

TIME SERIES ANALYSIS OF DOMESTIC MIGRATION OF POPULATION ALONG RAILWAY LINES IN THE TOKYO METROPOLITAN AREA UNDER THE DECREASING POPULATION

Takayoshi TSUCHIYA^a, Naohiko HIBINO^b, Shigeru MORICHI^c

^{a,b,c}*National Graduate Institute for Policy Studies, 7-22-1, Roppongi, Minato-ku, Tokyo, 105-0001 Japan*

^a*E-mail: doc12004@grips.ac.jp*

^b*E-mail: hibino@grips.ac.jp*

^c*E-mail: smorichi.pl@grips.ac.jp*

Abstract: Japan has the fastest growth of aging ratio in the world. In addition to population decrease, the combination of the aging population with a diminishing number of children is becoming a critical issue. It is said that aging reduces the total railway demand. The study clarifies the number of immigrants and emigrants in each area along railway lines. The migrations between the railway lines having different characteristics of changes in age-structure are compared in the study. In the area where the aging rate is high, the number of immigrants as well as emigrants is fewer. In addition, this trend is particularly evident with the increasing distance from Tokyo's center. In considering the details of population migration as presented in this study, additional strategic railway policy is necessary in the near future.

Keywords: railway strategy, population migration, aged society, depopulation, Tokyo metropolitan area

1. Introduction

1.1 Background and objectives

Since 2005, the total population of Japan has started to decline. The population decrease, combined with aging population and diminishing number of children is becoming a critical issue. The National Institute of Population and Social Security Research (JPSS) reported the following two points. The first is that in the 50-year period from 2010 to 2060, the total population of Japan will decrease by 30% to around 87 million (Figure 1). The second is that in terms of age the population of youth age (under 15 years) and productive age (15-64 years) will decrease, while the population of old age (65 years and over) will increase. The rate of aging is becoming a major issue. Compared to other countries in the world, Japan records highest aging rate (percentage of total population aged 65 and over). The United Nations reported that the aging rate in Japan would increase to over 30% in 2015 — a first for any country — and that Japan would retain the top position after that year (Figure 2). Following Japan, the aging rate in European and North American industrialized countries such as Germany, Italy and France and in East Asian countries like South Korea, Hong Kong, and China is also expected to get above 30%. . Japan will be the first country in the world to deal with this issue. Therefore, policy research on an aging population combined with a diminishing number of children is a future-oriented research for any other country that will be

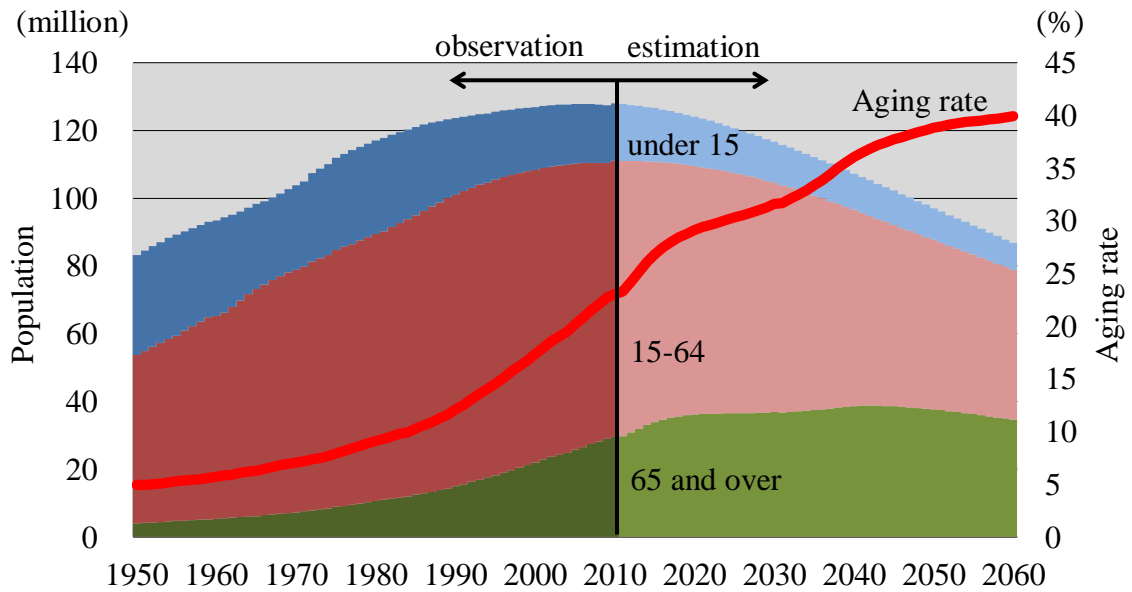
confronted with the issue.

While the total population in Japan is decreasing, it is said that the population of the Tokyo metropolitan area (TMA: Tokyo, Kanagawa, Saitama, and Chiba) would increase until 2015. However, the rapid aging is a problem in the TMA as well. JPSS also forecasted in 2007 that in the TMA, the population of old-age will grow to 10.6 million by 2035, approximately 1.8 times that of 2005. The growth rate of the population of old age is larger than that of any other metropolitan area in Japan. It is therefore important for the TMA to address this situation immediately.

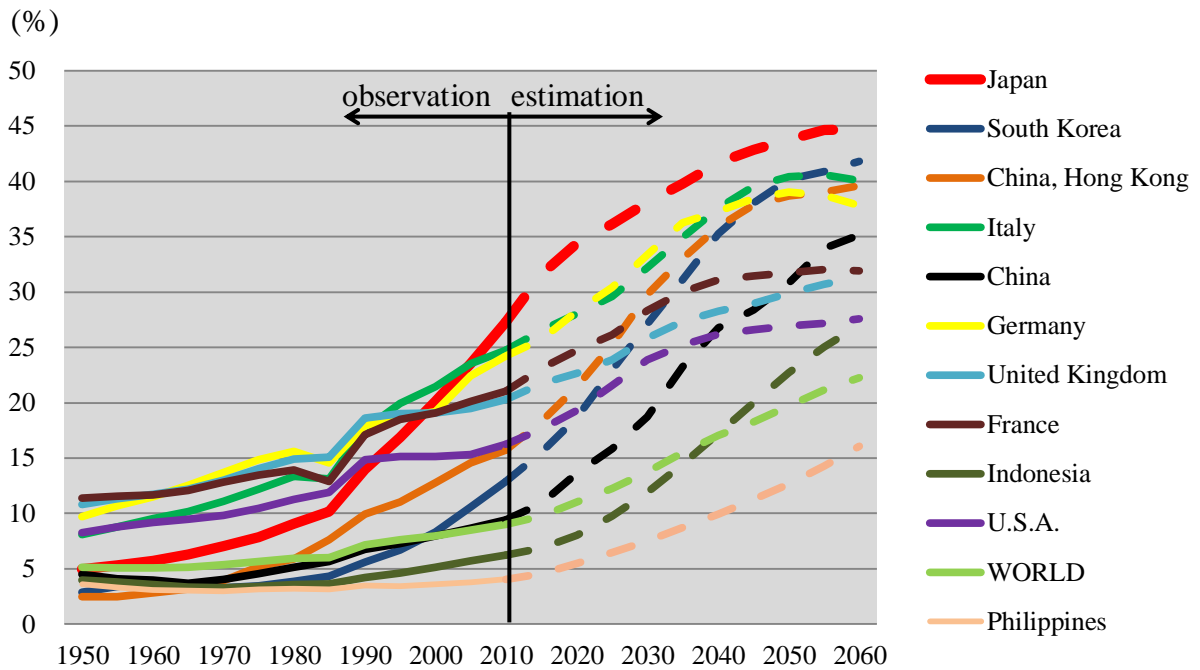
Changes in population and age structure significantly vary by time and area. In some areas an aging rate is especially high, in other areas young people flow continuously. Recently, a phenomenon called the “return to central Tokyo” has occurred. In 1996, the first social increase in the population of Tokyo’s 23 wards (central area of the TMA) since 1963 was recorded. On the other hand, in some large-scale “New Town” (built during the 1960s) suburban areas, rapid aging and decrease of population have caused serious problems such as a decline in the vitality of local society and local community. It has been pointed out that railway passenger demand has decreased due to aging. For example, aging decreases total railway demand because the decrease of commuter demand exceeds the increase of private demand. This is a significant concern for railway companies (Hibino *et al.* (2007)). However, the situations vary by time and area. While the management of some railways is expected to become more difficult due to a decrease in demand, other railway networks are expected to become increasingly congested. In such conditions, to achieve sustainable urban and railway management, railway companies and local governments have been discussing various measures, such as mixed residences for multi generation (Kajitani *et al.* (2012)). To manage urban development and railway strategies in depopulating and aging societies, it is very important to precisely capture the time-space characteristics of population dynamics and age-structure. Policy research on an aging population combined with a diminishing number of children is future-oriented research for any other city that will face the problem.

