Differentiating In and Outflows: A Multiple Discriminant Analysis

- A Case in the Seoul Metropolitan Area -

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< Abstract >

Central city and suburban contrasts are closely related to housing careers. Their choices of location and dwelling are affected by individual preferences, socio-economic characteristics and life cycle. In mega-metropolitan region, mobility shifts between the central city area and suburban areas have been regarded as trade-offs between local housing opportunity and job accessibility. However, individuals’ preferences vary and they are socio-demographically diverse. Existing studies have rarely taken personal characteristics and aspirations into consideration in explaining suburbanisation phenomenon. Using a multiple discriminant analysis this paper attempts to socio-demographically distinguish between-groups moving for different reasons between suburban ring and central city. It found that both family life cycle and housing career stage clearly distinguish various mover groups. One must take these two factors into serious consideration when designing a socio-demographically well integrated new town in the future.

Keywords: discriminant analysis, residential mobility, suburbanisation, housing careers and life cycle

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I. Introduction

Some studies on the geographic patterns of mobility have focused on structural changes in demography, housing and labour market and government policy, while others have been particularly concerned with their moving behaviour. The factors that have impacted on population movements vary and in the contemporary period they include the impact of government policy, economic restructuring and the suburbanisation of manufacturing, changing demographies and changes in markets for housing and labour, together with households preferences for particular residential environments. These multi-faceted explanations for population movement at the macro level do of course reflect the widely published outcomes of empirical studies into residential mobility. Some urban analysts focused on the impact of changing labour market structure on residential relocation (Cho et al. 2000; Park 1993) and others emphasised the impact of new residential development on residential relocation (Lim et al. 2002). Notwithstanding the macro level of influences on residential relocation process concerning the government population decentralisation policy, very little is known about links between suburbanisation and residential choice behaviours; such as mover’s socio demographic characteristics and motivations to move, as related to environmental amenity, housing and job opportunities. It is this context that the analysis presented in this paper has been developed.

II. Literature Review: Suburbanisation

In many countries, problems associated with urban concentration and agglomeration are often the results of government’s economic and housing policy that has a significant effect on accelerating urbanization, and thereby, the urban population concentration process. Such a policy as developing large suburban or new satellite towns (Cervero 1995), or special eco-
nomic development zones (Lo and Marcotullio 2000) has the potential to reverse patterns of over-concentration in metropolitan areas. Suburbanisation refers to the expansion of suburban or peripheral settlements, often leaving a lower density of residents in the core areas of the city. Suburbanisation is an example of capital switching from the primary to the secondary urban space, emphasizing the importance of the suburbs in absorbing economic surplus as well as providing increased housing opportunities (Walker 1981).

Motivations for migratory movements tied to suburbanisation are largely linked to the characteristics of the desired habitation: a single-family home in a ‘green’ area, and property ownership (Van Hecke and Savenberg 2002). Other reasons include relocation in an attempt to acquire a more desirable bundle of local public goods (Graves 2003). The ability of households to move to outlying areas is often a function of factors such as age, family structure, and socio-economic levels. In particular, household income is an important factor; those who are living in outlying areas are more likely to be affluent. Some studies have shown that the majority of households relocating from city core to suburban areas have one or more children; more than one half have university degrees and one third occupy executive positions (Herfurt 1996).

In an early study, Grigsby et al. (1977) argued that while suburban development is a natural response to growing populations, processes of urban consolidation and improved efficiency of land use remain crucial to providing accommodation opportunities in core areas. In a study of the relationship between different settlement forms and socio-economic mechanisms of evolving decentralisation inside a city region, Vartiainen (1992) found that the residential relocation from the city region to the surrounding municipalities are mediated mainly by new single family housing construction. Dieleman et al (2000) also emphasised housing opportunity in residential relocation. He focused on the interplay between the relocation process and the structure of metropolitan housing markets. House prices vary across metropolitan areas and are influenced by city size, but the major determinants of variation in housing prices are household income and the tenure structure of housing market. Knox and Pinch (2000: 331) emphasized the relationship between residential “mobility and housing policy stating that mobility is seen as a product of housing opportunities- the new and vacant dwellings result-
ing from suburban expansion, inner-city renewal and rehabilitation, etc.- and the housing needs and expectations of households.”

