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**Conference Paper**

## Multiplicative and additive methods for the decomposition of the migration rates to/from Tokyo ma., 1985-90

38th Congress of the European Regional Science Association: "Europe Quo Vadis? - Regional Questions at the Turn of the Century", 28 August - 1 September 1998, Vienna, Austria

**Provided in Cooperation with:**

European Regional Science Association (ERSA)

*Suggested Citation:* Gedik, Ayse (1998) : Multiplicative and additive methods for the decomposition of the migration rates to/from Tokyo ma., 1985-90, 38th Congress of the European Regional Science Association: "Europe Quo Vadis? - Regional Questions at the Turn of the Century", 28 August - 1 September 1998, Vienna, Austria, European Regional Science Association (ERSA), Louvain-la-Neuve

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**MULTIPLICATIVE AND ADDITIVE METHODS  
FOR THE DECOMPOSITION OF THE MIGRATION RATES  
TO/FROM TOKYO M.A.,1985-90**

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Paper to be presented at the  
38th European Congress of the Regional Science Association  
August 28-September 1, 1998, Vienna, Austria

## **1. Introduction**

Policy makers of most of the countries state that the concentration of population in the largest cities, as one of their significant problems. Various policies are designed to reduce the net migration rate which is composed of in- and out-migration. The purpose of this paper is to study the sizes of each of the three components of the migration rates, ie.: (1) mobility component; (2) age structure component; and (3) destination choice component (ie, preference of out-migrants towards Tokyo Metropolitan Area). This would facilitate us to find which one of the three components have been the largest in the change in the migration rates to/from Tokyo Metropolitan Area (TMA).

The purpose of this paper is to propose a methodology to study the above stated three components of migration rates in a simple and transparent manner which can also facilitate future simulation. To serve our purpose, it would be preferable to compare two different time periods, and find the differences in the sizes of each of the three components. However, this was impossible due to the problems in the available data<sup>1</sup>. Consequently, our analysis had to be limited to the 1985-90 period, and to the differences between prefectures. Migration rates are discussed in aggregate, as well as for different age groups (five-year cohorts), and by prefectures.

There are existing related studies which emphasised the significance of age structure besides the effects of economic variables on the migration rates (Greenwood, 1988; Plane, 1993; Plane and Rogerson, 1994; Rogers and Castro, 1994). Shift-share analysis to decompose these three components is explained and applied to US data in the studies by Plane

(1992) and Plane and Rogerson (1989). The same method is applied to Japanese data by Ishikawa (1992).

After briefly describing the available data in Section 2, the migration rates are defined in terms of three components in multiplication form in Chapter 3, and in additive form in Chapter 4. The additive form of the migration rates is applied to compare the sizes of the three components: in each prefecture in Chapter 4; in the in-, out-, and net-migration rates to/from Tokyo Metropolitan Area (TMA) in Chapter 5; and in the differences between the prefectures during the 1985-90 period, in Chapter 6.

In both multiplicative and additive methods, in-migration rate to TMA is studied in terms of the summation of the out-migration rates from 43 prefectures to TMA. Because of time constraints, only the six age groups between 15-19 and 40-44 are included in the discussions. Ages 5-14, and 45 and above are summed together as “other” ages, and are not analysed. This should not cause a problem since our purpose was to expose a method. Furthermore, the ages 15-44 comprise as high as 79.09% of all out-migrants.

## 2. Data

Migration data is from 1990 Population Census of Japan which took place in October 1. Concept of *de jure* population is used for enumeration. Migrant is defined as the person whose usual place of residence in 1990 P.Census is not same as in the 1985 P. Census. “...’Persons usually living’ was defined in the census as those persons who had lived or were going to live for three months or more at their respective households at the census date” (S.B., 1991, p.8). Migration is in terms of inter-prefectural mobility, and excludes the international migration, as well as those in ages 0-4.

## 3. Multiplicative Form of the Migration Rates

**3.1. Gross out-migration rates and the destination choice.** Out-migration rates to TMA ( $OMR_{i,j=TMA}$ ) can be expressed as percentage of the gross out-migration rates from each prefecture ( $OMR_i$ ) who prefer TMA as their destination choice ( $CHOICE_{i,j=TMA}$ ) (see eqs. 3.2 and 3.4). Gross out-migration rates ( $OMR_i$ ) are the proportion of population ( $POP_i$ ) who migrate ( $OM_i$ ) (see eq. 3.3). Therefore, out-migration rates to TMA ( $OMR_{i,j=TMA}$ ), can also be expressed as the proportion of population who migrates to TMA (see eq. 3.5). Each rate can also be expressed as the summation of the respective age-specific rates.

$$OMR_{i,j=TMA} = \dot{a} OMR_{i,j=TMA,a} \quad (3.1)$$

$$OMR_{i,j=TMA} = (OMR_i) * (CHOICE_{i,j=TMA}) = \sum (OMR_{i,a}) * (CHOICE_{i,j=TMA,a}) \quad (3.2)$$

$$OMR_i = (OM_i / POP_i) = \sum (OM_{i,a} / POP_i) \quad (3.3)$$

$$CHOICE_{i,j=TMA} = (OM_{i,j=TMA}) / (OM_i) = \sum (OM_{i,j=TMA,a}) / (OM_{i,a}) \quad (3.4)$$

$$OMR_{i,j=TMA} = (OM_i / POP_i) * (OM_{i,j=TMA}) / (OM_i) = OM_{i,j=TMA} / POP_i = \quad (3.5)$$

$$OM_{i,j=TMA,a} / POP_i$$

**3.2. Gross out-migration rates.** As stated above, the gross out-migration rates from each prefecture ( $OMR_i$ ) is sum of gross age-specific out-migration rates ( $OMR_{i,a}$ ) which equals to the sum of the multiplication of the mobility component (ie., age-specific-migration-rates ( $ASMR_{i,a}$ )), and the age structure component of the population (ie., the proportion of that age group in the total population ( $PPOP_{i,a}$ )). In other words, the gross out-migration rates are, age-specific-migration-rates ( $ASMR_{i,a}$ ) which are weighted by the age structure ( $PPOP_{i,a}$ ) and summed over all age groups (Rogerson, 1987, p.348).

$$OMR_i = \sum (ASMR_{i,a}) * (PPOP_{i,a}) \quad (3.6)$$

$$ASMR_{i,a} = (OM_{i,a}) / (POP_{i,a}) \quad (3.7)$$

$$PPOP_{i,a} = (POP_{i,a}) / (POP_i) \quad (3.8)$$

The population of the prefectures ( $POP_{i,a}$ ) in the denominator of the mobility component ( $ASMR_{i,a}$ ) and in the numerator of the age structure component ( $PPOP_{i,a}$ ) refers to mid-period *de jure* population according to the 1990 Population Census. In other words, it is the arithmetic mean of 1985 and 1990 populations. The 1985 population is the sum of those who did not change their prefecture of residence plus those who out-migrated. Likewise, 1990 population is the sum of those who did not change their prefecture of residence plus those who in-migrated. Cohorts refer to ages at the 1990 Population Census<sup>2</sup>.

**3.3. Age-specific out-migration rates to TMA and the three components.** The age specific out-migration rates to TMA ( $OMR_{i,j=TMA,a}$ ) equals to the multiplication of the three components concerning mobility ( $ASMR_{i,a}$ ), age structure of population ( $PPOP_{i,a}$ ), and the destination choice of the out-migrants ( $CHOICE_{i,j=TMA,a}$ ) (see eqs. 3.2 and 3.6).

$$OMR_{i,j=TMA,a} = (ASMR_{i,a}) * (PPOP_{i,a}) * (CHOICE_{i,j=TMA,a}) \quad (3.9)$$

$$OMR_{i,j=TMA,a} = (OM_{i,a} / POP_{i,a}) * (POP_{i,a} / POP_i) * (OM_{i,j=TMA,a} / OM_{i,a}) \quad (3.10)$$

$$OMR_{i,j=TMA} = \sum (ASMR_{i,a}) * (PPOP_{i,a}) * (CHOICE_{i,j=TMA,a}) \quad (3.11)$$