1.2 Literature review and scope

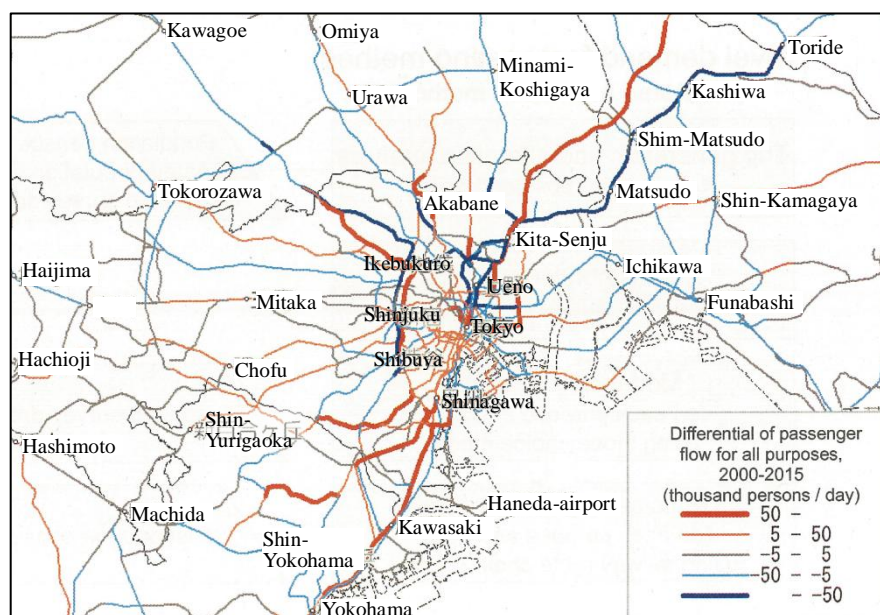
Many studies on domestic migration can be found both in domestic and international literature. In Japan, the following topics have been under investigation for many years: population concentration in large cities during period of high economic growth, suburbanization or the donut phenomenon, and the phenomenon referred to as the “return to central Tokyo”. Esaki (2006) provided an overview of the migration of the TMA. According to the study, the “return to central Tokyo” phenomenon is explained as follow. Although in the past many people came from the provinces to the center of the TMA have migrated to the suburban areas, in recent years that stay the center of the TMA. Focusing on age-structure of areas along railways, Hibino *et al.* (2007) pointed out that although the overall numbers of railway demand in the TMA increase, there are several lines where demand decrease contrary to overall trend due to aging (Figure 3). Oda *et al.* (2011) and Makimura *et al.* (2012) clarified region-by-region characteristics of changes in population and age-structure. According to these studies, there are areas along railways in which aging is especially rapid because changes in age-structure are very slight, whereas there are other areas that receive a continuous inflow of young people. However, few Japanese researchers have dealt with migration and railways in a depopulating and aging society; herein lies the originality of this study. Therefore, the study focuses on population migration by time and space and its objective is to clarify the time-space characteristics of population migration along railway lines.



data source: Projections of future population produced by JPSS
 Figure 1. Population and aging rate of Japan



data source: Projections of future population produced by the United Nations
 Figure 2. Aging rate of countries



source: Hibino et al. (2007)

Figure 3. Differences between 2000 and 2015 passenger flow for all purpose

2. Data and research analytical flow

Both the migrant data of the National Population Census and the Report on Migration of basic resident register are used for the analysis as statistical data of population migration. The National Population Census is an inventory survey and the data of that enable to analyze the migration in detail, such as by age and inter-area. On the other hand, because the survey is conducted once every ten years and the data only understand habitation five years ago, it is difficult to understand short-term trend of the migration. Although the Report on Migration of basic resident register can understand the inter-prefecture migration every year, it cannot understand by age and sex. Therefore, this study uses these data to complement. Table 1 shows the properties of these data.

The following is research analytical flow. First, it analyzes changes in population migration about total of the TMA. Next, it analyzes changes in population migration in each area of the TMA and along railway lines.

Table 1. properties of data

	the migrant data of the National Population Census	the Report on Migration of basic resident register
survey interval	annually	every 10 years
period of migration	migration for one year (the person moving resident card)	habitation 5 years ago
respondent to a survey	resident card base	present habitation base
resolution	inter-prefecture	inter-prefecture by age, by sex inter-city

3. Changes in the population migration of the total of the TMA

Figure 5 shows changes in the number of net migration in three major metropolitan areas (Tokyo, Osaka and Nagoya). In high economic growth period (mid-1950s – mid-1970s), the number of net migration have been positive in both areas. After the mid-1970s, the number of net migration in the Osaka metropolitan area (OMA) and Nagoya metropolitan area (NMA) shifted to negative. It is a situation of over concentration of the population in the TMA.