However, a major problem with new housing development is that they fail to include an explicit examination of residential relocation process such as suburbanisation. Clark and Deurloo (2000) argued that there is generally a poor understanding of the relationship between residential mobility and housing market structure. Studies on residential mobility have focused on changes in the status of employment and the stages of family life cycle. The life cycle approach to residential mobility recognises that a variety of demographic and economic factors play a central role in the relocation process. However, Clark and Withers (1999) pointed out job change is also an important triggering process in residential relocation, emphasising the interconnected nature of life cycle events. They found both occurrence and the timing of residential moves triggered by employment transitions.

Within the sociological and geographical literature these frameworks have focussed on the impacts of significant transitions, including changing family life cycle stage or housing career stage. Households also frequently move to maximise the place utility of their housing needs. Resultant conceptual frameworks have presented mobility as taking place as a result of family’s desires to better match their housing with their particular family needs. Rossi (1955: 10) provided one of the seminal sociological pieces in this area suggesting that residential mobility is the means by which “families adjust their housing to the housing needs that are generated by shifts in family composition that accompany life cycle changes.” Studies such as Rossi’s and others of the same genre (McHugh 1984; McLeod and Ellis 1982; Sandefur and Goldscheider 1987) take the household and transitions within households as their frame of reference and investigate how they are associated with residential mobility decision-making processes. Cadwallader (1992) interpreted household mobility as a process whereby families change their housing stock as they experience changes in both family status and socio-economic status. Similarly Webber (1983) pointed out residential mobility is primarily related to housing, family status, and stages in the life cycle, which are the dominant forces behind their decision to move. For instance transition to homeownership during child-bearing and -rearing years as people become more settled and permanency becomes important. Kawauchi
(1997) traced the household relocation process with reference to the life cycle of each household. The frequency of moves increased twice at the child-bearing stage, and this stage overlapped with the first time homeownership. He regarded the location choices of the first home buyers as constrained, and that the locus of initial acquisition constrains the relocation process of household residential behaviour after that stage (Kawauchi, 1997). A study from Dieleman et al (2000) also showed that more than three quarters of the residential mobility are generated by renters and most of the movers are households under 35 years of age.

However, traditional family life cycles and the importance of space and accessibility to city mean that housing careers vary between countries. Dokmeci and Berköz (2000) investigated residential location preferences in Istanbul with respect to different cohorts, household sizes and income groups. The results show a strong desire for mobility among the middle and older age groups, which contrasts with the findings of the studies reviewed above. In this case study, a majority of the middle and older age group, when moving, prefer the intermediate area between the core and the periphery which happens to be the most easily accessible zone in the city, while the young prefer the periphery.

III. Conceptual Framework: Macro and Micro Approaches

This paper develops a conceptual framework based on concepts and theories presented in suburbanisation and residential relocation literature. Figure 1 shows the conceptual level relationship between housing opportunity and residential location choices. It consists of macro and micro approaches. A micro behavioural analysis is based on individual perception towards dwelling and location choices, while a macro structural analysis focuses on aggregate level mobility patterns associated with housing and labour market restructuring and government's housing and population decentralisation policies. These policies are also closely related to the micro perspectives of residential mobility because they are likely to influence individual moving behaviour, although they may not predetermine it. For instance, the national
government of the Republic of Korea seeks to influence migration patterns as a means of achieving various policy goals. The decentralisation policy, which involves a large scale new satellite city development and relocation of the existing industries, is likely to be influenced by public policies. For example, government controls over new housing construction, level of demolitions, and urban renewal or redevelopment programs influence both the macro level of the spatial mobility patterns as well as the micro level of individual relocation decision-making.

*Figure 1* Conceptual Framework: Macro and Micro approaches

**Macro Structural Perspectives**

- Urban population growth and capital accumulation
- Suburban development policy
- Housing opportunity differentials

**Micro Behavioural Perspectives**

- Demography
- Socio-economic
- Life cycle
- Individual needs & expectation

Decision to relocate → Suburbanisation

Source: Author’s

This study examines micro perspectives of residential relocation and suburbanisation associated with macro perspectives of the Korean government’s urban planning schemes and housing development policy in the Seoul Metropolitan Region (hereinafter being referred to as SMR; see Fig 1). In the macro approach the study focuses on the change in urban system formed by aggregate mobility flows between the city of Seoul and the suburban rings.
(Gyonggi & Inchon) and examines the relationship between the spatial mobility patterns and the suburban new housing developments in the SMR. Rapid urban population growth and capital accumulation, particularly in the city of Seoul, forced the government to seek underdeveloped areas for potential urban growth. In case of the SMR, urban population concentration along with capital surplus helped achieve the national economic growth during the 1980s and also draw public policy support and funding for satellite city developments on the edges of the central city. The scale of the peripheral developments was massive; the total cost of the new satellite city developments (1988-1996) was over US$14 billion including land acquisition and infrastructure improvement and the number of dwellings constructed were 292 thousand units during the same period (Korea Land Corporation 1996).

