An Analysis of Inter-Municipal Migration Flows in Japan Using GIS and Spatial Interaction Modeling

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Abstract: The purpose of this paper is to carefully examine the spatial pattern of human migration during the second half of the 1980s, by using geographical information system (GIS) and spatial interaction models (SIMs). It should be noted that this paper is based on the full data set of the inter-municipal migration extracted from the 1990 population census of Japan. This paper firstly uses GIS to provide the features of the Japanese migration system based on municipality units. As a result, the two major migration patterns in the late 1980s are observed; influx of population to the Keihin metropolitan area from non-metropolitan areas, and to prefectural capital cities from other cities of the same prefecture. Next, Fotheringham's competing destinations models are also applied to the inter-municipal migration flows. It is found that the spatial distribution of accessibility parameter estimates has a significantly contrastive pattern: the estimates of the origins in the non-metropolitan areas are positive and show the agglomeration effect in migration process, while the ones in the metropolitan areas are negative and show the competing effect. These results suggest that accessibility parameter estimates reflect not only the spatial configuration of origins and destinations, but also the preference of migrants for the large metropolitan areas reflecting the Japanese core-periphery structure and the business cycle in the boom period of the late 1980s.

Key words: inter-municipal migration flows, spatial interaction model, competing destinations model, Japan

Introduction

Human migration, which is an excellent indicator of functional relationships among districts, has widely been investigated in previous geographical literature (Boyle et al. 1998). With respect to migration in Japan, according to Ishikawa's (1987) study on inter-prefectural migration in postwar Japan, there was a turning point in internal migration in the latter half of the 1960s. Until 1970, migration was characterized by an increase in population flows from non-metropolitan areas to some leading areas (Wakabayashi 1987). As a result, until the early 1970s all of the three largest metropolitan areas (Keihin, Keihanshin and Chukyo) had large positive net flows. The new trend is represented by an increase in migration from metropolitan areas to non-metropolitan areas and inter-/intra-metropolitan migration (Kuroda 1979). The 1970s witnessed a sharp decline in net migration of these metropolitan areas. Since then, the net migration of the Keihanshin metropolitan area has been negative, and that of the Chukyo metropolitan area slightly positive, implying a great decline in their importance in terms of the Japanese migration system. However, the Tokyo metropolitan area increased its net inflow gradually from the early 1980s (Ishikawa and Fielding 1998).

Previous studies have devoted much attention to inter-prefectural migration mainly due to data availability. Nevertheless, great dependence on this spatial scale has made it difficult to explore closely whether the obtained results from the existing literature are peculiar to the scale or common to various scales. It was generally difficult to obtain nation-wide migration data on lower scales than inter-prefectural one comprehensively. As noted below, such a drawback is being removed recently.

Reports of the population census of Japan have provided the inter-municipal migration
data since 1970. However, the data of the 1970 census are obtained from only 20% sample while those of the 1980 census are tabulated only for the inter-city flows with fifty migrants or more. Thus, they are quite inadequate for detailed investigation. Meanwhile, the 1990 census contains all the inter-municipal migration data in the country. Even though this data source has been regarded as useful, only a few studies have used it partially so far (e.g., Morikawa 1985; Yano 1994; Isoda 1995). In particular, there has been no comprehensive nation-wide investigation by the use of all the inter-municipal migration data, mainly because they are huge and expensive.

As a result, previous studies have thus far been forced to only use inter-prefectural migration data derived mostly from the system of the Basic Residential Registers (e.g., Ishikawa 1987, 1990; Yano 1993; Nakaya 1995). The demerits of this source are exemplified by the following facts: First, the substantial spheres of a few major metropolitan areas in Japan extend beyond prefecture boundaries, and second, accessibility, which plays an important part in modeling spatial interaction including migration, cannot be specified sufficiently if prefectures are used as building blocks. Especially, accessibility calculated on a prefectural basis is rather rough. In the meantime, the merit of inter-municipal migration data, particularly those derived from the 1990 census, lies in that they enable us to pursue comparative studies between the different spatial units from various perspectives. In other words, possible investigations using inter-prefectural migration data can be included in a case of those using inter-municipal counterparts.

The purpose of this paper is, chiefly based on the inter-municipal migration data tabulated in the 1990 census of Japan, to carefully examine the spatial pattern of human migration during the second half of the 1980s, by using geographical information system (GIS) and spatial interaction models (SIMs).