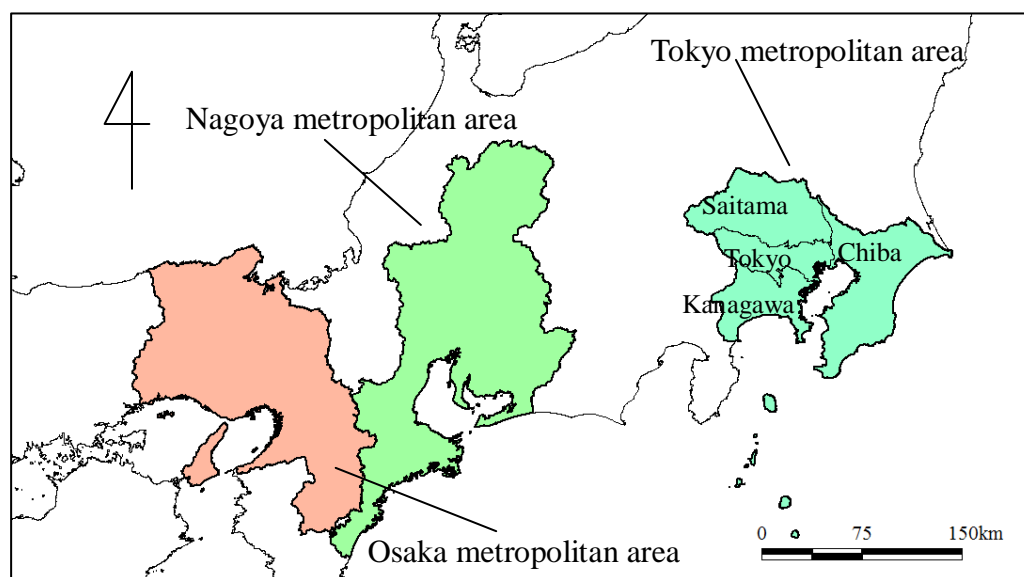


Figure 4. Locations of three major metropolitan areas

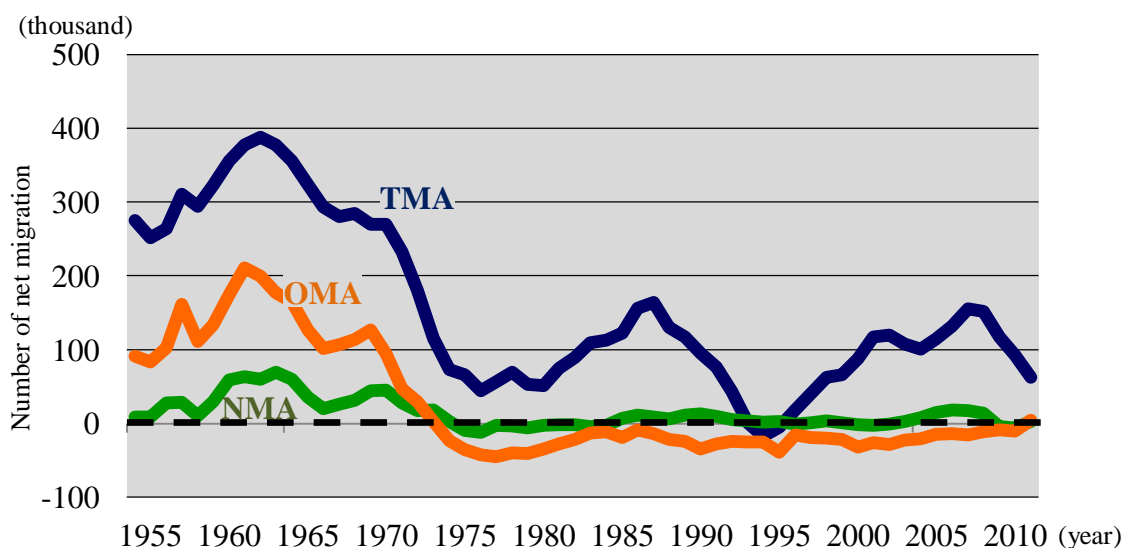


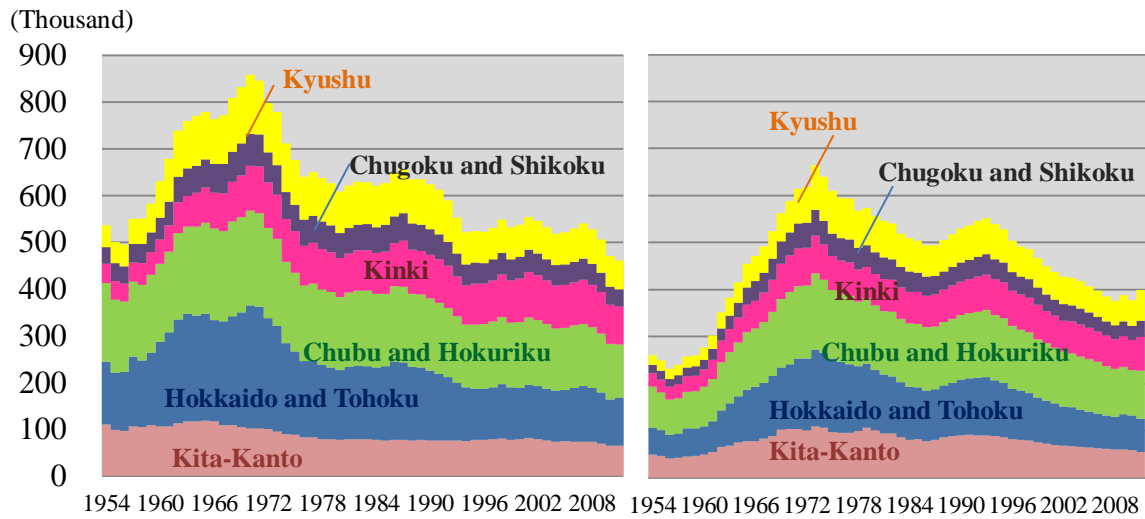
Figure 5. Changes in number of net migration

Table 2. Area classification

Block	Prefecture
Hokkaido and Tohoku	Hokkaido,Aomori,Iwate,Miyagi,Akita, Yamagata,Fukushima
Kita-Kanto	Ibaraki,Tochigi,Gunma
Chubu and Hokuriku	Niigata,Toyama,Ishikawa,Fukui,Yamanashi, Nagano,Gifu,Shizuoka,Aichi,Mie
Kinki	Shiga,Kyoto,Osaka,Hyogo,Nara,Wakayama
Chugoku and Shikoku	Tottori,Shimane,Okayama,Hiroshima, Yamaguchi,Tokushima,Kagawa,Ehime, Kochi
Kyushu	Fukuoka,Saga,Nagasaki,Kumamoto,Oita, Miyazaki,Kagoshima,Okinawa

In the TMA, there are three characteristics periods. The first has a peak in 1962, the second has a peak in 1987 (from 1976 to 1995), and the third has a peak in 2008 (from 1995). The first shows the situation of migration into large cities in high economic growth period. In high economic growth period, concentration of the population in large cities occurred in connection with change in industrial structures. Figure 6 shows changes in the number of migration to/from the TMA. Figure 7 shows the same data as Figure 6 by line graph. Table 6 shows area classification about figure 6 and 7. Both the second and the third periods have similar characteristic on the following points. Changes in the number of net migration are positive because although changes in the number of migration to the TMA remain at approximately the same level, that of from the TMA decline (Figure 6). People who migrated to the TMA are becoming not to return to rural.

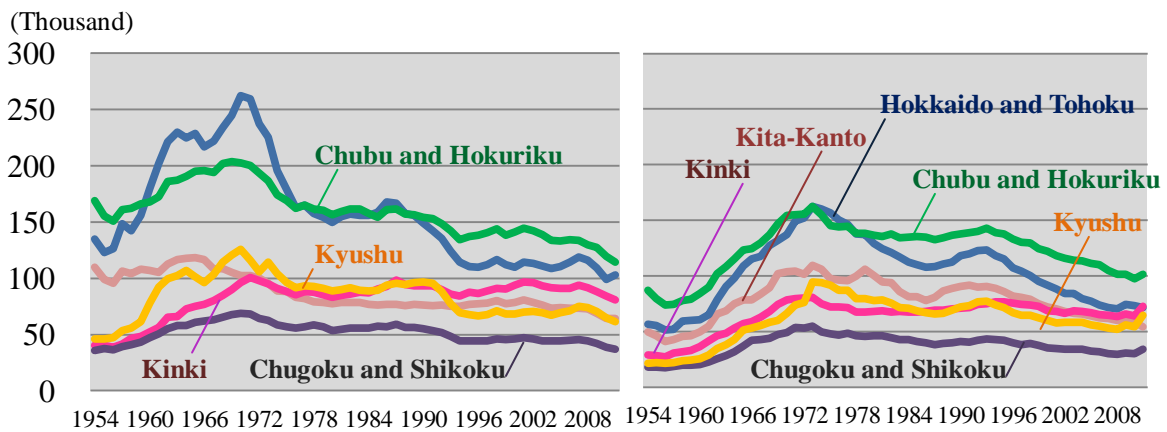
Breaking down the number of migration to/from the TMA by block, the number of Hokkaido and Tohoku block and Chubu and Hokuriku block are large which are closer to the TMA. In the second period (have a peak in 1987), the number of migration to Hokkaido and Tohoku block significantly decreased. On the other hand, in the third period (have a peak in 2008), the number of migration to not only Hokkaido and Tohoku block but also to each areas decreased.



Migration to TMA

Migration from TMA

Figure 6. Changes in number of migrant to/from the TMA
(summation graph)



Migration to TMA

Migration from TMA

Figure 7. Changes in number of migrant to/from TMA

Focusing on the age structure, figure 8 shows the number of migration between the TMA and other area by age in three periods (1985 to 1990, 1995 to 2000 and 2005 to 2010). These data are available only at the three periods. In both three periods, although the number of net migration of 15-19 years and 20-24 years is significantly large, others are small. Migration in the TMA depends to a large extent on people of 15-24 years, which age is college entrance time. Seeing in chronological order, the number of migration of 15-24 years is declining year by year.

Figure 9 shows the number of migration between the TMA and that of Hokkaido and Tohoku blocks. Figure 9 shows the same tendency as that of Figure 8.