The Korean government policy of viewing new housing development as capital accumulation significantly affects the structure of housing opportunity in a metropolitan region. This study hypothesizes that suburbanization that has initiated a decentralisation of urban population from the city of Seoul owes its success the individuals’ desire for spacious housing and homeownership. Although the household moves away from the central city where land and house are more expensive there are still significant number of people who move from suburban areas to the central city. Thus it is important to understand what differentiates the mobility flows.

Individual desires are useful to explain the recent suburbanisation process, but the preferences are not isolated from the government policy contexts in which they occur. In particular the massive scale of suburban housing development may have directly or indirectly impacted on changing spatial mobility patterns due to housing opportunity differentials particularly between the core city and suburban areas.

However the housing needs and expectations of households are a product of their socio-economic and demographic characteristics (tenure, employment, education, life style etc), including stages in life cycle (see Fig 1). Those beyond the tolerance level or threshold of discordance between their housing needs and the actual place utility are more likely to move in order to meet their needs. In this sense the newly developed suburban areas could provide housing opportunity for them to close the gap between aspiration and actual accomplishment.
IV. Data and Methodology


Many geographers and urban analysts have attempted to examine residential mobility by analysing determinants of residential relocation decisions and choices (Lee et al. 1994; Lu 1998; Withers 1998). These studies have focused on intra urban mobility factors associated with individual behaviour to maximise place utility. These studies mostly use LOGIT models that examine the relationship between several independent variables and a dichotomous dependent variable (e.g. move versus not move). The model is used when the outcome (independent) variable is dichotomous rather than continuous (Kim 1987; Berry 1993). Albeit the usefulness of the logistic regression model, there is a major limitation; it cannot be applied directly to a situation in which the outcome variable has more than two categories. This study is not about predicting whether people move or not; it is about characterizing different types of moves by origin and destination. Therefore, logistic regression is not appropriate, and instead, multiple discriminant analysis appears to be a good substitute.

Clark and Dieleman (1996) pointed out that an important geographical context in housing choice is the central city-suburbs contrast, and that the relative sizes of these environments vary between cities and over time. They generate complicated patterns of aggregate flows of residential moves between these environments. For analysing these contrast this study first creates the longitudinal housing transitions of the actual movers by four different mobility patterns: (1) out-movers from the city of Seoul to the outlying ring and (2) in-movers in the opposite direction, and (3) intra movers within the city of Seoul, and (4) intra movers within the outlying ring. The study is primarily interested in groups (1) and (2), and groups (3) and (4) are not considered further. The selected mover groups are characterised by their aspirations and needs. Table 1 presents four key reasons of movers who either relocated from the
city of Seoul to the outer ring of Gyonggi & Incheon, and vice versa, during 1992 to 1997.

<Table 1> Major reasons for relocation by in and out migrants, 1997

<table>
<thead>
<tr>
<th></th>
<th>Job</th>
<th>Housing</th>
<th>Family</th>
<th>Living</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outflows (N)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seoul to outlying rings</td>
<td>184</td>
<td>319</td>
<td>348</td>
<td>75</td>
<td>926</td>
</tr>
<tr>
<td></td>
<td>19.9</td>
<td>34.4</td>
<td>37.6</td>
<td>8.1</td>
<td>100</td>
</tr>
<tr>
<td>Inflows (N)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outlying rings to Seoul</td>
<td>62</td>
<td>130</td>
<td>154</td>
<td>65</td>
<td>411</td>
</tr>
<tr>
<td></td>
<td>15.1</td>
<td>31.6</td>
<td>37.5</td>
<td>37.5</td>
<td>100</td>
</tr>
</tbody>
</table>

\(X^2=20.401, \text{df}=3, \text{sig}=0.00111\)


Different mobility reasons are found between in and out-movers. The percentage of family related reasons is the highest, accounting for 37.5 per cent for in-movers and 37.6 per cent for out-movers, respectively. The percentage rate of housing related reasons for out-moves is 34.4 per cent while the percentage for in-moves is 31.6 per cent. The rate of job related reasons 19.9 per cent for out-movers while that of the in-movers is 15.1 per cent. While housing and job related reasons are more closely associated with those out-movers, the living amenity (including education) related reasons are more with the in-movers. The rate of living amenity related reasons for in-movers is 15.8 per cent, twice as high as that of out-movers.