An example for the above definitions will be presented below for the Aomori prefecture ( $i=2$ ), and for the Wakayama prefecture ( $i=30$ ) which has the maximum and minimum out-

migration rates to TMA, respectively. It is clear that the age-specific out-migration rates to TMA are the result of the inter-play, trade-off between its three components (see eqs. 3.1, 3.2, and 3.9)

$$OMR_{i=2,j=TMA} = 4.710 = 0.808 + 1.717 + \dots + 0.239 + \dots \quad (3.12)$$

$$OMR_{i=30,j=TMA} = 0.898 = 0.139 + 0.303 + \dots + 0.044 + \dots$$

$$OMR_{i=2,j=TMA} = 4.71 = (9.21) * (51.17) \quad (3.13)$$

$$OMR_{i=30,j=TMA} = 0.90 = (6.38) * (14.07)$$

$$OMR_{i=2,j=TMA, a=15-19} = 0.808 = (1.44) * (56.09) = (0.1748) * (8.24) * (56.09) \quad (3.14)$$

$$OMR_{i=30,j=TMA, a=15-19} = 0.139 = (1.08) * (12.91) = (0.132) * (8.18) * (12.91)$$

$$OMR_{i=2,j=TMA, a=20-24} = 1.717 = (2.65) * (64.91) = (0.4104) * (6.44) * (64.91) \quad (3.15)$$

$$OMR_{i=30,j=TMA, a=20-24} = 0.383 = (1.91) * (15.89) = (0.298) * (6.40) * (15.89)$$

The above formulas can easily be thought as being analogous to the vital rates in the field of demography (Rogers and Castro, 1986; Plane and Rogerson, 1994). For example, age-specific-migration-rates (ASMR) is similar to the age-specific-fertility-rates (ASFR). The only difference is the rates are for migration instead of fertility. Consequently, the similar associations can be thought of between the Crude Birth Rate ( $CBR_i$ ) and the gross out-migration rate ( $OMR_i$ ); and between the survival rates and the destination choice ( $CHOICE_{i,j=TMA}$ ).

#### 4. Additive Form of the Migration Rates

The multiplicative form of the migration rates as explained in the previous section, is simple, clear and transparent. However, we cannot sum each of the three components, ie., of mobility ( $ASMR_{i,a}$ ), age structure ( $PPOP_{i,a}$ ), and the destination choice ( $CHOICE_{i,j=TMA, a}$ ): over cohorts either for each prefecture, or over prefectures for each cohort, or sum over all prefectures and all ages combined (ie, national total). Summation could be done only if we took logarithms; and only if the summation is for each cohort separately. Furthermore, in the multiplication form, since the denominator of each of the three components is different, it is impossible to directly compare their sizes<sup>3</sup>.

In order to overcome this shortcoming, an additive form of migration rates is proposed below. The correlation coefficient between the respective rates of the three components in

these two alternative approaches is approximately between 0.82 and 0.90 (with significance level less than 0.00005). They are also transferable to each other by simple arithmetic operations.

**4.1. Destination choice component (ORNCH).** As explained above, gross out-migration rates ( $OMR_i$ ) can be considered to be analogous to Crude Birth Rates ( $CBR_i$ ). Likewise the destination choice, ie, the rate of out-migrants who did “not” choose TMA as their destination ( $ORNCH_i$ ). can be thought as analogous to Crude Death Rate ( $CDR_i$ ). Consequently, the out-migration rates to TMA ( $OMR_{i,j=TMA}$ ) can be calculated by subtracting destination choice ( $ORNCH_{i,j=TMA}$ ) from the gross out-migration rates ( $OMR_i$ ). This is also analogous to the rate of population change ( $r$ ) which is estimated by subtracting CDR from CBR ( $r_i = CBR_i - CDR_i$ ).

$$OMR_{i,j=TMA} = OMR_i - ORNCH_{i,j=TMA} \quad (4.1)$$

$$ORNCH_{i,j=TMA} = (OM_i - OM_{i,j=TMA}) / POP_i = (OMNCH_{i,j=TMA}) / POP_i = \quad (4.2)$$

$$OMR_{i,j=TMA} = (OM_i - OMNCH_{i,j=TMA}) / POP_i = (OM_{i,j=TMA}) / POP_i \quad (4.3)$$

Destination choice component which is presented in the (a) multiplicative form as in the previous section above, as the “proportion” of the out-migrants who preferred TMA as their destination ( $CHOICE_{i,j=TMA} = OM_{i,j} / OM_i$ ); and (b) in the additive form, as the out-migration “rate” of those who did “not” prefer TMA ( $ORNCH_{i,j=TMA} = (OM_i - OM_{i,j=TMA}) / POP_i$ ), are highly associated with a correlation coefficient of - 0.82 (with significance level of less than 0.00005).

$$CHOICE_{i,j=TMA} = OM_{i,j=TMA} / OM_i \quad (4.4)$$

$$ORNCH_{i,j=TMA} = (OM_i - OM_{i,j=TMA}) / POP_i = (1 - CHOICE_{i,j=TMA}) * OMR_i \quad (4.5)$$

$$CHOICE_{i,j=TMA} = (1 - (ORNCH_{i,j=TMA})) / OMR_i \quad (4.6)$$

For example, for Aomori prefecture ( $i=2$ ) and Wakayama prefecture ( $i=30$ ), the values for  $CHOICE_{i,j=TMA}$  and  $ORNCH_{i,j=TMA}$ , and  $OMR_i$  are: 51.17% and 4.499%, and 0.0921 for Aomori ( $i=2$ ); and 14.07% and 5.486%, and 0.0638 for Wakayama ( $i=30$ ).

**4.2. Mobility component (ORMOB).** Above (see Section 4.1), the out-migration rate to TMA ( $OMR_{i,j=TMA}$ ), is presented in an additive form by subtracting destination choice ( $ORNCH_{i,j=TMA}$ ) from the gross out-migration rate ( $OMR_i$ ) (see eq. 4.1). Likewise, gross out-migration rate ( $OMR_i$ ) is also presented below in an additive form as the summation of the mobility component ( $ORMOB_i$ ) and the age structure component ( $ORAST_i$ ). Consequently,

all three rates representing the three components have population in their denominator ( $POP_i$ ) so that they can be summed, and be directly comparable.

$$OMR_{i,j=TMA} = (ORMOB_i) + (ORAST_i) - (ORNCH_{i,j=TMA}) = OMR_i - ORNCH_{i,j=TMA} \quad (4.7)$$

Mobility component ( $ORMOB_i$ ) is defined as the part of the gross out-migration rate ( $OMR_i$ ) which we would obtain if the age structure was homogeneous (ie, if proportion of population among cohorts was equally distributed)<sup>4</sup>. If we have  $m$  number of cohorts, then  $ORMOB_i$  would be arithmetic mean of the age specific migration rates (ASMR's)<sup>5</sup>. In this study,  $m$  equals 17, ie, there are 17 cohorts between ages 5, and 85 and over<sup>6</sup>.

$$ORMOB_i = \sum(1/m) * (ASMR_{i,a}) = (1/m) (\sum ASMR_{i,a}) \quad (4.8)$$

$$ORMOB_{i,a} = (1/m) (ASMR_{i,a}) \quad (4.9)$$

For example, values for  $ASMR_i$  for Aomori ( $i=2$ ) is greater than the respective values for Wakayama ( $i=30$ ) for every age group (0.1748, 0.4104, 0.1677, 0.1108, 0.0799, 0.0666, 0.4166; versus 0.1319, 0.2980, 0.1254, 0.8490, 0.0570, 0.0393, 0.2676, respectively). Likewise, the values for  $ORMOB_i$  for all ages combined, and for every age, is larger for Aomori. For example, the values of  $ORMOB_i$  for all ages combined and for ages 20-24, are 0.0839 and 0.02414 for Aomori; and 0.0591 and 0.017526 for Wakayama, respectively.

We can also think of the mobility component ( $ORMOB_i$ ) as a proportion of the Gross Migraproduction Rates ( $GMR_i = (5) * (\sum ASMR_{i,a})$ ). The GMR is analogous to total fertility rates ( $TFR_i = (5) * (\sum ASFR_{i,a})$ ) (Rogers and Castro, 1986, p. 164). In a way, GMR is respective rate for migration, instead of fertility. The  $TFR_i$ ,  $GMR_i$ , as well as  $ORMOB_i$ , are all not affected by the age structure of the population. Whereas, crude birth rates ( $CBR_i$ ) as well as the gross out-migration rates ( $OMR_i$ ) --since they are the result of the multiplication of  $ASFR_{i,a}$  or  $ASMR_{i,a}$  by the proportion of population in each cohort ( $PPOP_{i,a}$ )-- are partly determined by the age structure of the population.

