan	Daegu	Incheon	Gwangju	Daejeon	Ulsan	Suwon	Seongnam	Anyang	Bucheon	Ansan	Goyang	Namyangju	Youngin	Cheongju	Cheonan	Jeonju	Pohang	Chwangwon
2004	-0.46	-0.91	-0.53	-0.05	-0.22	0.18	0.16	-0.76	0.86	2.03	0.76	1.39	1.90	5.61	9.49	0.79	8.29	0.09	-0.67	0.00
2008	-0.57	-0.97	-0.51	0.35	0.03	-0.38	0.35	-0.92	-1.91	-1.38	-0.34	-0.46	0.94	1.99	1.17	0.11	0.17	0.64	0.09	0.00
2012	-1.02	-0.58	-0.42	0.98	-0.12	0.03	0.35	2.16	-0.65	-1.23	-0.87	-0.70	0.47	2.94	1.43	0.01	1.03	0.02	-0.01	-0.66

City

Figure 4. Scattergram of displacement and attraction effects