As noted above, the main research question is to investigate if there exists any statistically significant differences in socio-demographic and housing characteristics between in-movers and out-movers; the former, being designated as the ones that moved into the city of Seoul and the latter, the ones that moved to the outer suburban ring in the SMR. The groups of in-and out-movers in this analysis are determined by two factors; 1) movers’ origin and destination and 2) key mobility reasons. Combining these two results in eight different groups-four labelled as in-movers (those moving from Gyonggi & Incheon to Seoul) and four labelled as out-movers (those moving from Seoul to Gyonggi & Incheon). And as shown in Table 1 below, each of the four in-and-out mover groups are subsequently divided into four types based on reasons for moving: job, housing, family, and amenities (including education). Data are selected only from those people over 15 years old who moved specifically from the
city of Seoul to the outlying regions of the SMR or vice versa between 1992 and 1997. Those respondents who did not move and who moved within the same jurisdiction during the same time are deleted from the data set, thus there remained a total sample of 1,048.

<Table 1> Categorization of the Sample

<table>
<thead>
<tr>
<th>In-migrants</th>
<th>Job</th>
<th>Housing</th>
<th>Family</th>
<th>Living &amp; Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td></td>
<td></td>
<td>Group 3</td>
<td>Group 4</td>
</tr>
<tr>
<td>Group 5</td>
<td></td>
<td></td>
<td>Group 6</td>
<td>Group 7</td>
</tr>
</tbody>
</table>

Group 1: in-migrants for job reasons
Group 2: in-migrants for housing reasons
Group 3: in-migrant for family reasons
Group 4: in-migrant for living amenities and education reasons
Group 5: out-migrants for job reasons
Group 6: out-migrant for housing reasons
Group 7: out-migrant for family reasons
Group 8: out-migrant for living amenities and education reasons

In order to characterise these mover groups the paper employed a multiple discriminant analysis. The main purpose of multiple discriminant analysis is to statistically determine any major differences among predetermined groups. The discriminant model allows us to consider the difference between groups based on origin and destination of movement (in and out moves) with different individual needs and aspirations. The key outcome of the analysis is a set of (n-1) discriminant functions which are uncorrelated linear combinations of a set of dependent variables. Each function has a unique solution so that differences between groups based on a discriminate score (similar to a regression score) can easily be identified. The following notation shows how the discriminant Z score is a linear combination:

\[ Z_{jk} = a + W_1 X_{1k} + W_2 X_{2k} + \cdots + W_n X_{nk} \]
Where;

\[ Z_{jk} = \text{discriminant } Z \text{ score of discriminant function } j \text{ for object } k \]
\[ a = \text{intercept} \]
\[ w_i = \text{discriminant coefficient for independent variable } i \]
\[ x_{ik} = \text{independent variable } i \text{ for object } k \]

The above notation involves deriving a variate, the linear combination of several independent variables that discriminate best between \textit{a priori} defined groups (Hair et al. 1998). Each independent variable is multiplied by its corresponding weight and these products are added together, plus a constant. The result is a single composite discriminant \( Z \) score for each individual in the analysis. By averaging the discriminant scores for all the individuals within a particular group a centroid can be obtained (Hair et al, 1998). It yields the biggest mean difference between the groups.

1. Variables

Seven independent variables are introduced into the model to differentiate between mover types. These variables have been often considered as an important factor influencing residential mobility.

The impact of life cycle factors on residential mobility has been widely investigated (Clark et al. 2003; Dohmen and Berkoz 2000; Phe and Wakely 2000). In this study two variables associated with life cycle are included: age and marital status. Age is entered as a continuous variable in years while marital status is included as a dichotomous variable- married/unmarried. Inverse transformation for age is used to attain a normal distribution.