**4.3. Age structure component (ORAST).** The remaining part of the gross out-migration rate (ie, when the mobility component ( $ORMOB_i$ ) is subtracted from the gross out-migration rate ( $OMR_i$ )) is considered to be due to age structure ( $ORAST_i$ ).

$$ORAST_i = (OMR_i) - (ORMOB_i) = (OMR_i) - ((1/m) * \sum ASMR_{i,a}) \quad (4.10)$$

$$ORAST_{i,a} = (OMR_{i,a}) - (ORMOB_{i,a}) = (OMR_{i,a}) - ((1/m) / ASMR_{i,a}) \quad (4.11)$$

The  $ORAST_{i,a}$  is highly correlated with the corresponding age structure component (ie, the proportion of population in each cohort,  $PPOP_{i,a}$ ) which was discussed in the previous

section with a correlation coefficient of  $r = 0.89$  (and the significance level of less than 0.00005).

$$\text{ORAST}_{i,a} = \text{ASMR}_{i,a} (\text{PPOP}_{i,a} - 1/m), \text{ where } m=17 \quad (4.12)$$

For example, values for  $\text{PPOP}_{i,a}$  and  $\text{ORAST}_{i,a}$  for Aomori ( $i=2$ ) is greater than the respective values for Wakayama ( $i=30$ ) for every age group. These values for the age group 20-24 ( $\text{PPOP}_{i,a=20-24}$ , and  $\text{ORAST}_{i,a=20-24}$ ) for Aomori and Wakayama are 6.44% and 0.231, and 6.40% and 0.153, respectively. Likewise, corresponding  $\text{ORAST}_i$  for all ages is greater for Aomori (0.8212) than for Wakayama (0.4781).

Negative sign of  $\text{ORAST}_{i,a}$  indicate that, the proportion of that age group is less than  $1/m$  ( $=0.0588$ , if  $m = 17$ ), and vice versa<sup>7</sup>. For example, proportion of population ( $\text{PPOP}_{i,a}$ ) in age groups 20-24 and 25-29 for Akita are 5.33% and 5.40% which are less than the value of equal proportions ( $1/17=0.0558\%$ ). Consequently, its values for  $\text{ORAST}_{i,a}$  for the same age groups are -0.222 and -0.0608. The  $\text{ORAST}_{i,a}$  with negative sign is observed in the prefectures in traditionally heavy out-migration regions (such as in North, South and West Japan): in ages 20-24 (in seven prefectures<sup>8</sup>); and in the ages 25-29 (in 17 prefectures<sup>9</sup>).

#### 4.4. Differences between sizes and signs of the three components in each prefecture.

The additive form for Aomori ( $i=2$ ) and Wakayama ( $i=30$ ) are presented below where the order of the components are mobility ( $\text{ORMOB}_i$ ), age structure ( $\text{ORAST}_i$ ), and the destination choice component ( $\text{ORNCH}_{i,j=\text{TMA}}$ ). They can be compared with the respective equations 3.12 - 3.15 which are in the multiplicative form.

$$\text{OMR}_{i=2,j=\text{TMA}} = 4.71 = 0.808 + 1.717 + \dots + 0.239 + \dots \quad (4.13)$$

$$\text{OMR}_{i=30,j=\text{TMA}} = 0.90 = 0.139 + 0.303 + \dots + 0.044 + \dots$$

$$\text{OMR}_{i=2,j=\text{TMA}} = 4.71 = 9.21 - 4.50 = 8.39 + 0.82 - 4.50 \quad (4.14)$$

$$\text{OMR}_{i=30,j=\text{TMA}} = 0.90 = 6.38 - 5.49 = 5.90 + 0.48 - 5.49$$

$$\text{OMR}_{i=2,j=\text{TMA}, a=15-19} = 0.808 = (1.44) - (0.632) = (1.028) + (0.412) - (0.632) \quad (4.15)$$

$$\text{OMR}_{i=30,j=\text{TMA}, a=15-19} = 0.139 = (1.08) - (0.939) = (0.776) + (0.303) - (0.939)$$

$$\text{OMR}_{i=2,j=\text{TMA}, a=20-24} = 1.717 = (2.65) - (0.928) = (2.414) + (0.231) - (0.928) \quad (4.16)$$

$$\text{OMR}_{i=30,j=\text{TMA}, a=20-24} = 0.303 = (1.91) - (1.603) = (1.753) + (0.153) - (1.603)$$



When all the ages are in aggregate, for each prefecture, *mobility* component is the largest ( $ORMOB_i$ ), followed by *destination choice* component ( $ORNCH_{i,j=TMA}$ ). The smallest component in every prefecture is the *age structure* component ( $ORAST_i$ ). On the average for all 43 prefectures (ie, the unweighted arithmetic mean), the large size of the *mobility* component is evident (see Table 1; and Figure 2).

$$0.0221 = 0.0640 + 0.005 - 0.0480 \quad (4.16a)$$

Although the mobility component ( $ORMOB_i$ ) is always larger than the destination component ( $ORNCH_{i,j=TMA}$ ), the differences are large especially in the ex-urban prefectures of TMA and in the north<sup>10</sup>; and small in the South and West Japan<sup>11</sup>--although both regions are traditionally high out-migrating regions such that the mobility component is large in both regions ( $ORMOB_i$ ). The difference occurs because the former region has high preference for TMA (thus, small value of  $ORNCH_{i,j=TMA}$ ); and the latter region have low preference for TMA (thus, large value of  $ORNCH_{i,j=TMA}$ ).

When the out-migration rate to TMA ( $OMR_{i,j=TMA,a}$ ) is desegregated according to age, the differences between the three components are largest for the age group of 20-24 (see Table 1; and Figure 2). For example, the mean values of the above stated differences for the age group of 20-24 are 0.604 (between  $ORMOB$  and  $ORNCH$ ); 0.950 (between  $ORNCH$  and  $ORAST$ ); and 1.554 (between  $ORMOB$  and  $ORAST$ ).

Furthermore, for different age groups, there are exceptions to the above statement concerning the sizes of the differences between the components due to the distinct regional differences in migration<sup>12</sup>. Firstly, in South and West Japan (such as Kagawa,  $i=37$ ), *destination choice* component ( $ORNCH_{i,j=TMA}$ ) is larger than the mobility component ( $ORMOB_i$ )--because of the low preference/ destination choice for TMA (thus, large values of  $ORNCH_i$ ).

$$OMR_{i=37,j=TMA,a=15-19} = 0.2109 = 0.808 + 0.319 - 0.9162 \quad (4.17)$$

Secondly, in the exurban prefectures of TMA<sup>13</sup> (such as Gumma,  $i=10$ ), for ages 15-19, *age structure* ( $ORAST_i$ ) is larger than the destination component ( $ORNCH_{i,j=TMA}$ )-- because of the large age structure component ( $ORAST_i$ ); and high preference, destination choice to TMA (thus, small values of  $ORNCH_{i,j=TMA}$ ).

$$OMR_{i=10,j=TMA,a=15-19} = 0.5585 = 0.513 + 0.241 - 0.195 \quad (4.18)$$

Thirdly, in Osaka M.A., for ages 20-24, the difference between age structure ( $ORAST_i$ ) and mobility component ( $ORMOB_i$ ) is very low -- because of the large *age structure*

$$(ORAST_i); \text{ and small mobility component } (ORMOB_i) \quad OMR_{i=27,j=TMA,a=20-24} = 0.259 = 0.690 + 0.332 - 0.763 \quad (4.19)$$

#### 4.5. Future improvements.

As previously stated, the “other” ages which is the sum of ages 5-14, and 45 and above should be desegregated and the analysis should be carried out for each individual cohort in this age group.