It should be noted that this period is characterized by a remarkable economic prosperity (often called “bubble” boom) and resultant phenomenon exemplified by the popular use of the term *Tokyo ikkyoku shuchu* (unipolar concentration of various functions in Tokyo) (e.g., Hatta 1994). Impact of such an economic factor on migration will also be discussed. The perspective of relationship between the destination choice process assumed in the competing destinations model and underlying economic condition has been investigated inadequately in previous literature.

The organization of the rest of the paper is as follows. After a detailed explanation of the data source is given, the methodology employed in this paper is explained. Then, the obtained results are presented. The final section summarizes the major findings and discusses their implications.

**Data**

The 1990 census report (or, *1990 Population Census of Japan, Volume 7, Results of tabulation on internal migration*) publishes data of migration flows (with ten migrants or more) from prefectural capital cities and ones with a population of 300,000 or more, to other municipalities. Data on all the inter-municipal migration flows in the country, however, is available from the Japan Statistical Association (*Nihon Tokei Kyokai*) on special order. It is for these data that our careful investigation is attempted here.

In the 1990 census, migration between every pair of 3,327 local municipalities is derived from the difference of residence between census date (October 1st, 1990) and five years ago (October 1st, 1985). Intra-municipal migration data is also available. This source contains the flows of sex-specific population five years of age and over and sex-specific employed persons fifteen years of age and over. Additionally, data of in-migration, out-migration and non-movers by age (five-year interval) are also available. The local municipalities here specifically correspond to *shi* (city), *ku* (ward), *machi* (town) and *mura* (village). Wards are only existent in the ordinance-designated cities (*seirei shitei toshi*) such as Sapporo, Sendai, Tokyo, Yokohama, Kawasaki, Nagoya, Kyoto, Osaka, Kobe, Hiroshima, Kitakyushu and Fukuoka. Please note that a prefecture consists of *shi, machi* and *mura*. Regarding Sendai City, since the designation was gained in April 1989, flow data by
ward are unobtainable.

As a preliminary to detailed investigation, the following two are carried out. First, we prepared the entire OD matrix (3,372 origins × 3,372 destinations) for the whole of Japan excluding intra-municipal flows. Therefore, the total number of dyads is as many as 11,367,012 (3,372×3,372−3,372). Its frequency distribution is very skewed; the number of dyads with zero being 10,139,925 (89.205%), with one or more being 1,227,087 (10.795%), with 1,000 or more being 1,845 (0.016%) and finally with 5,000 or more being 65 (0.001%).

Secondly, the database was constructed based on the entire OD matrix, which made it possible to aggregate the original inter-municipal flows into inter-prefectural and inter-metropolitan flows. With regard to the aggregation work into the latter, the metropolitan areas delineated by the Statistics Bureau, Management and Coordination Agency of Japan (Somu-cho tokei-kyoku 1988, 1994) were utilized (Figure 1).

Moreover, the geographic matrix associated with migration for each municipality was prepared: residential population, non-movers, intra-municipal migrants, in-migration, migrants from other municipalities of the same prefecture, migrants from other prefectures, migrants from outside Japan, out-migrants, migrants to other municipalities of the same prefecture and migrants to other prefectures. These migrants could also be disaggregated by sex and employment status, if a further analysis is needed.

Methodology

Describing migration patterns using GIS

The following two methods are adopted in order to describe the characteristics of Japanese migration. The first method is to draw some maps by municipality about basic migration features such as in-migrants and out-migrants, using ArcView (a GIS software). The second method is to draw maps of dominant flows from a particular municipality, especially towards the particular metropolitan areas.

For these methods, huge digital maps, with the boundaries of municipalities in 1990 as a polygon and the flows between them as a line, are created.

Explaining migration patterns by SIMs

We employ the two origin-specific spatial interaction models, i.e., the conventional production-constrained model.