Some studies found that residential relocation is highly correlated with both employment status and level of education (Deane 1990; Lu 1998). In this paper the former is measured by a dichotomous variable- employed or unemployed, while the latter, by a categorical variable- less than high school, high school, tertiary.
### Table 2: Definition of Discriminant Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGENV</td>
<td>Age of movers (Inverse transformation)</td>
</tr>
<tr>
<td>MARISTS</td>
<td>Marital status: Single, Married</td>
</tr>
<tr>
<td>EMPSTS</td>
<td>Employment status: Employed, unemployed</td>
</tr>
<tr>
<td>EDUCATE</td>
<td>Level of education: Less than high school, high school, tertiary</td>
</tr>
<tr>
<td>DWLSIZE</td>
<td>Transition of dwelling size: Larger, same or smaller</td>
</tr>
<tr>
<td>Dummy Variable</td>
<td>Tenure transition from owner to owner</td>
</tr>
<tr>
<td>OWN OWN</td>
<td>Tenure transition from owner to renter</td>
</tr>
<tr>
<td>OWN RNT</td>
<td>Tenure transition from owner to renter</td>
</tr>
<tr>
<td>RNT OWN</td>
<td>Tenure transition from renter to owner</td>
</tr>
<tr>
<td>(ref cat RNT RNT)</td>
<td>Arithmetic value of renter to owner</td>
</tr>
<tr>
<td>LGTHCSQRT</td>
<td>Length (duration) of residence in previous address. (Square root transformation)</td>
</tr>
</tbody>
</table>

A third set of variables impacting on the relocation process are referred to as 'housing transition' variables and they are supposed to influence changes in the size of dwelling and tenure. Studies by Deurloo et al. (1994), Huang and Clark (2002) and Withers (1998), have all illustrated that these variables impact on residential relocation decision. In this paper change of dwelling size is accounted for with a categorical variable- moved to larger dwelling, moved to the same size dwelling, moved to a smaller dwelling. Tenure transitions are expressed in terms of a categorical variable- owner to owner, owner to renter, renter to owner, renter to renter. Duration of residence also significantly affects residential relocation decision (Deng et al. 2003). Length of residence is represented in this paper by a continuous variable of a square root transformation.

### 2. Results of the analysis

Having briefly outlined the broad reasons associated with mobility within the Seoul Metropolitan Region, this section examines the differences in moving behavior among the eight mover types as identified in the methodology.
Diagnostics and assumptions

Base data were screened prior to conducting the analysis. No missing values are found in the predictors although the predictors are neither examined for outliers and normality, nor pair-wise linearity. There exists neither singularity problem, nor that of muticollinearity as the inter-correlations in the pooled correlation matrix are no higher than .31 (see Table 3) and all tolerances are over .90.

<Table 3> Pooled within-groups correlation matrix

<table>
<thead>
<tr>
<th></th>
<th>OWNOWN</th>
<th>OWN_RNT</th>
<th>RENTOWN</th>
<th>AGEINV</th>
<th>EDUCATE</th>
<th>EMPSTS</th>
<th>LGTHCSQT</th>
<th>MARISTS</th>
<th>DWLSIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>OWNOWN</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OWN_RNT</td>
<td>-.167</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RENTOWN</td>
<td>-.102</td>
<td>-.217</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGEINV</td>
<td>-.094</td>
<td>.104</td>
<td>-.072</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EDUCATE</td>
<td>-.090</td>
<td>-.105</td>
<td>-.034</td>
<td>-.015</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMPSTS</td>
<td>.008</td>
<td>-.053</td>
<td>.026</td>
<td>-.083</td>
<td>-.098</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LGTHCSQT</td>
<td>.027</td>
<td>-.077</td>
<td>.141</td>
<td>-.053</td>
<td>.015</td>
<td>-.052</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MARISTS</td>
<td>-.009</td>
<td>.011</td>
<td>.008</td>
<td>.310</td>
<td>.055</td>
<td>.059</td>
<td>-.031</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>DWLSIZE</td>
<td>.028</td>
<td>-.056</td>
<td>.037</td>
<td>.045</td>
<td>.060</td>
<td>.005</td>
<td>.076</td>
<td>-.014</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Box’s M test for equality of the covariance matrixes of independent variables across the groups of dependent variable shows that the population covariance matrixes are significantly different (p<0.001), suggesting that the assumption of equality is violated. However, according to Steven (1996) discriminant analysis is robust to violations of the assumption of homogeneity of covariance matrixes when group sizes are fairly equal and the sample size is large. The sample size in this analysis (N=1048) is large and so is the minimum group (38 observations), suggesting that the violation of this assumption is not problematic.