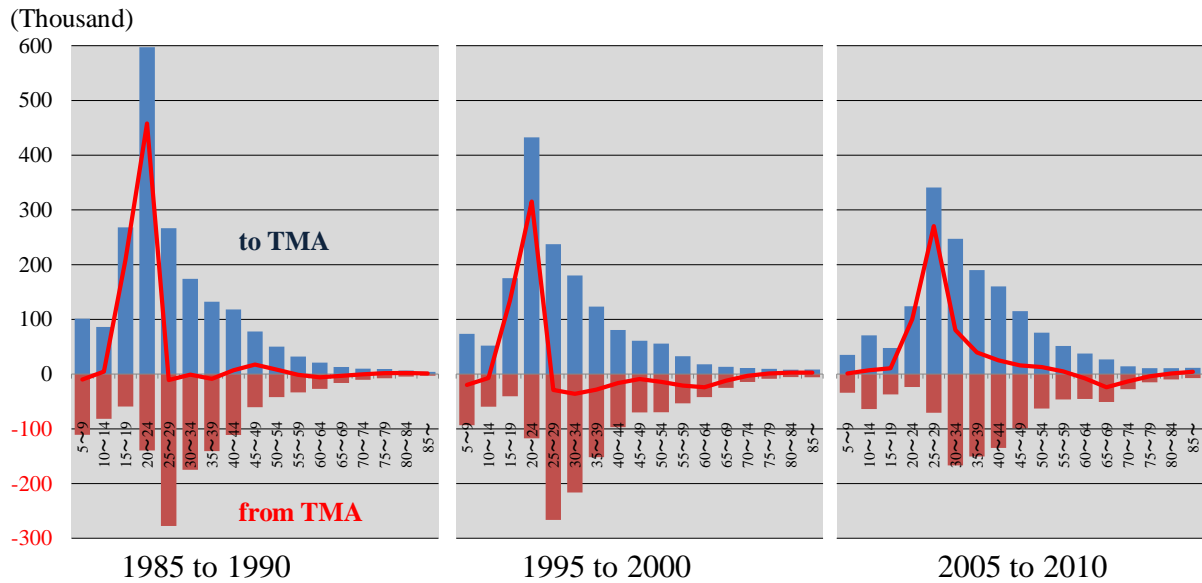


Figure 8. Number of migration to/from TMA by age

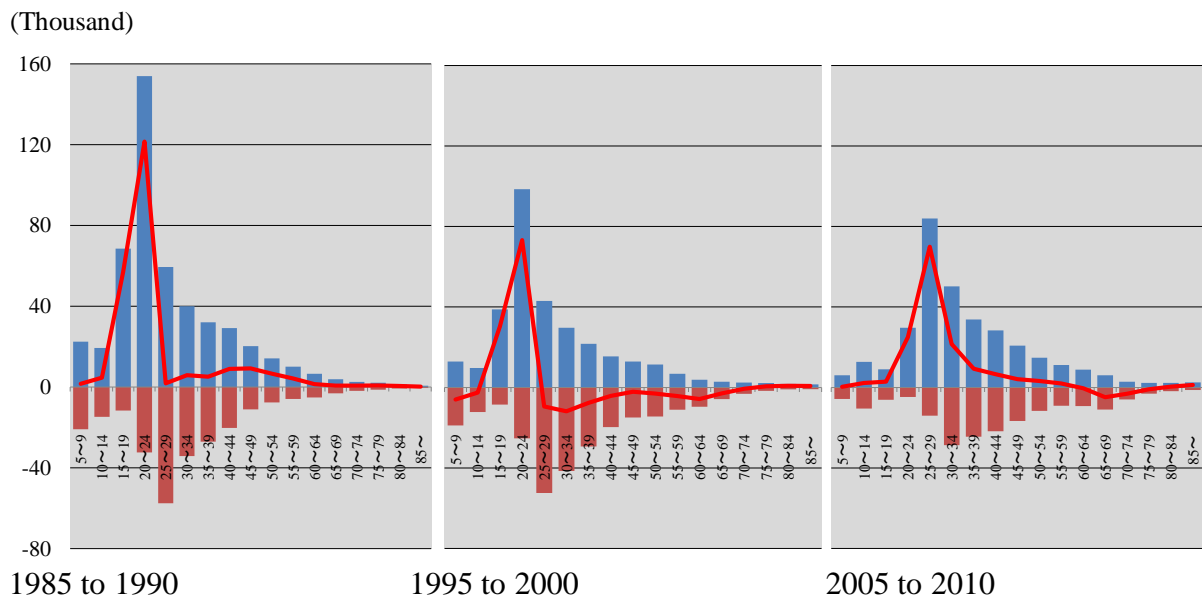


Figure 9. Number of migrant Hokkaido and Tohoku block to/from TMA by age

4. Changes in population migration in the TMA

This section focuses on migration of people in each area of the TMA. Especially, it focuses on a phenomenon called the “return to central Tokyo” (4-1) and characteristics by the area along with railways(4-2).

4-1. Changes in population migration about each areas in the TMA

Figure 10 shows the TMA zones. The TMA consist of Tokyo, Kanagawa, Saitama and Chiba prefectures. Tokyo prefecture is divided into 23 wards of Tokyo and Tama area. In addition, 23 wards of Tokyo is divided into 3 areas(the first is 3 wards of central Tokyo area, the second is 9 wards of surrounding central Tokyo area, the third is the edge of 23 wards of Tokyo).

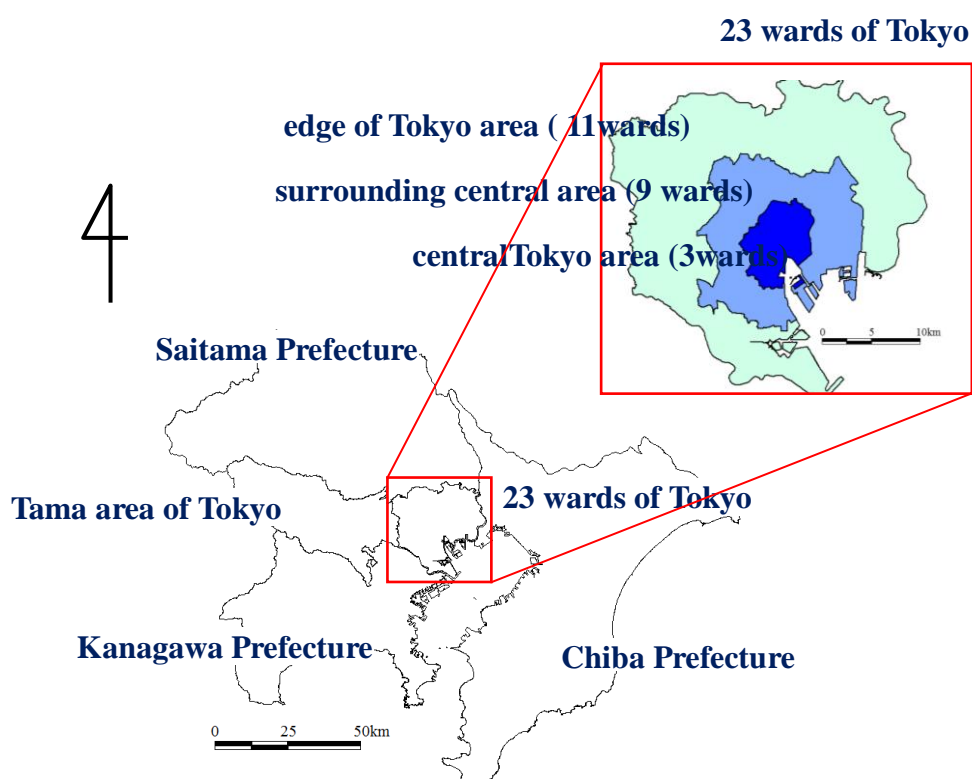


Figure 10. Analysis zones in the Tokyo metropolitan area

Figure 11 shows changes in the number of net immigration in total of Tokyo, 23 wards of Tokyo, Kanagawa, Saitama and Chiba. Figure 12 shows the same data as figure 11 by prefecture. There are significantly different characteristics between the second period and the third period; both periods discussed in section 3. In the period of the second (from 1976 to 1995), although the number of net migration of Kanagawa, Saitama and Chiba are positive, that of Tokyo and 23 wards of Tokyo are negative. On the other hand, in the third period (from 1995), although that of Tokyo and the 23 wards of Tokyo is very large, that of Kanagawa, Saitama and Chiba is small or negative. Thus, although increasing of migration to the TMA in the second period is due to suburbanization, that increasing of migration to the TMA in the third is due to the “return to central Tokyo”.