The other future improvement, or in other words, the present shortcoming of this method is about the destination choice component (ORNCH) which in this study equals to

$$ORNCH_{i,j=TMA} = (OM_i - OM_{i,j=TMA}) / POP_i = (OMNCH_{i,j=TMA}) / POP_i \quad (4.21)$$

$$ORNCH_{i,j=TMA} = (1 - CHOICE_{i,j=TMA}) * (OMR_{i,j=TMA}) \quad (4.21a)$$

$$ORNCH_{i,j=TMA} = ((OM_i - OM_{i,j=TMA}) / (OM_i)) * (OM_i / POP_i) \quad (4.22)$$

The first part of the equation (eq. 4.22) represents explicitly and only the destination choice. In other words, it is the preference of out-migrants for TMA once they out-migrate (which is same as the respective value in the multiplicative form ( $CHOICE_{i,j=TMA}$ )) (see eq. 3.4). However, the second part of the equation is the gross out-migration rate ( $OMR_i$ ). Therefore, the destination component in the additive form ( $ORNCH_{i,j=TMA}$ ) is multiplication-interaction of these two terms. However, they are highly associated such that the correlation coefficient between  $CHOICE$  and  $ORNCH$  is, as previously stated, as high as -0.82.

Another alternative additive method which could also overcome the above stated shortcoming in the destination choice component ( $ORNCH$ ) is proposed below. In this alternative method, the decision to migrate to TMA is not sequential such that push from the origin is followed by the pull to the destination. In other words, the decision to migrate and where to migrate is considered to be “simultaneous”.

In such a case, the numerator of the age-specific migration rates (ASMR) is the number of out-migrants to TMA ( $OM_{i,j=TMA}$ ), instead of being only the number of out-migrants ( $OM_i$ ) as in the earlier case (see eqs. 4.25 and 3.7). In a way, the ASMR in this case, is interaction-multiplication of the ASMR of the previous sections (see eq. 3.7) with the destination choice ( $CHOICE$ ). In such a case, we have only two, instead of three, components: (1) mobility to TMA ( $ORMOB_{i,j=TMA}$ ); and (2) the age structure ( $ORAST_i$ ).

$$OMR_{i,j=TMA,a} = (ASMR_{i,j=TMA,a}) * (PPOP_{i,a}) \quad (4.23)$$

$$OMR_{i,j=TMA,a} = ((OM_{i,j=TMA,a}) / (POP_i)) * ((POP_{i,a}) / (POP_i)) \quad (4.24)$$

$$ASMR_{i,j=TMA,a} = ((OM_{i,j=TMA,a}) / (POP_i)) = (OM_{i,a} / POP_{i,a}) * (OM_{i,j=TMA,a} / OM_{i,a}) \quad (4.25)$$

The rest of the method would be same as it is in the first additive method (see eqs. 4.8 - 4.11).

$$ORMOB_{i,j=TMA} = \sum(1/m) * (ASMR_{i,j=TMA,a}) = (1/m) * (\sum ASMR_{i,j=TMA,a}) \quad (4.26)$$

$$ORMOB_{i,,j=TMA,a} = (1/m) (ASMR_{i,j=TMA,a}) \quad (4.27)$$

$$ORAST_i = (OMR_{i,j=TMA}) - (ORMOB_{i,j=TMA}) = (OMR_{i,j=TMA}) - ((1/m) * (\sum ASMR_{i,,j=TMA,a})) \quad (4.28)$$

$$ORAST_{i,a} = (OMR_{i,j=TMA,a}) - (ORMOB_{i,j=TMA,a}) = (OMR_{i,,j=TMA,a}) - ((1/m) / ASMR_{i,,j=TMA,a}) \quad (4.28a)$$

## 5. Additive Form: In-, Out-, and Net Migration to/from TMA

In this study, Tokyo Metropolitan Area (TMA) consists of 4 prefectures out of total of 47: Tokyo-to, Chiba, Saitama, and Kanagawa prefectures. During 1985-90, TMA had a population of 29.5 million (29,527,317) which comprised 27.4% of all Japanese population (116,380,762). TMA received about one-third (32.87%) of all out-migrants from 43 prefectures. Its in-, out-, and net migration rates were 6.66%, 4.40%, and 2.26%, respectively.

In this section, the size of the three components of the migration rates to TMA (ie, ORMOB, ORAST, ORNCH) will be estimated and assessed for the in-, out-, and net migration to/from TMA. As will be discussed below, in each of the above stated three migration rates to/from TMA, both in terms of rates and the number of migrants, *mobility* component (ORMOB, and OMMOB) is the largest, and the age structure component (ORAST, and OMAST) is the smallest.

### 5.1. In-migration to TMA

The in-migration to TMA will be equal to the sum of out-migration from the 43 prefectures. Among 5,986,596 out-migrants from 43 prefectures (with total population of 86,853,446), 1,967,624 of them went to TMA (see Table 2). The shares of the different components in 1,967,624 out-migrants, was as follows with the *mobility* component being the largest: 5,492,206 (mobility component,  $\sum OMMOB_i$ ); 494,390 (age structure component,  $\sum OMAST_i$ ); and 4,018,972 (those who did not choose TMA,  $\sum OMNCH_{i,j=TMA}$ ).

$$OM_{j=TMA} = 1,967,624 = 5,492,206 + 494,390 - 4,018,972 \quad (5.1)$$

The weighted mean for the 43 prefectures for out-migration rate to TMA, and the three components are 2.26%, 6.32%, 0.57%, and 4.63%, respectively

(see eq. 4.16a) Among the three components, similar to the above stated case for the number of migrants, the *mobility* component (ORMOB) is the largest whereas the age structure component is the smallest (ORAST).

$$\text{OMR}_{i,j=\text{TMA}} = 2.26 = 6.32 + 0.57 - 4.63 \quad (5.2)$$

As for the TMA, it had the above stated 1,967,624 out-migrants from 43 prefectures as its in-migrants (see eq. 5.1). Its respective in-migration rate and the rates for the three components of mobility, age structure, and destination choice were as follows: 6.66%, 18.60%, 1.67%, 13.61% (see Table 2).

$$\text{IMR}_{j=\text{TMA}} = 6.66 = 18.60 + 1.67 - 13.61 \quad (5.3)$$

When the findings are desegregated, clearly, the ages 20-24 (followed by ages 15-19, and 25-29) have the largest values in the rates for in-migration to TMA which decrease in the older cohorts (see Table 2; and Figure 2). In ages 40-44, ORNCH is larger than ORMOB; and in ages 35-39, the two are almost equal. This is because of the decrease in the mobility component (ORMOB) in the older ages rather than the increase in the destination choice component (ORNCH).

$$\text{IMR}_{j=\text{TMA},a=20-24} = 0.0202 = 0.0422 + 0.0058 - 0.0278 \quad (5.4)$$

$$\text{IM}_{j=\text{TMA},a=20-24} = 597,353 = 1,244,862 + 172,166 - 819,675$$

$$\text{IMR}_{j=\text{TMA},a=35-39} = 0.0045 = 0.0123 + 0.0037 - 0.0116 \quad (5.5)$$

$$\text{IM}_{j=\text{TMA},a=35-39} = 132,275 = 364,405 + 109,186 - 341,316$$

$$\text{IMR}_{j=\text{TMA},a=40-44} = 0.0040 = 0.0089 + 0.0048 - 0.0097 \quad (5.6)$$

$$\text{IM}_{j=\text{TMA},a=40-44} = 118,230 = 264,950 + 140,395 - 287,115$$

## 5.2. Out-migration from TMA

TMA has 1,300,417 out-migrants to 43 prefectures, and its out-migration rate is 4.40%. Since “all” the out-migrants from TMA will all go to the 43 prefectures, there are only two components: mobility component (ORMOB), and age structure component (ORAST). The share of the two components in the 1,300,417 out-migrants is 701,979 for mobility component, and 598,437 for age structure component (see Table 2; and Figure 3). The respective rates are 0.044, 0.0238, and 0.0203<sup>14</sup>. Although the *mobility* component is larger

than the age composition component, the difference is not as large as it is for the in-migration to TMA (see eqs. 5.1 and 5.3).

$$OM_{i=TMA} = 1,300,417 = 701,979 + 598,437 \quad (5.7)$$

$$OMR_{i=TMA} = 0.044 = 0.0238 + 0.0203 \quad (5.8)$$

For every cohort, similar to the in-migration to TMA, the largest component is always the *mobility* component (ORMOB). However, there are very significant differences between in-migration to, and out-migration from TMA. In the in-migration to TMA, the largest rates is for the mobility component (ORMOB<sub>i</sub>) which peak in the ages 20-24, and is followed by 15-19 and 25-29, and gets smaller in each successive cohort (see Table 2; and Figure 3). On the other hand, in the out-migration from TMA, the respective peak is observed in older age group of 25-29, and is followed by 30-34, 35-39, 20-24, 40-44, and 15-19--such that the ages 20-24 and 15-19 are only fourth and sixth largest.

$$OMR_{j=TMA, a=15-19} = 0.0020 = 0.0013 + 0.0007 \quad (5.9)$$

$$OM_{j=TMA, a=15-19} = 59,394 = 39,566 + 19,828$$

$$OMR_{j=TMA, a=25-29} = 0.0094 = 0.0068 + 0.0026 \quad (5.10)$$

$$OM_{j=TMA, a=25-29} = 277,470 = 201,091 + 76,379$$

$$OMR_{j=TMA, a=30-34} = 0.0059 = 0.0050 + 0.0009 \quad (5.11)$$

$$OM_{j=TMA, a=30-34} = 174,921 = 147,488 + 27,433$$

### 5.3. Net migration to TMA

TMA received 667,207 net migrants and had net migration rate of 2.26 %.