Significance of Discriminant Functions

The discriminant analysis has generated seven discriminant functions with the first three accounting for the majority of the variance (see Table 4). The overall relationship between
the predictors and groups is significant as evidenced by $\chi^2 (63) = 354.892, p<.001$. Each of
the seven estimated discriminant functions is examined to determine the statistical sig-
nificance of each. Three functions can adequately explain between-group differences. After
the first function is extracted, the chi-square is recalculated. There is still a significant rela-
tionship between the predictors and the mover groups, $\chi^2 (48) = 220.638, p<.001$. When the
second function is removed the third function also shows a significant relationship, $\chi^2 (35)$
$= 91.793, p<.001$. However, as the third factor is deleted, the significant relationship sub-
stantially decreases in the fourth function; $\chi^2 (24) = 42.906, p<.01$. And the fifth function is
not significant; $\chi^2 (15) = 20.768$. The strength of the overall relationship between the de-
pendent and independent variables is measured by the canonical correlation. In this analysis,
the first and the second functions, the two most important functions, are taken into
consideration. The squared canonical correlations reveal that the first function accounts for
11.6 percent of between-group variance while the second accounts for 11.2 percent of the re-
mainng between-group variance.

Since these two functions are statistically most significant, the study now examines them
to determine the relative importance of each independent variable in discriminating among
the reason-specific mover groups. There are three methods to do that: (1) F statistics, (2)
structure correlations, and (3) relative weights. All of them are employed, and the results are
used to interpret and label the functions.

(1) F-statistics

The analysis begins by reviewing the group means to see if the groups are significantly
different on any single variable. The univariate F-Ratio (simple ANOVAs) measures be-
tween-group differences on specific variables by the means for each group. Large F values
indicate greater discriminatory power. The most important predictor in displaying significant
differences between the group means on a univariate basis is the frequency of age
(AGEINV). One-way ANOVAs reveals that all of the variables except EDUCATE and
LGTHCSQT show significant differences using an alpha level of .001. Those two factors
would be important determinants for distinguishing movers from non-movers, but they may
not be important determinants for differentiating the in- and out-movers. In order to account for all the variables simultaneously across all dimensions, F-TO-REMOVE statistics are used. Tabachnick and Fidell (1996) suggested that when testing the F-TO-REMOVE statistics for significance, it is best for the alpha levels be adjusted for the number of variables in the set, p. It controls for shared variance among the discriminating variables. Six predictors (AGEINV, MEMPSTS, EMPSTS, DWLSIZE, OWN_OWN, RNT_OWN) are uniquely associated with the groups (all p<.01). However, both the F-ratio and the F-to-remove ratio demonstrate that AGEINV and RNT_OWN are the most important variables in discriminating between the groups (see Table 4).

<Table 4> Importance of the predictors in explaining between-group variance

<table>
<thead>
<tr>
<th></th>
<th>F-Ratio</th>
<th>F to Remove</th>
<th>Structure Correlations</th>
<th>Relative Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F (8, 1086)</td>
<td>F (8, 1078)</td>
<td>Function 1</td>
<td>Function 2</td>
</tr>
<tr>
<td>AGEINV</td>
<td>16.88***</td>
<td>11.96***</td>
<td>-0.004</td>
<td>0.907</td>
</tr>
<tr>
<td>MARISTS</td>
<td>6.38***</td>
<td>3.23***</td>
<td>-0.269</td>
<td>0.468</td>
</tr>
<tr>
<td>EMPSTS</td>
<td>9.43***</td>
<td>8.60***</td>
<td>-0.489</td>
<td>-0.327</td>
</tr>
<tr>
<td>EDUCATE</td>
<td>2.57*</td>
<td>1.92</td>
<td>0.270</td>
<td>0.005</td>
</tr>
<tr>
<td>DWLSIZE</td>
<td>3.92***</td>
<td>2.80***</td>
<td>0.349</td>
<td>0.135</td>
</tr>
<tr>
<td>LOTHCSQT</td>
<td>1.58</td>
<td>1.68</td>
<td>0.030</td>
<td>-0.086</td>
</tr>
<tr>
<td>OWN_OWN</td>
<td>3.82***</td>
<td>3.88***</td>
<td>-0.076</td>
<td>0.085</td>
</tr>
<tr>
<td>OWN_RNT</td>
<td>3.90***</td>
<td>1.63</td>
<td>-0.312</td>
<td>0.205</td>
</tr>
<tr>
<td>RNT_OWN</td>
<td>11.05***</td>
<td>8.94***</td>
<td>0.688</td>
<td>-0.184</td>
</tr>
</tbody>
</table>