![Figure 1. Three largest metropolitan areas and regions.](image)
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\[ T_{ij} = O_i W_j^{\beta_i} d_{ij}^{\gamma_i}/\Sigma_j W_j^{\alpha_j} d_{ij}^{\beta_j}, \]  

(1)

and the production-constrained competing destinations model (Fotheringham 1983)

\[ T_{ij} = O_i W_j^{\alpha_j} H_j^{\gamma_j} d_{ij}^{\beta_i}/\Sigma_j W_j^{\alpha_j} H_j^{\gamma_j} d_{ij}^{\beta_j}. \]  

(2)

In these equations, \( T_{ij} \) denotes migration from origin \( i \) to destination \( j \), \( O_i \) is the total outflow from \( i \), \( W_j \) is the attractiveness (population size) of \( j \), \( H_j \) is accessibility of \( j \), and \( d_{ij} \) is the great circle distance between \( i \) and \( j \). \( \alpha_i \) is the attractiveness parameter, \( \beta_i \) is the distance parameter, and \( \gamma_i \) is the accessibility parameter. \( H_j \) is defined as

\[ H_j = \Sigma_k W_k / d_{kj}. \]  

(3)

Features of Japanese Migration

Characteristics of inter-municipal migration in 1985–90

We would like to outline Japan’s migration in 1985–90 by, first, examining municipality-specific indicators associated with migration, and second, extracting major inter-municipal flows. Important figures concerned with this migration are shown in Table 1.

According to the 1990 census, 29.1 million people lived at a different address from five years ago. This percentage comprises 29.4% of the total population five years of age and over in 1990.

In-migration rate The rate of in-migration here is defined by dividing in-migrants by population five years of age and over. The in-migration rates are between 3.0% and 55.4% with an 11.1% average. This suggests a considerable variation in terms of this indicator. As shown in Figure 2, the rate is particularly high in the three largest metropolitan areas such as the Keihin area (including Tokyo and Yokohama as central cities), the Chukyo area (Nagoya), and the Keihanshin area (Kyoto, Osaka and Kobe), and metropolitan areas including prefectural capital cities as central cities. This largely reflects a considerable influx of population to these areas from surrounding rural areas and small-sized cities especially located in a provincial portion of Japan. As an exceptional case, a high-rate of 55.4% can be observed for Simukkapu-mura of Hokkaido, a municipality that experienced resort development in the late 1980s. Generally, municipalities in Hokkaido have a relatively high rate of intra-municipal migrants basically due to their wider areas.

Non-mover rate Rates of non-movers also have a large range between 39.4% and 96.6% with an 83.8% average. The rates, shown in Figure 2, exhibit a striking contrast to the in-migration counterparts. Higher rates above 90% are found in municipalities in Tohoku and Chugoku regions, which constitute northern and western tips of the main island of Japan, respectively. These regions seem to correspond to the areas where the rates of the elderly population are high. It can be noted that the rate of non-movers (migration rate in the opposite term) shows a great variation by age: whereas the rate of non-movers of 65+ group is remarkably high (89.6%), that of 25–29 group is 44.7%.

Net migration rate The net migration of each municipality is the gap between in-migration and out-migration. Although the spatial pattern of the net migration is similar to the one of in-migration rate, there is a significant loss in the central cities of the three largest metropolitan areas (Figure 2). Municipalities with larger positive net-migration are generally located around the urban cores of the major metropolitan areas (such as Midori-ku in

| Non-movers | Intra-migrants | In-migrants | Net-migrants | Accessibility |
|------------|----------------|-------------|--------------|---------------|
| Average    | 83.3%          | 5.6%        | 11.1%        | 123           | 567,034      |
| S.D.       | 8.1%           | 3.6%        | 6.0%         | 3,463         | 329,593      |
| Range      | 57.2%          | 37.5%       | 52.4%        | 74,854        | 2,130,732    |
| Max.       | 96.6%          | 37.6%       | 55.4%        | 42,723        | 2,202,597    |
| Min.       | 39.4%          | 0.1%        | 3.0%         | −32,131       | 71,866       |
Yokohama-shi, Nishi-ku in Kobe-shi, Sagamihara-shi, and so on). Prefectural capital cities in the provincial portions exhibit remarkable positive net gains as well.

**Inter-municipal migration**

**Dominant flows between municipalities** It is extremely difficult to draw the pattern of all inter-municipal flows at one time. Therefore, the dominant flows between municipalities are
Figure 3. Dominant inter-municipal flows.

Figure 4. Dominant flows for the three largest metropolitan areas in Japan.