The shares of the three components were 4,790,227 (0.1622%) for mobility component (ORMOB); -104,047 (-0.0035%) for age structure component (ORAST)<sup>15</sup>; and 4,018,972 (0.1361%) for destination component, ie, those who did not prefer to go to TMA (ORNCH) (see Table 2; and Figure 4).

$$NM_{j=TMA} = 667,207 = 4,790,227 + (-104,047) - 4,018,972 \quad (5.12)$$

$$NMR_{j=TMA} = 0.0226 = 0.1622 + (-0.0035) - 0.1361 \quad (5.13)$$

When the rates are desegregated according to age groups, the peak occurs, similar to the in-migration rates to TMA, in the ages 20-24, and is followed by the age 15-19. In all the

three cohorts between 25-39, TMA has net out-migration which indicates the return migration in the older ages (see Table 2; and Figure 4).

The other distinctive characteristic is that the mobility component (ORMOB) is higher than the destination component (ORNCH) only in the age groups of 15-19 and 20-24. In all other ages, mobility component (ORMOB) is less than the destination component (ORNCH). This is because of the fact that in the older cohorts, decrease in the mobility component is more in the in-migrants than in the out-migrants. Consequently, in the net migration, the decrease in the mobility component is large.

$$NOM_{a=15-19} = 208,620 = 479,648 + 196,134 - 467,162 \quad (5.14)$$

$$NOM_{a=20-24} = 458,022 = 1,153,186 + 124,511 - 819,675 \quad (5.15)$$

$$NOM_{a=25-29} = -10,970 = 580,639 + 6,281 - 597,890 \quad (5.16)$$

$$NOM_{a=40-44} = 7,022 = 196,476 + 97,661 - 287,115 \quad (5.17)$$

## 6. Comparisons Between Prefectures

If the comparable data for two or more periods was available, each prefecture would be compared with its respective value in a previous period. However, as stated earlier, because of data availability, to compare the two five-year periods was impossible. Therefore, the prefectures are compared during the same period.

In our research, which this paper is only a part of, the study of in-, out-, and net migration to Tokyo M.A. is carried out in terms of only as “out-migration”. Therefore, the comparisons between different prefectures is carried out in terms of only as out-migration from the 43 prefectures to TMA. This is because the in-migration to TMA is in terms of summation of out-migrants from 43 prefectures; and since out-migration from TMA involves only one case, ie, TMA.

For the purpose of comparisons, alternative reference points can be considered. For example, we could consider a prefecture with median value for out-migration rate to TMA; or a synthetic prefecture with values of the rates taken as the mean or median; or a prefecture with minimum or maximum out-migration rate to TMA, etc. For example, if we took the prefecture of Yamaguchi (i=35) which has the median out-migration rate to TMA, we could see those problematic prefectures with higher than median out-migration rate, and indicate which one of the components makes the difference.

As the point of reference changes, the differences between the three components of out-migration rates would also “change”. Therefore, interpretation should be limited to the special point of reference chosen, and should not be generalized. In this study, for the purpose of demonstration, the point of reference for the comparisons below, is Aomori prefecture ( $i=2$ ) which has the maximum out-migration rate to TMA ( $OMR_{i,j=TMA}= 4.715$ ).

We can find the differences by subtracting the values of prefectures from the values for Aomori. The comparison can be done between Aomori ( $i=2$ ) and **(a)** any other prefecture, such as Wakayama ( $i=30$ ) which has the minimum out-migration rate to TMA ( $OMR_{i,j=TMA}= 0.898$ ); or **(b)** all other prefectures where the differences are added. Furthermore, differences can be estimated as **(i)** differences by subtracting the values of the prefectures from the respective values for Aomori (horizontal comparison); and **(ii)** as well as the percentage change, ie, differences as percentage of the values for Aomori (vertical comparison).

**(a.i)** For all ages in aggregate, and for rates and number of migrants, the largest difference between the two prefectures of Aomori and Wakayama is in the *mobility* component (ORMOB, and OMMOB), followed by the *destination choice* component (ORNCH, and OMNCH).

$$OMR_{i,j=TMA} = ORMOB_i + ORAST_i - ORNCH_{i,j=TMA} \quad (6.1)$$

$$OMR_{i=2,j=TMA} = 4.715 = 8.39 + 0.821 - 4.499 \quad (6.2)$$

$$OMR_{i=30,j=TMA} = 0.898 = 5.91 + 0.478 - 5.486 \quad (6.3)$$

$$DOMR = DORMOB + DORAST - DORNCH \quad (6.4)$$

$$DOMR = (ORMOB_{i=2} - ORMOB_{i=30}) + (ORAST_{i=2} - ORAST_{i=30}) - \quad (6.5)$$

$$(ORNCH_{i=2,j=TMA} - ORNCH_{i=30,j=TMA})$$

$$DOMR = 3.816 = 2.486 + 0.343 - 0.988 \quad (6.6)$$

$$DOM = DOMMOB + DOMAST - DOMNCH \quad (6.7)$$

$$DOM = [((ORMOB_{i=2}) * (POP_{i=2})) - ((ORMOB_{i=30}) * (POP_{i=30}))] + \quad (6.8)$$

$$[((ORAST_{i=2}) * (POP_{i=2})) - ((ORAST_{i=30}) * (POP_{i=30}))] -$$

$$[((ORNCH_{i=2,j=TMA}) * (POP_{i=2})) - ((ORNCH_{i=30,j=TMA}) * (POP_{i=30}))]$$

$$DOM = 58,432 = 59,795 + 6,877 - 8,240 \quad (6.9)$$

**(a.ii)** However, in terms of the differences as “percentage” change from the values for Aomori, both for the rates and number of out-migrants, *age structure* component (ORAST,

and OMAST) is the largest, and the mobility component (ORMOB, and OMMOB) is the second largest.

$$\text{DOMR} / \text{OMR}_{i=2} = (3.816/4.715) = 0.809 \quad (6.10)$$

$$\text{DORMOB}/\text{ORMOB}_{i=2} = 2.486/8.39 = 0.296 \quad (6.11)$$

$$\text{DORAST}/\text{ORAST}_{i=2} = 0.342/0.821 = 0.418 \quad (6.12)$$

$$\text{DORNCH}/\text{ORNCH}_{i=2} = 0.988/4.499 = 0.219 \quad (6.14)$$

$$\text{DOM} = \text{DOM}/\text{OM}_{i=2} = 58,432/67,654 = 0.864 \quad (6.15)$$

$$\text{DOMMOB}/\text{OMMOB}_{i=2} = 59,795/120,423 = 0.497 \quad (6.16)$$

$$\text{DOMAST}/\text{OMAST}_{i=2} = 6,877/11,784 = 0.584 \quad (6.17)$$

$$\text{DOMNCH}/\text{OMNCH}_{i=2} = 8,240/64,553 = 0.128 \quad (6.18)$$

**(b.i)** When all the differences between Aomori and the rest of the 42 prefectures are summed, the findings are not same between the rates and the number of migrants, because of the differing size of the population of each of the prefectures which makes it difficult to interpret. Therefore, the comparison below will be limited to the rates. Our findings about the rates as will be discussed below (b.i and b.ii), are “similar” to our previous findings above (a.i and a.ii) about the comparison between Aomori and Wakayama ( $i=30$ ).