***significant at p<.001; **p<.01; *p<.05

(2) Structure Correlations

The structure coefficients show the relative importance of the different predictors to each of the two functions (see Table 4) and measure the simple linear correlation between each independent variable and two discriminant functions. Variables that correlate highly with a function define that function for labelling purposes. In this analysis only structure coefficients greater than 0.4 (Sig at p < .001) are used to interpret the two functions. Using this criteria
RNT OWN (r=.69), BMPSTS (r=.49) and DWLSIZE (r=.35) are used to label function one (housing careers) while AGEINV (r=.91) and MARISTS (r=.47) were used to label function two (life cycle).

(3) Relative Weights

Thomas (1992) introduced the method of relative weights which are the products of structure coefficients and standardised discriminant ratio coefficients. They indicate for each function the proportion of between-group variability accounted for by a variable. Independent variables with relatively larger weights contribute more to the discriminating power of the function than do variables with smaller weights (Hair, 1998). The relative weights of the variables labelling functions are all over 10 percent and confirmed that they are important for interpreting the functions (see Table 4).

Overall the three variables - tenure transition from rent to own, employment status, and larger dwelling in Function 1 - are taken as the ones that better relate to housing careers. For example, two variables, housing transition rent-to-own and to-a larger-dwelling, are important for housing careers and employment status is also very likely to affect their housing choices and moving behaviour. On the other hand two variables in Function 2 can be interpreted as the ones relating to the family life cycle; the age and the marital status.

V. Interpretation of Residential Relocation

1. Separation of Mover Groups

An analysis of pair-wise group comparisons is used to overview group separation using F ratios (see Table 5). This analysis presents a pair of comparison of eight mover groups, using 8 by 8 matrix (28 comparisons).
Differentiating In and Outflows: A Multiple Discriminant Analysis

<Table 5> Pair-wise group comparisons

<table>
<thead>
<tr>
<th></th>
<th>In-Job</th>
<th>In-House</th>
<th>In-Family</th>
<th>In-Living</th>
<th>Out-Job</th>
<th>Out-House</th>
<th>Out-Family</th>
<th>Out-Living</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Job</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-House</td>
<td>3.523***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-Family</td>
<td>2.961**</td>
<td>5.676***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-Living</td>
<td>2.034*</td>
<td>2.908**</td>
<td>7.961***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-Job</td>
<td>7.837***</td>
<td>4.737***</td>
<td>11.084***</td>
<td>9.483***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-House</td>
<td>5.997***</td>
<td>7.160***</td>
<td>3.383***</td>
<td>12.051***</td>
<td>7.714***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-Family</td>
<td>2.217*</td>
<td>2.268*</td>
<td>2.941**</td>
<td>1.232</td>
<td>3.329***</td>
<td>2.956**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*** significant at p<.001; ** p<.01; * p<.05

The pair-wise comparison results demonstrate that the out-movers with housing reasons and the in-movers for living amenity reasons are the most separated group combinations (F=12.051, Sig <.001). The out-movers for job motivations is significantly isolated from many other groups including; the in-movers for family reasons (F=11.084, Sig <.001), in-movers for living amenity reasons (F=9.483, Sig <.001) and in-movers for job related reasons (F=7.837, Sig<.001). However, the out-movers for family related reasons are not so different from other mover groups, particularly the in-movers related living amenity (F=1.232, not significant). These results are well matched with the previous graphical display of group centroids in Figure 1.

The results indicate that the job and housing are the important factors for relocating to suburbs. Considering each pair of groups with same reasons for relocation, one finds that the in- and out-movers for job, housing, and living amenity are significantly different from other groups, while the in- and out-movers for family are relatively less separated (F=2.941, Sig <.01).

2. Socio-demographical Separations

To make substantive interpretations of the discriminant analysis results, the combined functions of housing careers and life cycle as the two most important functions are used to ana-
lyse the complex process of residential relocation in the SMR. Figure 2 shows how the mover groups are separated across the selected two functions.