 Dominant flows

- To Keihin Metropolitan Area
- To Keihanshin Metropolitan Area
- To Chukyo Metropolitan Area

Derived from a connectivity measure defined as $(T_{ij}/O_i + T_{ji}/O_j)$, where $T_{ij}$ denotes migration from origin $i$ to destination $j$, $T_{ji}$ from $j$ to $i$, $O_i$ total out-migration from $i$, and $O_j$ total out-migration from $j$. Only the flows with very high connectivity values are depicted in Figure 3. Worthy of note is that there tends to be obvious clusters of migration exchanges within the boundary of a particular prefecture. This tendency is remarkable for peripheral prefectures such as Miyagi, Ishikawa, Kochi and Kagoshima. Meanwhile, the municipalities with higher connectivity value are hardly found within the large metropolitan areas. It is probably because such municipalities have diverse linkages to many other municipalities rather than a simple linkage to a particular city.

Dominant flows for three largest metropolitan areas

Dominant flows from a given municipality to municipalities located in the three largest metropolitan areas are also examined carefully. These dominant flows show the most attractive destination of the three large metropolitan areas for the resident of each municipality. Figure 4 clearly shows that all municipalities situated in the eastern half of Japan and the Kyushu region have dominant flows for the Keihin metropolitan area including Tokyo.
the central part of Japan, migration oriented to the Chukyo metropolitan area including Nagoya is notable. Moreover, major migration towards the Keihanshin metropolitan area focused on Kyoto, Osaka and Kobe is limited to Kinki, Chugoku and Shikoku regions.

It is thus obvious that inter-municipal migration shows a remarkable preference for Japan's largest metropolitan area (Keihin). After 1980 net in-migration of the Keihin metropolitan area gradually rose reaching a peak in 1987, and the metropolitan area of Keihanshin showed net outflow and that of Chukyo only slight net in flow, then the reconcentration trend of population into the Keihin metropolitan area in the late 1980s was remarkable (Ishikawa and Fielding 1998). Therefore, this dominance of the metro as a major destination is probably due to its overwhelming attractiveness during the late 1980s, when Tokyo grew to an influential international financial center. In this sense, the popular term Tokyo ikkyoku shuchu is convincing.

Results of Application of Spatial Interaction Models

In this section, the two spatial interaction models (the conventional production-constrained model and the production-constrained competing destinations model) are applied to the entire OD matrix in an origin-specific way. The parameters calibrated by the models are summarized in Table 2, including two statistics of goodness-of-fit; the coefficient of the determination, \( r^2 \), and the percentage of the deviance, \( pdev \). We would like to examine the spatial distribution of the obtained parameter estimates of distance, attractiveness (population size) and accessibility, in this order, hereafter.

Distance parameter

The idea of the competing destinations model (Fotheringham 1983) is that the estimated parameters of the conventional model can be misspecified by a spatial structure effect of the system under consideration. It is because, when origin-specific distance parameters are mapped, they usually have a systematic spatial pattern. As Fotheringham (1983, 1986, 1987) and Ishikawa (1987) showed in their results of application of the conventional production-constrained model to air-passerger flows and migration in the US, the Netherlands and Japan, accessible origins basically have less-negative estimates, whereas inaccessible origins tend to exhibit more-negative ones.

As an illustration, Figure 5 was prepared to show accessibility distribution of Japan from calibrating equation (3). Figure 6, which was drawn to explore the spatial pattern of the distance parameter estimates (\( \beta_i \)) obtained from the conventional model, also shows a similar tendency to the above-mentioned previous investigations. Hence, we also have to consider here that the distance estimates are a function of accessibility, which implies a configuration of origins and destinations within the spatial system under analysis.

On a closer inspection of Figure 6, however, the cause of the spatial variation of distance parameter needs to be examined in a more detailed way. For example, we can find less-negative estimates in inaccessible parts of such regions as Hokkaido and Kyushu and more-negative estimates in accessible areas of central Japan. The less-negative estimate implies that migration from the municipality with such an estimate extends to more distant destinations. As was seen in the dominant flow maps (Figure

| Table 2. Summary of origin-specific SIMs parameters |
|---------------------------------------------------|
| 1) Conventional Model                              |
| \( a_i \) | \( \beta_i \) | \( pdev \) | \( r^2 \) |
|-----------|--------------|----------|----------|
| Average   | 1.148        | -1.978   | 0.803    | 0.716    |
| S.D.      | 0.189        | 0.514    | 0.071    | 0.197    |
| Range     | 1.367        | 8.491    | 0.547    | 0.943    |
| Max.      | 1.874        | -0.726   | 0.945    | 0.993    |
| Min.      | 0.507        | -9.217   | 0.398    | 0.050    |