When the differences between Aomori ( $i=2$ ) and the 42 prefectures are summed, the largest is for the *mobility* component (ORMOB). The second largest is for the destination choice (ORNCH) for ages 20-24 and 25-29; and for the age component (ORAST) for the rest of the cohorts of ages 30 and above.

$$\text{DOMR} = \sum (\text{OMR}_{i=2} - \text{OMR}_i) = 107.68 \quad (6.19)$$

$$\text{DORMOB} = \sum (\text{ORMOB}_{i=2} - \text{ORMOB}_i) = 85.61 \quad (6.20)$$

$$\text{DORAST} = \sum (\text{ORAST}_{i=2} - \text{ORAST}_i) = 13.04 \quad (6.21)$$

$$\text{DORNCH} = \sum (\text{ORNCH}_{i=2} - \text{ORNCH}_i) = 9.03 \quad (6.22)$$

**(b.ii)** The respective differences in rates as “percentage” change from the values of Aomori ( $i=2$ ) is largest for the *age structure* component (ORAST), followed by the mobility component (ORMOB).

$$\text{DOMR}/\text{DOMR}_{i=2} = 0.531 \quad (6.23)$$

$$\text{DORMOB}/\text{ORMOB}_{i=2} = 0.237 \quad (6.24)$$

$$\text{DORAST}/\text{ORAST}_{i=2} = 0.369 \quad (6.25)$$

$$\text{DORNCH}/\text{ORNCH}_{i=2} = 0.0467 \quad (6.26)$$



## 7. Conclusion

In order to assess the sizes of the three components of mobility, age structure, and destination choice, in the in-, out-, and net-migration to/from Tokyo Metropolitan Area (TMA), multiplicative and additive methods are proposed. The values of the three components in the two methods are closely associated with the correlation coefficient between of 0.82 and 0.90. Due to the problems in the multiplicative method, in obtaining summations of each individual component over different cohorts, additive method was chosen in the assessment of different sizes of the three components, and were applied in the subsequent analyses.

For each of the 43 prefectures which send out-migrants to TMA, and for all ages combined, the largest was the *mobility* component followed by the destination choice component. When the results are desegregated according to the age groups, there were some exceptional prefectures due to the regional differences in their migration characteristics.

Likewise, as for the migration to/from TMA, *mobility* component was the largest. However, for the older ages (such as 40-44 for in-migration, and 25 and above for net migration) the mobility component was less than the destination choice component. This was because of the relatively larger decreases in the in-migration rates to TMA, in the mobility component in the older ages.

There were significant differences in the peak ages. In the in-migration rates to TMA, the peak age was at 20-24 which was followed by the ages 15-19 and 25-29. However, in the out migration from TMA, the peak age was in the older cohorts, ie, in ages 25-29; whereas, the young ages of 20-24 and 15-19 (which were the peak ages for in-migration) were only the fourth and sixth largest. As for the net migration, the age pattern was similar to the in-migration rates. In the older ages such as between 25-39, net migration was negative which indicated the return migration in the older cohorts.

Differences between prefectures are obtained only for the period of 1985-90 due to data availability problems. Aomori prefecture (which had the largest out-migration rate to TMA) was the point of reference for comparisons. The comparison was with (a) the Wakayama prefecture (which had the minimum out-migration rate to TMA), and with (b) all other 42 prefectures in aggregate (where the differences are added). Comparisons are carried out in terms of (i) “subtracting” the values of the prefectures from the respective values for Aomori;

and (ii) as “percentage” changes, ie, the differences as percentages of the values for Aomori. For the first type of comparison (i), the largest difference was in the *mobility* component. Whereas for the second type of comparison (ii), largest difference was in the *age structure* component.

Future improvements of the method is suggested in the destination component. Furthermore, a possible alternative additive method is proposed where the out-migration rates to TMA is not in a sequential manner, but where the decision to migrate and where to migrate is simultaneous.

**Acknowledgment.** This research is carried out during the time while I was a Japan Foundation Fellow at the University of Hokkaido, Graduate School of Environment Earth Sciences, during 9/1997-8/1998. I am very grateful to Professor Dr. E. Yamamura my host professor; and to Professor Dr David Plane for his very useful comments.

#### ENDNOTES

(1) Japanese migration data for five-year periods are incomparable because of the differences in the definition of migration. Although the annual migration data does not have this problem, it does not have the information concerning the age of the migrants. Among different available time periods, 1985-90 period is selected for this study, because the definition of migrants is similar to the definition in the Turkish migration data. This is important because the author plans to compare in the future the findings of this study with the findings based on the migration to/from Istanbul Metropolitan Area.

(2) Instead of the mid-period, 1985 population at the time of 1990 Population Census (ie., those who survived until 1990) would be a better measure as it would represent “population at risk” and would facilitate the related analyses, such as Markov chain. However, in this study, the mid-period population is preferred because the author plans in the subsequent studies, to explain, to account for the out-migration rates, and the migration refers to the entire period of 1985-90. I am indebted to Professor Dr D. Plane for his comments on this point.

(3) Denominator in the  $ASMR_{i,a}$ ,  $PPOP_{i,a}$ , and  $CHOICE_{i,a}$  are  $POP_{i,a}$ ,  $POP_i$ , and  $OM_i$ , respectively.

(4) As an alternative method, we could have taken national averages (weighted mean) for the proportion of population in each cohort, instead of equal proportions as we did in this study. In such a case, it would better facilitate for us to see the regional differences from the national average. However, shortcoming of such an approach, would arise when we compare two time periods--such that we would be comparing the differences from the national average, and not the differences between periods.

(5) Needless to say the values of the correlation coefficients between  $ORMOB_{i,a}$  and  $ASMR_{i,a}$  are always 1.0.

(6) One shortcoming of this method would be that the results of studies only with equal number of cohorts ( $m$ ) can be compared. However, the results of unequal number of cohorts can be very easily adjusted by a simple arithmetical operation. Another alternative would be to overcome this shortcoming would be to consider only the out-migrants in the six cohorts in the age groups between 15-44 which account about 80% of all out-migrants. However, this in return would exclude the old ages which may become problematic in countries where the retirement migration becomes significant in the future.

(7) The “other” ages in which the ages between 5-14, and 45 and above are lumped together due to practical reasons, have negative sign for all 43 prefectures. Because of the aggregate characteristic of the “other” ages, for the rest of the paper, the comparison of the cohorts are limited to ages 15-44.

(8) In prefectures of Akita ( $i=5$ ), Yamagata ( $i=6$ ), Tottori ( $i=31$ ), Shimane ( $i=32$ ), Kochi ( $i=39$ ), Miyazaki ( $i=45$ ), Kagoshima ( $i=46$ ).

(9) In prefectures of Iwate ( $i=3$ ), Akita ( $i=5$ ), Yamagata ( $i=6$ ), Niigata ( $i=15$ ), Toyoma ( $i=16$ ), Nagano ( $i=20$ ), Tottori ( $i=31$ ), Shimane ( $i=32$ ), Yamaguchi ( $i=35$ ), Tokushima ( $i=36$ ),

Kagawa (i=37), Ehime (i=38), Kochi (i=39), Nagasaki (i=42), Oita (i=44), Miyazaki (i=45), Kagoshima (I=46).

(10) In prefectures of Hokkaido (i=1), Ibaraki (i=8), Tochigi (i=9), Gumma (i=10), Niigata (i=15), Yamanashi (i=19), and Nagano (i=20).

(11) Such as prefectures of Saga (i=41), Nagasaki (i=42), Oita (i=44), Miyazaki (i=45), Kagoshima (I=46).

(12) For ages 15-19: in prefectures i= 17,18, 21, 23-39, 41-45. For ages 20-24: in prefectures i= 26-27, 29. For ages 35-39: in prefectures i= 18, 21, 25,26, 29-32, 36-46. For ages 40-44: in prefectures i= 16-18, 21, 23-46.

(13) In prefectures of Ibaraki (i=8), Tochigi (i=9), Gumma (i=10), and Yamanashi (i=19).

(14) Sum of  $\sum ASMR_a$  of out-migrants from TMA is 0.404115. Therefore, the value of  $\sum ORMOB_a$  is 0.023771 (= (1/17) \* (0.404115)). Likewise, the value of  $\sum ORAST_a$  is 0.020269 (= 0.04404115 - 0.023771).

(15) The reason why the sign of age structure component (ORAST) is negative is because of the “other” ages which is the only age group which has the negative sign (see endnote 7).

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Table 1. Unweighted Arithmetic Mean Rates for the Three Components in the Out-migration Rates to Tokyo M. A.