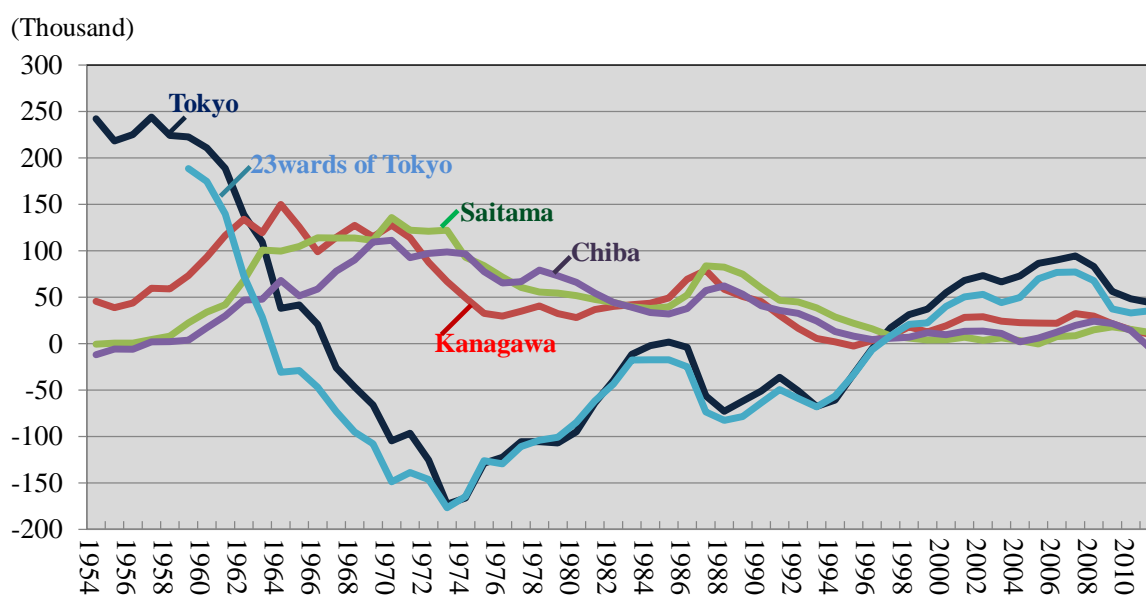


Figure 11. Changes in number of net migration in the TMA

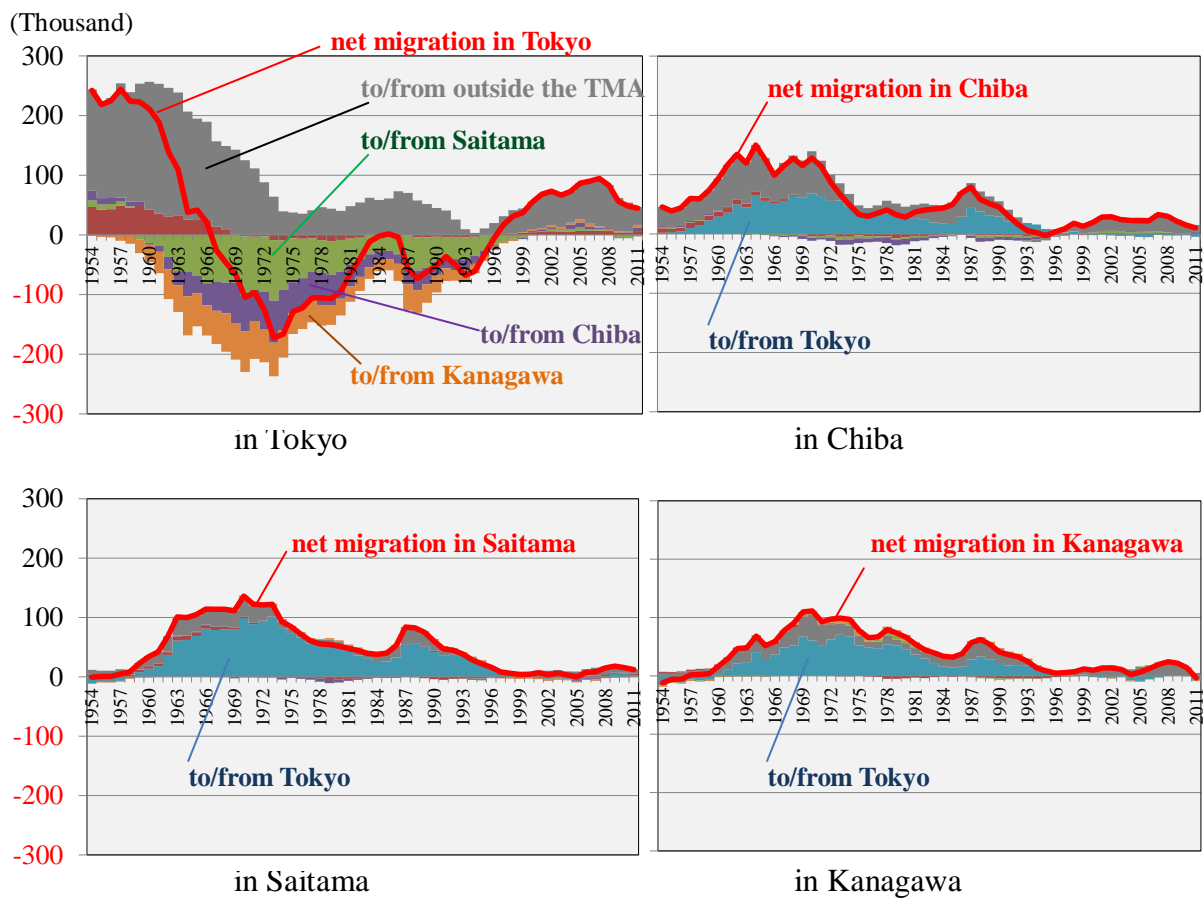


Figure 12. Changes in number of net migration in TMA of the total (summation graph)

Figure 13 shows changes in the number of migrant to/from Tokyo 23 wards. Figure 14 shows figure 13 by line graph. Seeing the third period which is after 1996, from 1996 to 2006 the number of net migration is increasing because that the number of migration to Tokyo 23 wards remain the same level and that to Tokyo 23 wards is decreasing. On the other hand, from 2006 to 2011 increasing of the net migration is slow down because that from to Tokyo 23 wards is slightly decreasing and that from Tokyo 23 wards remain the same level. In 2005, average official land price in Tokyo 23 wards increase-decrease rate turn a positive, it would appear that increasing of land price have an effect on this situation. Looking at the results according to area, although the number of migration from Kinki increased greatly from 1996 to 2006, that of other areas remained the same (Figure 13-14).

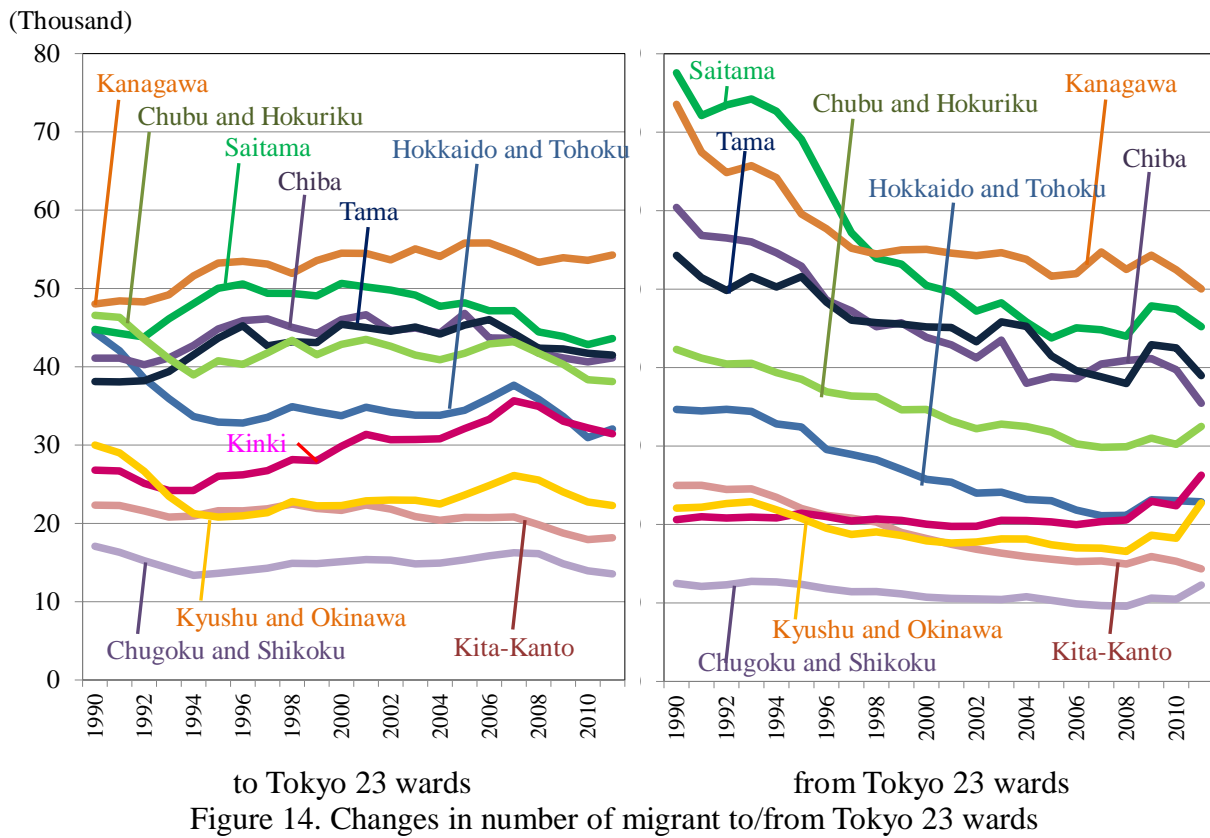
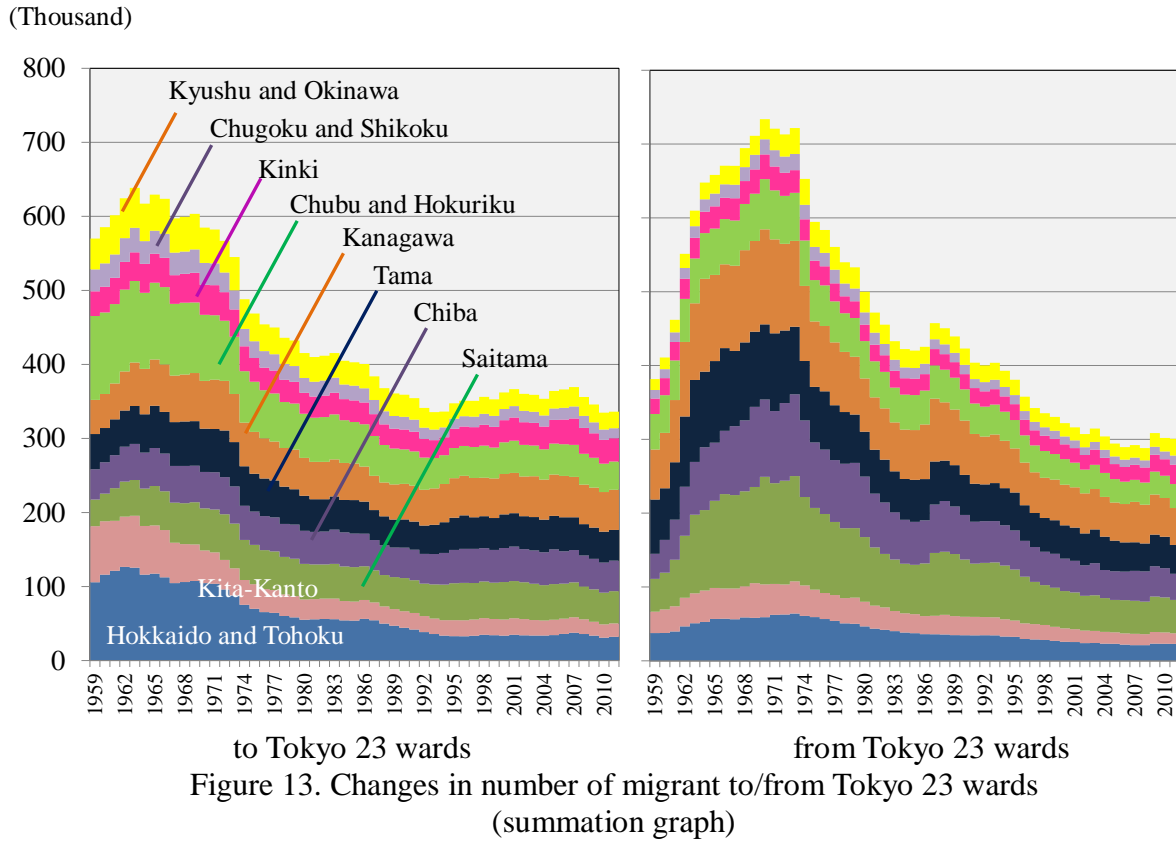