2) Competing Destinations Model

| \( a_i \) | \( \beta_i \) | \( \gamma_i \) | \( pdev \) | \( r^2 \) |
|-----------|--------------|--------------|----------|----------|
| Average   | 1.167        | -2.122       | 0.244    | 0.814    | 0.735    |
| S.D.      | 0.169        | 0.501        | 0.967    | 0.068    | 0.191    |
| Range     | 1.360        | 6.267        | 7.183    | 0.529    | 0.943    |
| Max.      | 1.806        | -0.750       | 4.152    | 0.950    | 0.995    |
| Min.      | 0.446        | -7.018       | -3.031   | 0.421    | 0.052    |

\( pdev \): the percentage of the deviance explained
\( r^2 \): the coefficient of determination
4), a certain part of the municipalities in Hokkaido and Kyushu have dominant out-flows to the Keihin metropolitan area, suggesting long-distance flows. Thus, we can understand why relatively less-negative estimates are observed in the peripheral parts of Japan.

In the meantime, for the non-metropolitan areas of peripheral prefectures, the more-negative estimates tend to be dominant. This is because short-distance migration to urban areas (mostly for prefectural capital cities within each prefecture) is conspicuous. To cite an interesting example, in Hokkaido, although the municipalities except the Sapporo metropolitan area have a higher migration rate, their distance parameter estimates are generally less-negative.

Accordingly, it is likely that the spatial variation of the parameter estimate associated with distance variable fundamentally stems from the local accessibility of the municipality under consideration, but its impact on migration is somewhat complicated on the inter-municipal scale.

In a comparison of the spatial patterns of distance parameter estimates ($\beta$s) from the con-
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Figure 7. The spatial variation of attractiveness parameters of the production-constrained model.

Attractiveness parameter \((\alpha_i)\)

- 0.1 – 1.0
- 1.0 – 1.2
- 1.2 – 1.4
- 1.4 – 2.0

Figure 8. The spatial variation of accessibility parameters of the production-constrained competing destinations model.

Accessibility parameter \((\gamma_i)\)

- -3.5 – -1.0
- -1.0 – 0.0
- 0.0 – 1.0
- 1.0 – 4.5

ventional model with those from the competing destinations model, there is little difference between the two. Although a few previous studies showed that the spatial variance of the distance estimates is greatly reduced by employing the competing destinations model (Fotheringham 1983, 1986), such an improvement is not confirmed here. This finding is also the case for Ishikawa (1987) based on inter-prefectural migration in Japan.

**Attractiveness parameter**

Next, the estimates of attractiveness parameter \((\alpha_i)\) obtained by the conventional model are examined (Figure 7). The estimate below 1.0 is prominent in the municipalities of the Keihin and Keihanshin metropolitan areas. Such lower estimate indicates a relatively weak explanatory power of the population size variable as destination attractiveness. On the other hand, the more-positive parameters over 1.0 are found in most municipalities except major metropolitan areas in the country. In this case, out-migrants from such municipalities, particularly to the two largest metropolitan areas of Keihin and Keihanshin, tend to be more sensitive to destination size.

Like the distance parameter, there is also no great difference of the spatial pattern associated with the attractiveness parameter between
the conventional model and the competing destinations model: the averages of the estimate are 1.148 and 1.167, respectively (Figure 7).

**Accessibility parameter**

The accessibility parameters ($\gamma$s) obtained from calibrating the competing destinations model are mapped in Figure 8. As is well known, the competing destinations model (Fotheringham 1983, 1984) provides one idea of how the effect of the spatial structure of the system under investigation is incorporated in spatial interaction modeling, and the accessibility variable concerned with the two-stage destination choice process plays an important role.

The parameter of accessibility concerns how broader spatial units are chosen as choice alternative at the first-stage decision making in the two-stage destination choice process. If the parameter estimate for the accessibility of equation (2) is negative, then it suggests that competition force among destinations is at work. As a destination is more accessible to other destinations, interaction to it decreases, ceteris paribus. On the other hand, if the accessibility variable has a positive parameter estimate, then it suggests that agglomeration force is at work. As a destination becomes more accessible to other destinations, interaction to it increases, ceteris paribus.