	Rates		Rates		Rates
ORAST <sup>1</sup>	0.005	ORAST25-29	0.043	ORAST40-44	0.143
ORMOB <sup>1</sup>	0.064	ORMOB25-29	0.882	ORMOB40-44	0.289
OMR <sub>i</sub> <sup>1</sup>	0.069	OMR25-29 <sub>i</sub>	0.925	OMR40-44 <sub>i</sub>	0.432
ORNCH <sup>1</sup>	0.048	ORNCH25-29	0.645	ORNCH40-44	0.315
OMR <sub>i,j</sub> <sup>1</sup>	0.022	OMR25-29 <sub>i,j</sub>	0.279	OMR40-44 <sub>i,j</sub>	0.117
ORAST15-19	0.273	ORAST30-34	0.058	ORASTOT <sup>2</sup>	-0.258
ORMOB15-19	0.703	ORMOB30-34	0.578	ORMOBOT <sup>2</sup>	1.865
OMR15-19 <sub>i</sub>	0.976	OMR30-34 <sub>i</sub>	0.636	OMROT <sub>i</sub> <sup>2</sup>	1.607
ORNCH15-19	0.645	ORNCH30-34	0.455	ORNCH <sup>2</sup>	1.187
OMR15-19 <sub>i,j</sub>	0.332	OMR30-34 <sub>i,j</sub>	0.181	OMROT <sub>i,j</sub> <sup>2</sup>	0.421
ORAST20-24	0.141	ORAST35-39	0.117		
ORMOB20-24	1.695	ORMOB35-39	0.388		
OMR20-24 <sub>i</sub>	1.836	OMR35-39 <sub>i</sub>	0.505		

ORNCH20-24	1.091	ORNCH35-39	0.370
OMR20-24 <sub>i,j</sub>	0.745	OMR35-39 <sub>i,j</sub>	0.135

Source: Compiled from Statistics Bureau (1993), *1990 Population Census of Japan*, Vol. 7.

Notes: ORAST is “age structure” component; ORMOB is “mobility” component; OMR<sub>i</sub> is “gross out-migration rate”; ORNCH is “destination choice” component; OMR<sub>i,j</sub> is “out-migration rate to Tokyo M.A.”; Tokyo M.A. consists of four prefectures: Tokyo-to, Saitama, Chiba, and Kanagawa; (1) All ages combined; (2) “Other” ages which include ages 5-14, and 45 and above. For the sum of number of migrants, see Table 2.

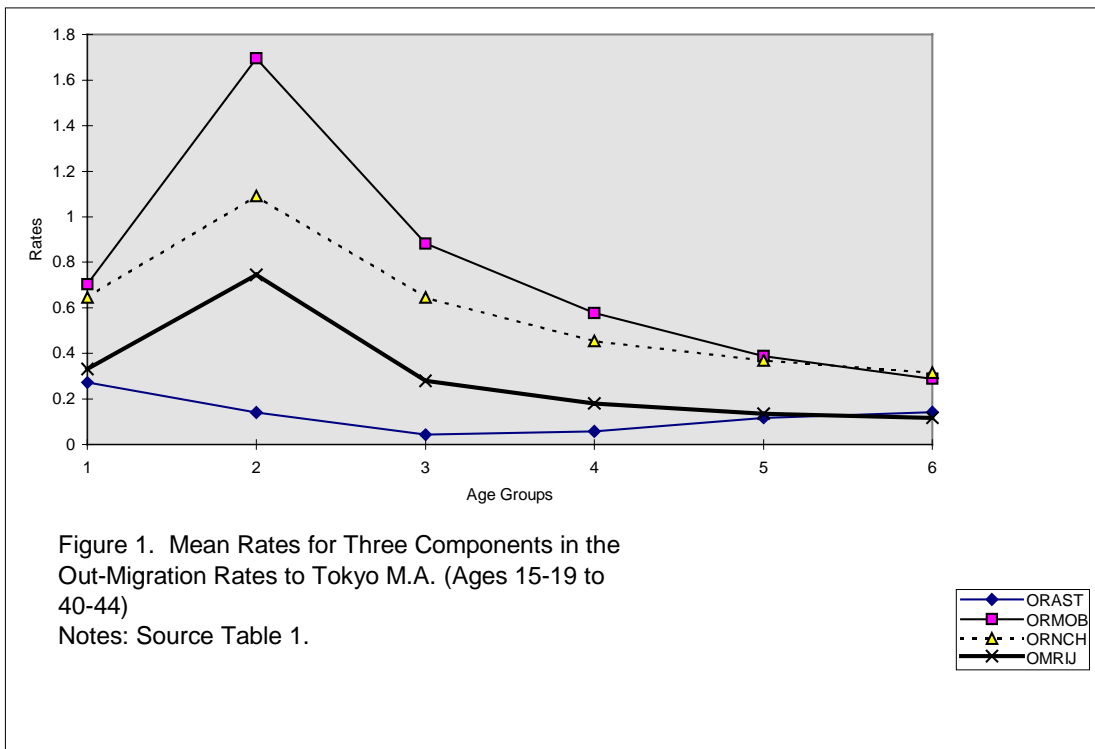
Table 2. Rates for the Three Components in the In-, Out-, and Net Migration to/from Tokyo M.A.

	Rates			Nos. of Migrants (in 1,000)		
	In-mig.	Out-mig.	Net-mig	In-mig.	Out-mig.	Net-mig.
ORAST <sup>1</sup>	0.0167	0.0203	-0.0035	494	598	-104
ORMOB <sup>1</sup>	0.1860	0.0238	0.1622	5,492	702	4,790
OMR <sub>i</sub> <sup>1</sup>	0.2027	0.0441	0.1587	5,987	1,300	4,686
ORNCH <sup>1</sup>	0.1361		0.1361	4,019		4,019
OMR <sub>i,j</sub> <sup>1</sup>	0.0666	0.0441	0.0226	1,968	1,300	667
ORAST15-19	0.0073	0.0007	0.0066	216	20	196
ORMOB15-19	0.0176	0.0013	0.0162	519	40	480
OMR15-19	0.0248	0.0020	0.0228	735	59	676
ORNCH15-19	0.0157		0.0157	467		467
OMR15-19 <sub>i,j</sub>	0.0091	0.0020	0.0071	268	59	209
ORAST20-24	0.0058	0.0016	0.0042	172	48	125
ORMOB20-24	0.0422	0.0031	0.0391	1,245	92	1,153
OMR20-24 <sub>i</sub>	0.0480	0.0047	0.0433	1,417	139	1,278
ORNCH20-24	0.0278		0.0278	820		820
OMR20-24 <sub>i,j</sub>	0.0202	0.0047	0.0155	597	139	458
ORAST25-29	0.0028	0.0026	0.0002	83	76	6
ORMOB25-29	0.0265	0.0068	0.0197	782	201	581
OMR25-29 <sub>i</sub>	0.0293	0.0094	0.0199	864	277	587
ORNCH25-29	0.0202		0.0202	598		598
OMR25-29 <sub>i,j</sub>	0.0090	0.0094	-0.0004	267	277	-11
ORAST30-34	0.0019	0.0009	0.0010	57	27	30
ORMOB30-34	0.0181	0.0050	0.0132	536	147	388
OMR30-34 <sub>i,j</sub>	0.0201	0.0059	0.0142	593	175	418
ORNCH30-34	0.0142		0.0142	419		419
OMR30-34 <sub>i,j</sub>	0.0059	0.0059	-0.00003	174	175	-1
ORAST35-39	0.0037	0.0012	0.0025	109	34	75
ORMOB35-39	0.0123	0.0036	0.0087	364	107	258
OMR35-39 <sub>i</sub>	0.0160	0.0048	0.0113	474	141	333
ORNCH35-39	0.0116		0.0116	341		341
OMR35-39 <sub>i,j</sub>	0.0045	0.0048	-0.0003	132	141	-9
ORAST40-44	0.0048	0.0014	0.0033	140	43	98
ORMOB40-44	0.0090	0.0023	0.0067	265	68	196
OMR40-44 <sub>i</sub>	0.0137	0.0038	0.0100	405	111	294