Figure 15-17 show the number of migrant to/from the central Tokyo area, the surrounding central Tokyo area and the edge of Tokyo area at two points of time (one is from 1985 to 1990 the other is from 2005 to 2010). Figure 18,19 show the net migration in the TMA by diagram. These figures make it possible to analyze the migration by od-base in detail. At point of time from 2005 to 2010, although the number of migration of the central Tokyo area and the surrounding central Tokyo area to/from the suburban areas (Kanagawa, Saitama and Chiba) is positive, that of the edge of Tokyo area is negative. Thus, the “return to central Tokyo” phenomenon shows especially the return to the 3 wards of central Tokyo and the 9 wards of surrounding the central Tokyo area.

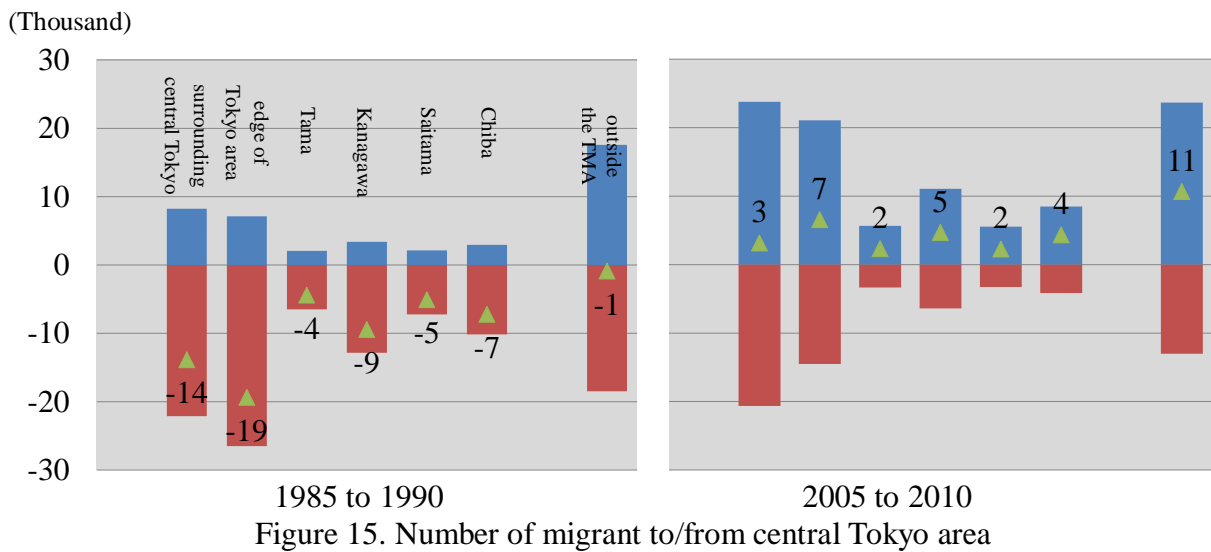


Figure 15. Number of migrant to/from central Tokyo area

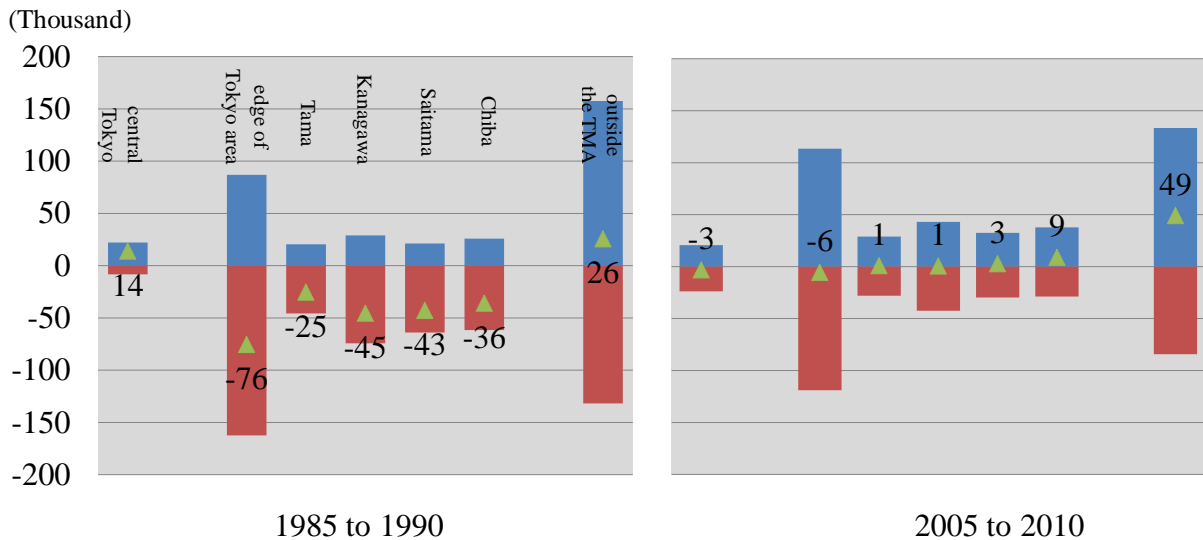


Figure 16. Number of migrant to/from surrounding central Tokyo area

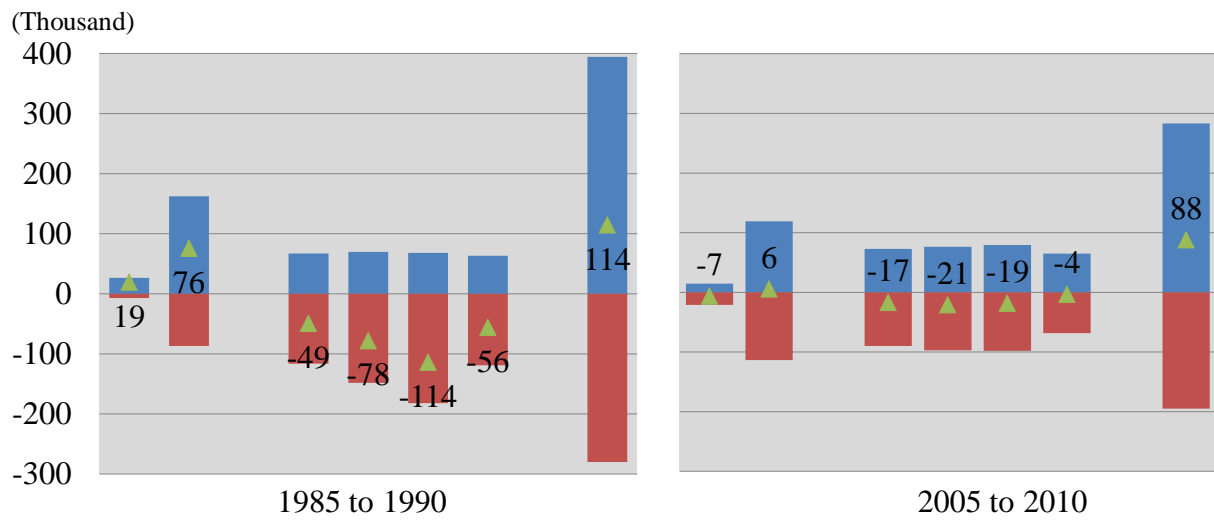


Figure 17. Number of migrant to/from edge of Tokyo area

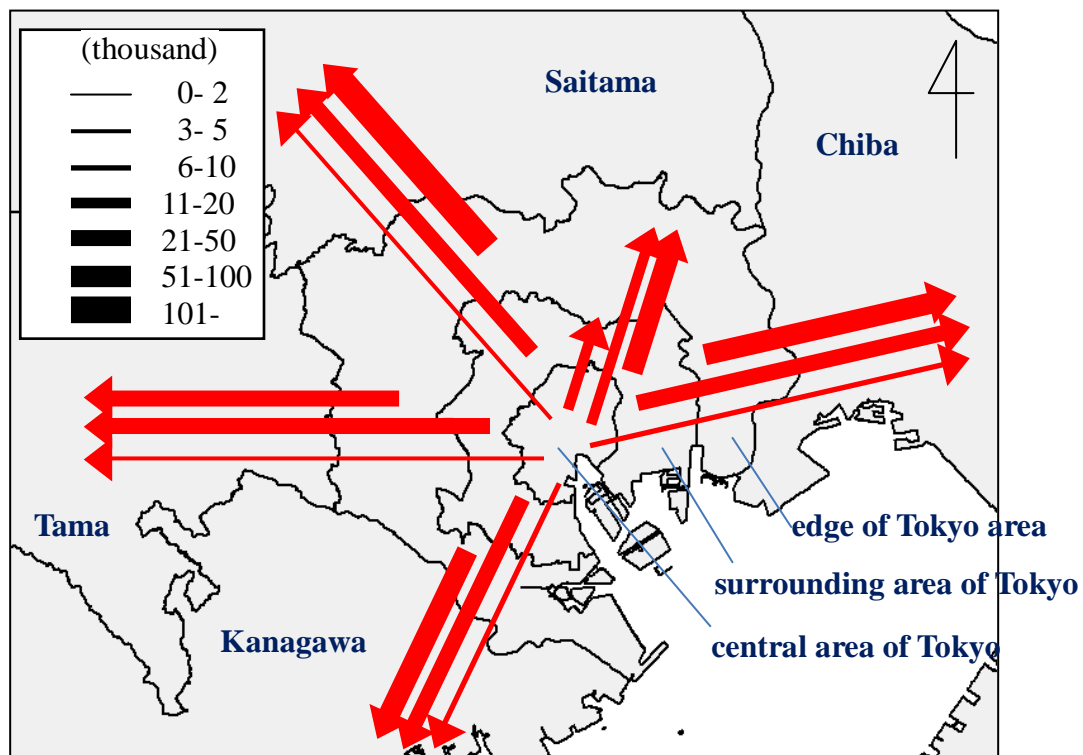


Figure 18. Net migration in the TMA (from 1985 to 1990)

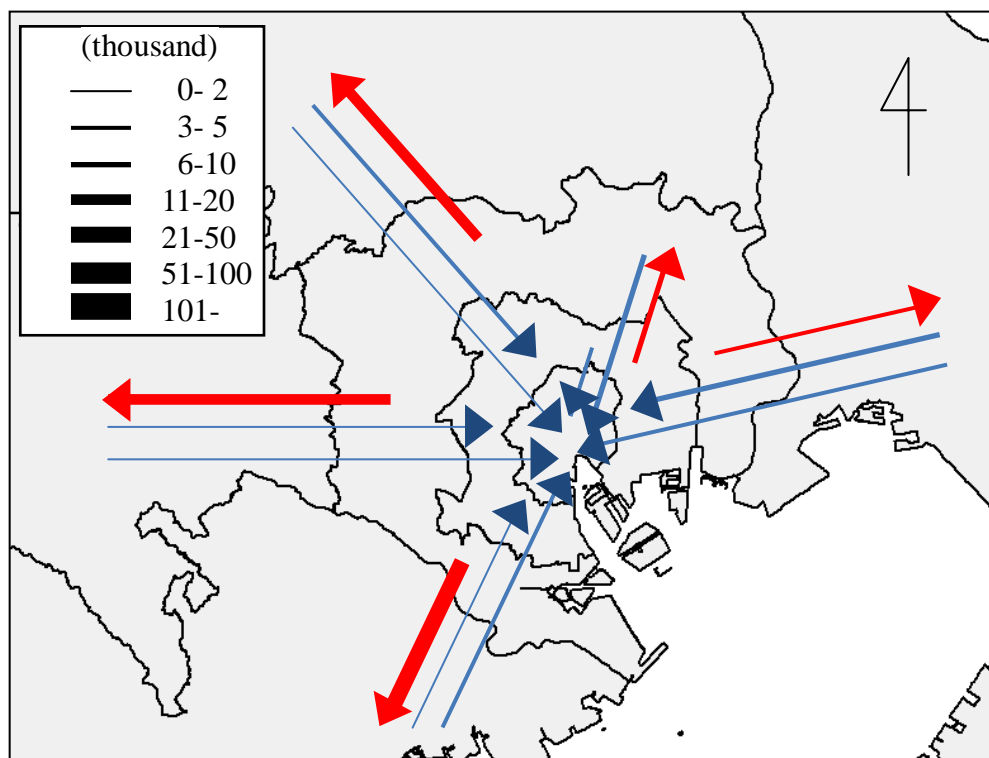


Figure 19. Net migration the in TMA (from 2005 to 2010)

4-2. Changes in population migration along railway lines

Figure 20 shows location of two railway lines which have characteristics of the changes in age-structure. Table 3 shows the characteristics of areas along railway lines. Figure 21 and 22 show changes in age-structure along Tokyu Den-en-toshi line and Tobu Isesaki line. According to Oda *et al* (2011), in the area along Tokyu Den-en-toshi line it is difficult to observe aging because young people continuously flow into these areas. On the other hand, the area along Tobu Isesaki line aging rate is exceptionally high because changes in age-structure are very small. Focusing on the migration, there are different characters in each areas from this perspective. Figure 23 and 24 show the migrant to/from the cities along Tokyu Den-en toshi line and Tobu Isesaki line. The volume of migration of the area of Tobu Isesaki line is smaller than that of Tokyu Den-en toshi line. In addition, the number of migration from the outside the TMA to the area along Tobu Isesaki line is smaller than that to the area along Tokyu Den-en toshi line.

Table 3. the characteristics of areas along railway lines

Railway line	Characteristics of age-structure
Tokyu Den-en-toshi line	Difficult to aging
Tobu Isesaki line	Aging is especially rapid