The obtained accessibility parameter estimates for 3,372 origin municipalities have a marked spatial pattern (Figure 8). Note that this spatial pattern is a reversal of the one of accessibility distribution itself, shown in Figure 5.

The estimates of the municipalities in Kyushu and Tohoku regions are clearly positive (more than 1.0), while the ones in the three major metropolitan areas are clearly negative (less than $-1.0$). Accordingly, out-migrants from the former municipalities prefer relatively accessible destinations, while those from the latter prefer relatively inaccessible destinations. The outflows from the municipalities with positive parameter correspond to a typical migration from non-metropolitan areas of peripheral regions to the major metropolitan areas. This result seems to reasonably support that these migrants consider the agglomeration as attractiveness consciously or unconsciously in their first-stage destination choice. In particular, the Keihin metropolitan area, the most accessible region in Japan, had a huge inflow of migrants.

Regarding out-migrants from the metropolitan areas with negative estimates of accessibility, it is possible to have two types of migration behavior; intra-metropolitan migration and return migration called a “U-turn.” The former is the flows from the urban core, that is, the central city, to the suburb, and the latter is the flows from the metropolitan areas to non-metropolitan areas. Migration flows of both cases basically mean ones from accessible areas to inaccessible areas. As a result, in the metropolitan areas, especially the Keihin metropolitan area, more negative parameter estimates of accessibility are dominant.

Within Hokkaido there are not more positive estimates of accessibility, though it is located in an inaccessible area of Japan. This is possibly because its prefectural capital, Sapporo city, has a great influx from other parts of Hokkaido.

Then, let us examine the impact of economic conditions on the inter-municipal migration system during the late 1980s. Regarding the interpretation of the estimates of accessibility, although the spatial units used are different from the analysis here, the results of Ishikawa (1987) who applies the competing destinations model to the inter-prefectural migration in the country, are very informative. When the accessibility parameter estimates between 1960 and 1980 are compared, the 1960 result shows the dominance of positive parameters in peripheral prefectures, suggesting the agglomeration effect. On the other hand, the 1980 result shows an increase in the number of prefectures with near zero or negative parameters, suggesting the competing effect. This difference in the parameters of the same area between two periods can be considered economically as a reflection of the Japanese migration system in the two periods. Japan enjoyed rapid economic growth from the mid-1950s to the early 1970s. However, it experienced a recession during the period between the mid-1970s after the oil crisis and the early 1980s. It can be said therefore that there is a close relationship between the
trends of the spatial pattern of accessibility parameters and the business cycle.

In the boom period during which the net migration in major metropolitan areas greatly increased, the agglomeration effect was seen to be dominant in a majority of municipalities of provincial portions of the country. In the meantime, during the recessionary period, the competing effect was seen to be prominent there.

In the second half of the 1980s, Japan experienced an economic boom and Tokyo underwent a rapid development to a world city. The state of business cycle is indicated by the spatial pattern of accessibility parameters. In the peripheral portions of Japan the municipalities from which migrants to the Keihin metropolitan area including Tokyo are predominant, and show more positive parameters of accessibility.

As mentioned above, the framework of competing destinations models assumes a hierarchical two-stage decision making process; migrants first choose a macro destination and then choose a micro destination within that macro destination. The results presented here suggest, with respect to hierarchical destination choice, the following conjecture. Outmigrants, especially from municipalities located in peripheral prefectures, tend to first choose a more accessible area (in particular, the country's largest metropolitan area) mainly due to their rich job opportunities, and then, choose a specific municipality included within the area chosen at the first stage.

The competing destinations model is originally proposed to remove the misspecification problem arising from spatial structure effect of the system under analysis in spatial interaction modeling. Moreover, the application of the model enables us to obtain fruitful findings: The inspection of the spatial pattern of accessibility parameters contributes to the interpretation of the migration system as mentioned above.

Conclusion

The purpose of this paper is to clarify the major spatial patterns of Japanese inter-municipal migration in 1985–90, derived from the 1990 census, based on GIS (Geographical Information System), and to explain them by employing SIMs (Spatial Interaction Models). The obtained results can be summarized as follows.