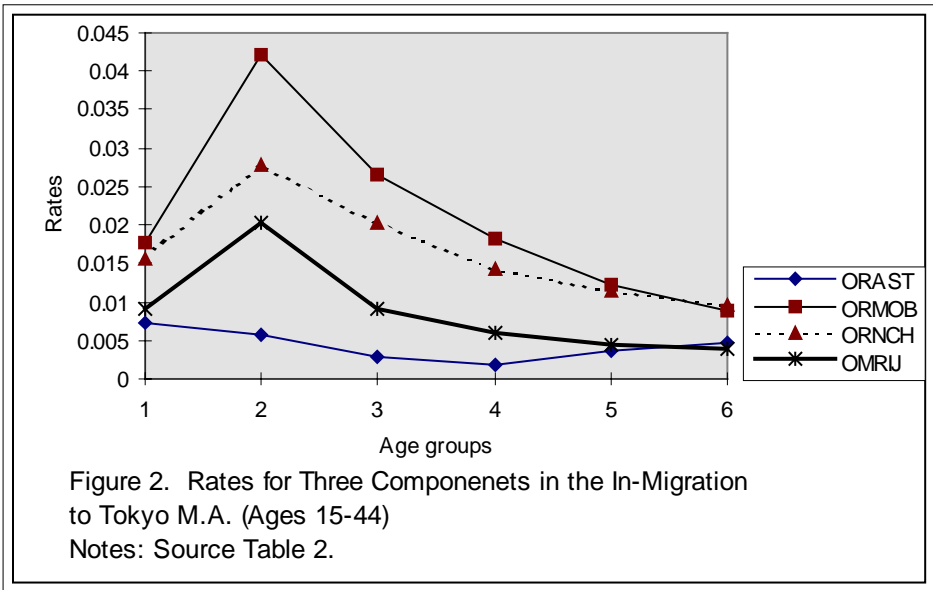
ORNCH40-44	0.0097		0.0097	287		287
OMR40-44 <sub>i,j</sub>	0.0040	0.0038	0.0002	118	111	7
ORASTOT <sup>2</sup>	-0.0096	0.0119	-0.0215	-283	350	-634
ORMOBOT <sup>2</sup>	0.0603	0.0016	0.0587	1,781	47	1,734
OMROT <sub>i</sub> <sup>2</sup>	0.0507	0.0135	0.0373	1,498	397	1,101
ORNCHOT <sup>2</sup>	0.0368		0.0368	1,087		1,087
OMROT <sub>i,j</sub> <sup>2</sup>	0.0139	0.0135	0.0005	411	397	14

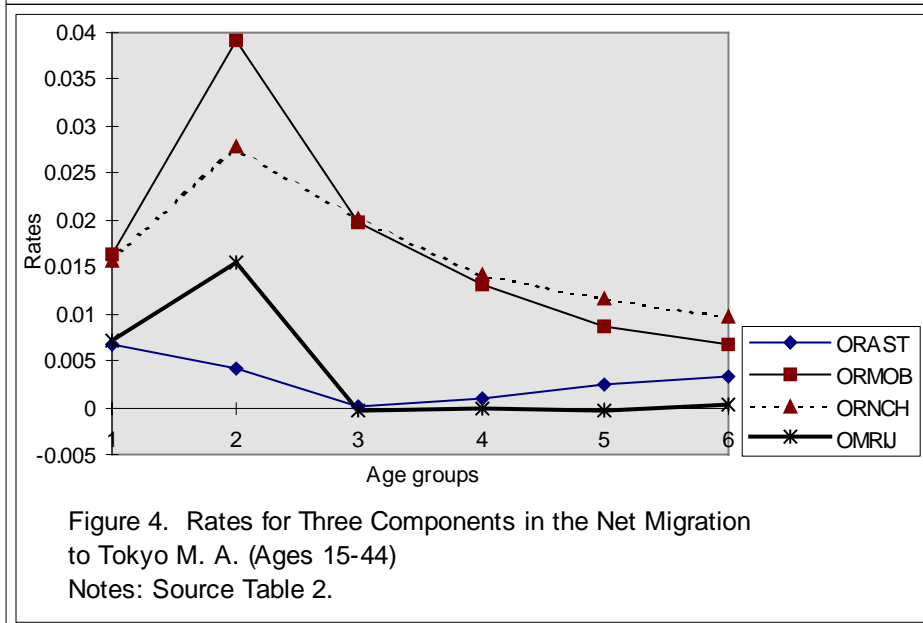
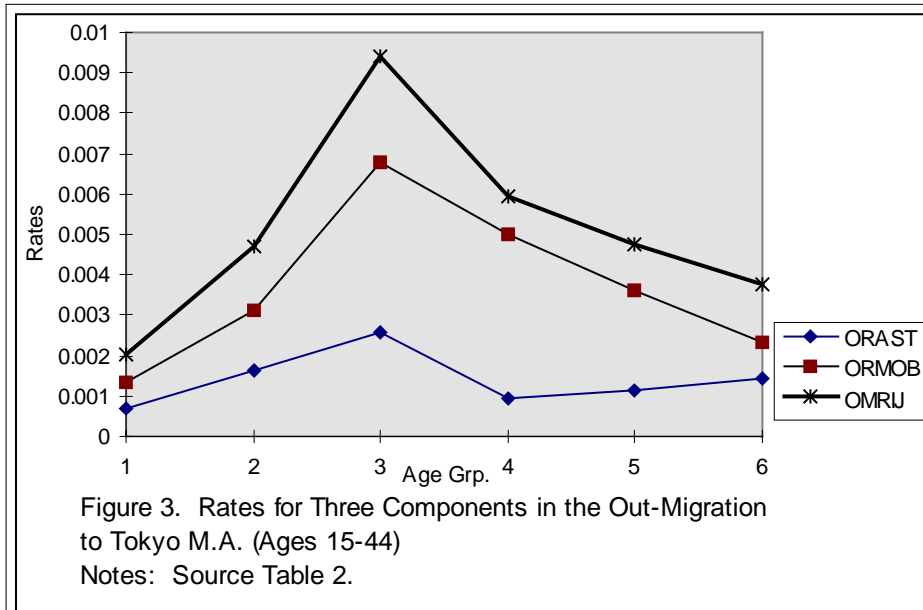
Source: Compiled from Statistics Bureau (1993), *1990 Population Census of Japan*, Vol. 7.

Notes: ORAST is “age structure” component; ORMOB is “mobility” component; OMR<sub>i</sub> is “gross migration”; ORNCH is “destination choice” component; OMR<sub>i,j</sub> is “migration to/from Tokyo M.A.”; Tokyo M.A. consists of four prefectures: Tokyo-to, Saitama, Chiba, and Kanagawa. (1) All ages combined; (2) “Other” ages which include ages 5-14, and 45 and above.









### ABSTRACT

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### Multiplicative and Additive Methods for the Decomposition of the Migration Rates to/from Tokyo M.A, 1985-90

The purpose of this paper is to study the sizes of each of the three components of the migration rates: ie, (1) mobility; (2) age structure; and (3) destination choice component (ie., preference of out-migrants to Tokyo Metropolitan Area (TMA)). Our purpose is to find out

which one of these three components was the largest component in the change in in-, out-, and net-migration to/from TMA.

Due to the problems of data availability, the comparisons could not be carried out between different time periods. Instead, the differences between the prefectures during the 1985-90 period were assessed.

The multiplicative and additive methods are proposed. Due to the problems in the multiplicative method, in obtaining summations of each individual component over different cohorts, additive method was chosen in the assessment of different sizes of the above stated three components .

For all of the 43 prefectures which send out-migrants to TMA, and for all ages combined, the largest was the *mobility* component followed by the destination choice component. Exceptional cases in certain age groups are discussed.

Likewise, as for the migration to/from TMA, *mobility* component was the largest. However, for the older ages (such as 40-44 for in-migration, and 25 and above for out-migration) the mobility component was less than the destination component. This was because of the relatively large decreases in the mobility component in the older ages. There were significant differences in the peak ages in the in-, out, and net migration to TMA. The return migration in the older ages was clearly evident.

Differences between the prefectures were obtained with Aomori prefecture (which has the largest out-migration rate to TMA) being the reference point.

In the differences obtained by “subtracting”, *mobility* component; whereas in the “percentage change”, *age structure* component were the largest. Future improvements of the method is suggested in the destination component. Furthermore, a possible alternative additive method is proposed where the out-migration to TMA is not in a sequential manner, but where the decision to migrate and where to migrate is simultaneous.