![Figure 2: Plot of group centroids in the space of Functions 1 and 2](image)

The figure plots the group centroids of the Functions 1 and 2; i.e., the space created by the horizontal and vertical axes. Higher coefficients in Function 1 represent a housing transition of employed persons from rent to ownership and to larger dwelling size, while higher coefficients in Function 2 refer to younger, single persons. The dots represent out-movers and the circles, in-movers. The small plots with stretched lines show the coordination of the five important variables outlined previously: tenure transition (RNT_OWN), dwelling size transition (DWLSIZE), age (AGEINV), marital status (MARISTS), and employment status (EMPSTS).

The stretched attribute vectors visually help us to comprehend how mover groups are related to the variables with closer positions indicating stronger relationship. For instance, Function 1 labelled ‘housing careers’ is closely related to the vectors of RNT_OWN and DWLSIZE as they are closely lying on Function 1 and it corresponds more to the variable of RNT_OWN than DWLSIZE as it has longer length of vector than the other. However, the variable of
AGEINV shows a very strong association with Function 2 as it appears almost same line to the function.

Those who are moving out for housing and job related reasons are more likely to prepare their housing careers while those moving in for job are not. It suggests that those who move from the city of Seoul to Gyeonggi and Incheon tend to significantly improve housing conditions; e.g., transferring from rental tenure to more stable tenure of homeownership and to a larger dwelling as compared to those who move into the city of Seoul. In particular, the out-movers for housing and jobs are highly separated by Function 2. They have about the same score on Function 1, but have different score on Function 2. However, those who move for living amenity are not likely to be separated by Functions 1 and 2. Similarly those groups who move for residential amenity show relatively small separation between in- and out-moving groups. Interestingly, the movers with family related reasons are not distinguished by Function 1, but by Function 2 (see vertically positioned group separation). This suggests that young single persons are likely to move into the city for family reasons regardless of housing careers. It also implies that age is more important factor than housing career that distinguishes the in-movers from the out-movers.

One of the most interesting findings in the graphical display is that there is a clear difference between those movers for housing and those movers for job reasons on Function 2 (life cycle). The out-movers for housing are more likely to be younger than the in-movers, whereas the out-movers for job are more likely to be older than the in-movers. It is also noted that the in-movers with family related reasons are much younger than the out-movers.

The findings strongly suggest that there is some evidence of trading-off between housing improvement opportunity and job opportunity within the SMR. It is clear that individual decision to move to outer ring is triggered by two key motivations; stable tenure (from renter to owner) and space (larger dwellings). However the employment status is closely related to in-moving. The figure 2 with the rotated vectors lends support to the trade-off between the opportunity for housing improvement and that for employment. The out-movers for housing reasons are more likely to transfer to larger and more spacious dwellings and those with job reasons are more likely to change from rental to ownership as they are close to DWLSIZE.
and RNT.OWN, respectively; whilst residential amenity and job conscious in-movers are closely positioned with the EMPSTS variable, which means they are more likely to be employed. In addition, those job related movers are likely to be young and unmarried. Interestingly, if only the job related reasons are considered, the in-movers are likely to be much younger than the out-movers.

**Winners and Losers**

The result of this analysis comes up with contrasting outcomes for different groups as defined in terms of housing and socio demographic characteristics. These contrasts between movers to the central city and those to the suburbia suggest there exists a link between different socio-demographic characteristics (such as age, employment status and marital status) and the changes in residential space and tenure. Four major characteristics of mover groups emerge from the analysis. There are eight mover groups, but only five of them are closely associated with Functions 1 and 2: ‘out-job’, ‘out-housing’, ‘in-job’, ‘in-living’, and ‘in-family’ as illustrated in figure 2. The other three groups located in the centre (out-family, out-living and in-housing) are not selected here.

(1) Win/Win (out-job)

Those who are moving out for job reasons are likely to promote their housing careers as compared to those moving in. Considering the fact that the dot is generally to the left of the diamond (outflows) for each reason, housing circumstances are generally improving among those who are moving to outer rings, compared to those moving to the city of Seoul. Interpreted in the light of trade-off theory, this means that while other reasons may be more plausible than housing in households’ moving decisions, the out-moving decision seems to be facilitated by reducing any trade-off between housing improvement and non-housing benefits. However, those moving in for job reasons, particularly the employed mature couples, are more likely to afford to purchase home within the city of Seoul, and this may seem to contradict a trade-off based explanation.
(2) Win/Lose (out-housing)

Those who are moving out for housing reasons are more likely to be earlier stages in life cycle and progressing housing careers. However, they are less likely to be employed. It should be also pointed out that one of the most important obstacles for the people moving out for housing improvement opportunity is job security or job mobility.