First, it turned out that the two major patterns of human migration in the late 1980s are influx of population to the three largest metropolitan areas and prefectural capital cities. The former generally constitutes longer-distance flows, whereas the latter consists of shorter-distance flows within a particular prefecture. The inter-municipal migration data utilized here greatly contributed to a careful elucidation of the latter in a detailed way, although migration focused on prefectural capitals was partially referred to in the previous literature (Morikawa 1985; Isoda 1995).

Second, the results of application of the two spatial interaction models (the conventional production-constrained model and the production-constrained competing destinations model) in an origin-specific way revealed no remarkable difference between the two in terms of the estimated parameters of attractiveness and distance variables. Worthy of note is spatial variation of parameter estimates of accessibility variable of the competing destinations model: negative parameters suggesting competing effects are found in the more accessible portion of the country (particularly in the Keihin metropolitan area including Tokyo), whereas positive parameters suggesting agglomeration effect are widely confirmed in provincial Japan (especially in Tohoku and Kyushu regions).

What implications does this result associated with accessibility parameter have? The following two points, which concern temporal change and spatial variation of migration system, can be noted.

First, as is well known, Fotheringham (1983) assumed the two-stage destination choice process by potential migrants and the spatial distribution of accessibility plays an important role in the process. Let us think about this by taking into account the results together by Ishikawa (1990, 1994), who analyzed inter-prefectural migration of 1960 and 1980 and attempted a verification of this process by using nested logit model.

With respect to postwar trends associated
with the Japanese migration system, we can demonstrate the importance of dispersion of job opportunities (especially manufacturing) from core regions to peripheral parts and decreasing supply of potential migrants due to decline of fertility. These aspects have interacted to reduce the motivation of potential migrants, who wanted to migrate to more accessible areas such as major metropolitan areas. This suggests a gradual substitution of competition effect for agglomeration effect on a long-term basis. Meanwhile, it cannot be denied that destination choices by migrants are influenced by economic environment at, or just before, the time of migration, as is shown in the preceding section. Consequently, it is likely that the migration system during a particular period is susceptible to both the long-term trend and contemporary economic conditions. Although our results are concerned with only one period of the economic boom in the late 1980s, the findings obtained here seem to reflect a temporal return to agglomeration effect dominance due to the economic boom of the late 1980s.

Secondly, possible impacts of accessibility on empirical destination choice by potential migrants may be rather complicated. According to the findings obtained in this paper, the parameter estimates of accessibility in the competing destinations model generally revealed remarkable spatial variation, which is more positive in the non-metropolitan area and more negative in the three largest metropolitan areas. Furthermore, within each prefecture, the estimates have no small variation.

This suggests a warning against investigating destinations choice processes based on calibration of the model using the inter-prefectural migration data and encouraging evidence of the supporting effectiveness of utilizing inter-municipal counterparts.

Moreover, the spatial variation of accessibility estimates leads the further interpretation of them. It seems reasonable to conclude that accessibility parameter estimates reflect not only the spatial configuration of origins and destinations, but also the preference of migrants for the large metropolitan areas other than population and distance considered in the conventional SIMs.

Notes

1. The criteria for establishing the three major metropolitan areas are as follows (Somu-cho tokei-kyoku 1988). Each metropolitan area consists of central cities and the surrounding area. The central cities of the three large metropolitan areas are Tokyo (special wards), Yokohama and Kawasaki for Keihin Metropolitan area, Nagoya for Chukyo Metropolitan Area, and Kyoto, Osaka and Kobe for Keihanshin Metropolitan Area. The surrounding area is composed of the surrounding cities, towns and village which satisfy the following conditions; 1) the rate of residential workers and students 15 years of age and over commuting to the central cities is 1.5 percent or more of its total residential population, and 2) it is contiguous to the central cities. In case that city, town or village with less than 1.5 percent of the rate, being enclosed by the areas defined as surrounding areas, is also included in the metropolitan area.

2. The percentage of the deviance explained is defined as

$$pdev = 1.0 - D/D_0,$$

where $D$ is the deviance of the model and, $D_0$ is one of the null model.

Acknowledgements

We would like to thank the financial support from the Ritsumeikan Fund for Research and Faculty, International Joint Research (1998–1999), and a Grant-in-Aid for Scientific Research from the Japanese Ministry of Education, Science and Culture (1996, No. 08780135), for this work.

(Received Jul. 27, 2000)
(Accepted Oct. 7, 2000)

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(J): written in Japanese

(JE): written in Japanese with English abstract