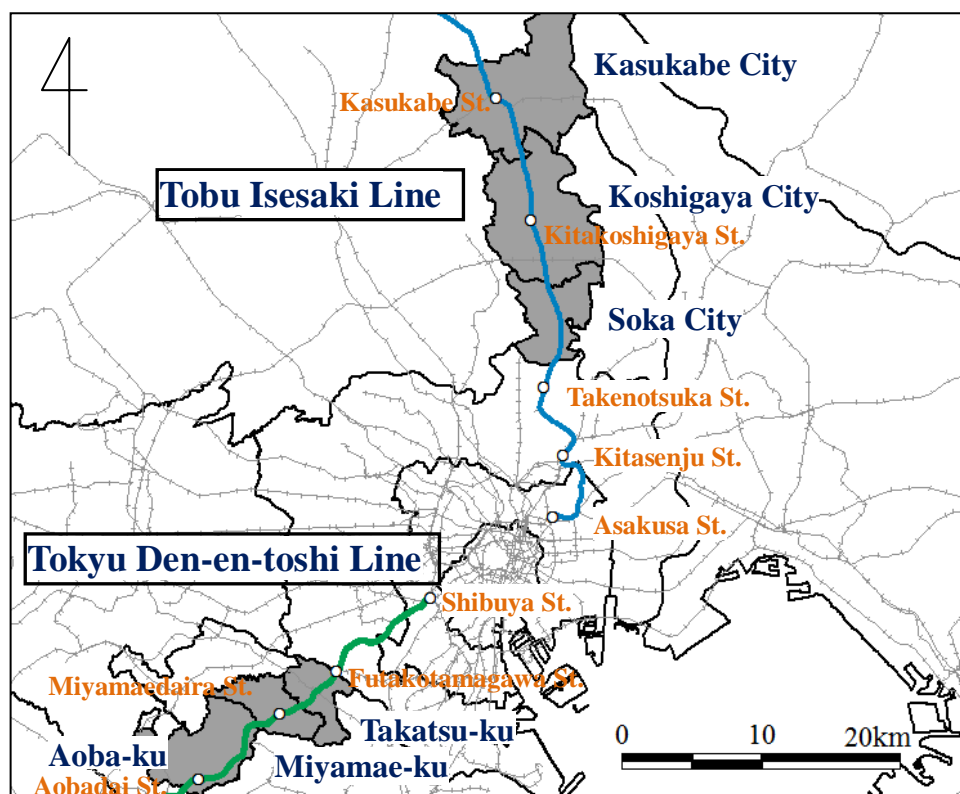


Figure 20. Location of the cities along railway lines

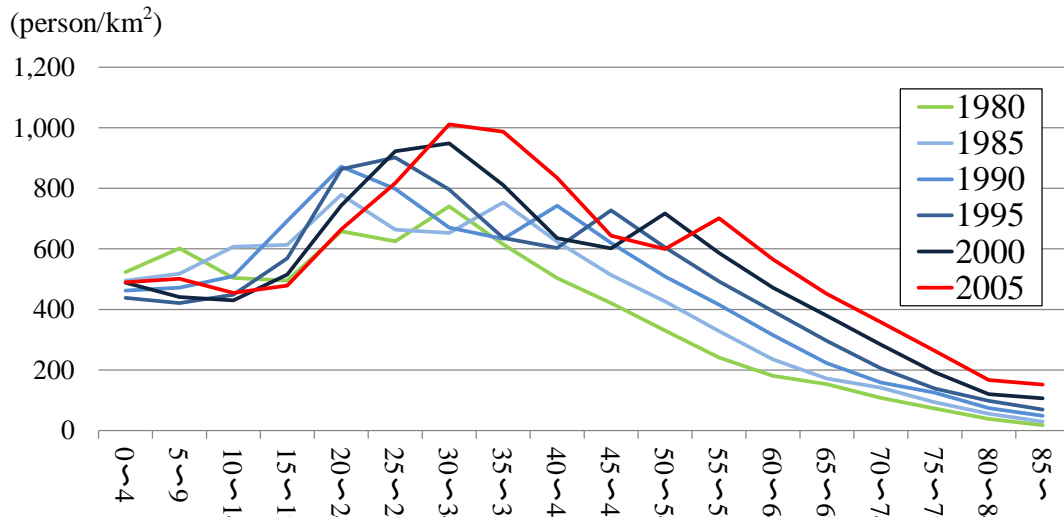


Figure 21. Changes in age structure along Tokyu Den-en-toshi line

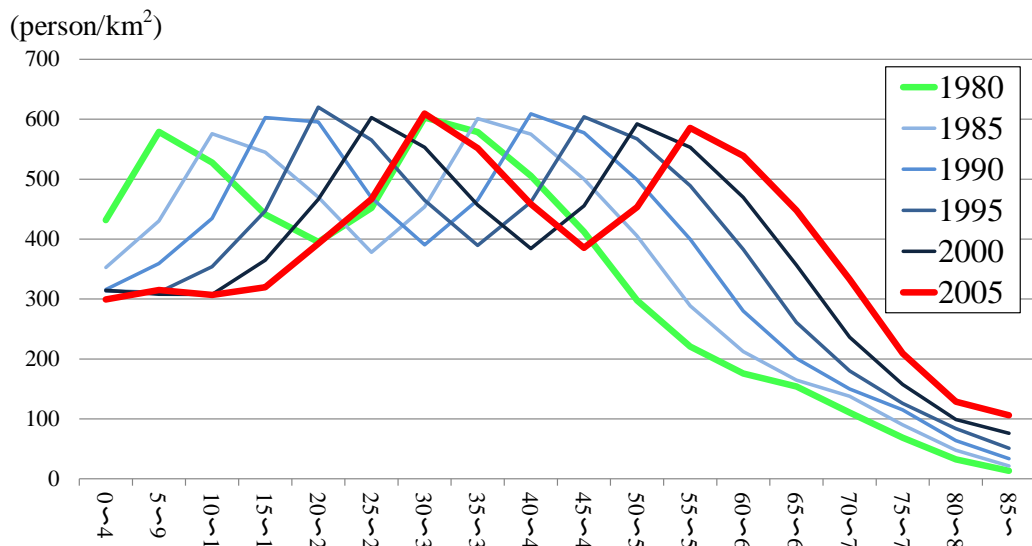
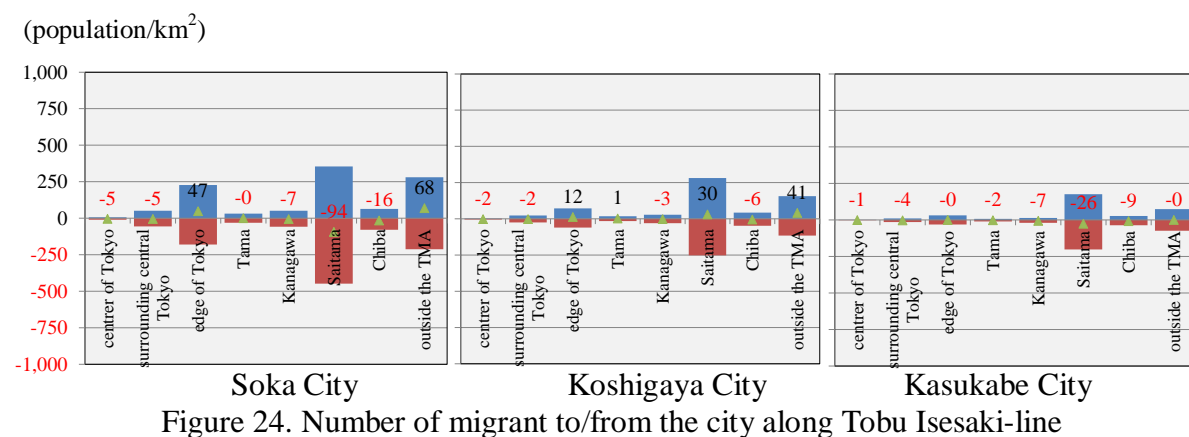
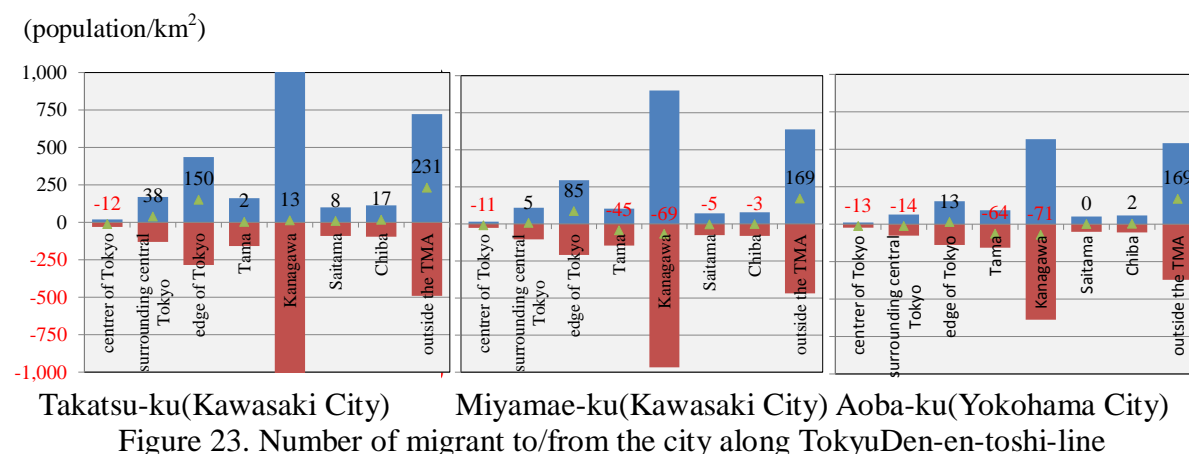


Figure 22. Changes in age structure along Tobu Isesaki line



5. CONCLUSIONS

This study focuses on population migration in a depopulating and aged society and clarifies the time-space characteristics of population migration along railway lines. The changes in the population migration of the TMA are outlined. It is shown that there are three characteristic periods in the TMA. The study clarifies the number of immigrants and emigrants by area in each area along railway lines. The study compares the migration between the railway lines having different characteristics of changes in age-structure. In the area where the aging rate is high, the number of immigrants as well as emigrants is fewer. In addition, this trend is particularly evident with the increasing distance from Tokyo's center. The area has potential for a growth in the aging rate because changes in age-structure are very small. The area especially cannot get immigrant from outside the TMA. On the other hand, the area (along Tokyu Den-en-toshi line) which achieve getting immigrant from outside the TMA is usually described as fascinating.

Conclusions of the study are as follows. In order to ensure a consistent number of railway passengers, it is important to boost the city's appeal, thus making it more fascinating; this is accomplished in collaboration with local governments and railway companies. On the other hand, many railway companies in Japan not only provide the rail transport service but also develop a suite of services such as housing land development and the operation of commercial facilities, including station buildings and supermarkets. In considering the details of

population migration as presented in this study, additional strategic railway policy is necessary in the near future.

6. ACKNOWLEDGEMENTS

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