

Self-containment of Non-mandatory Activities in an Aging Newtown: Modelling Destination Choice with Social Network Effects

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A shrinking and aging population have recently been observed in Japan, especially in “aging new-towns”. Since mobility level is usually decreasing with aging, having a self-contained neighborhood could be more important than before. This paper therefore explores the self-containment status of newtown for different activity types that they can opt the destinations such as shopping, volunteer, leisure activities, by using a multi-period (two waves) and multi-day (two weeks) panel survey which was collected in Koyo newtown in Hiroshima. For this purpose, we develop a panel mixed logit model of destination choice. The result reveals that social network impacts not only on self-containment of non-mandatory trips, but also on residents’ subjective well-being. Meanwhile, increasing number of friends within the newtown leads to rising non-mandatory trips in the newtown, and the more number of friends in the newtown the respondents have, the more happiness they get.

Key Words : *self-containment, non-mandatory activities, aging newtown, social networks, destination choice*

1. INTRODUCTION

Japan experienced a rapid population growth from the 1950s to 1980s, leading to the development of new neighborhoods, so-called “newtowns”, in sub-urban areas. A shrinking and aging population have recently been observed in Japan, especially in “aging new-towns”, since many of the residents living in the newtowns belong to a specific age group (over 65 years). Mobility level is usually decreasing with age due to physical depression and reduction of level-of-services of local public transport. It can also be expected that activity space of the elderly tends to be smaller after retirement, since they may not need to

make long distance trips to working places (mainly located in CBD). Instead, going to park, taking around, visiting their friends and so forth may become dominant trip purposes, most of which are done within the neighborhood. As a result, having a self-contained neighborhood could be more important than before.

The concept of self-containment (“balance”) has been a long established ambition in urban planning, especially in Europe but also in some cases in the United States. This concept was first promoted by Ebenezer Howard via the Garden City Movement which was planned as self-supporting communities (Howard, 1898, cited from Certero, 1995a), in order

to relieve London from overcrowding in the post-World War II period. Conventionally, self-containment has usually been interpreted as a balance between jobs and housing (job-housing balance) in a community. Thus, a number of studies have discussed self-containment in relation to working trips (Cervero, 1995a; Curtis & Olaru, 2010; Hui & Lam, 2005; Yigitcanlar et al., 2008). Taking a broader perspective, self-containment was considered as a form that allows people to live, work, shop and create within a community (Burby & Weiss, 1976, cited from Cervero, 1995a; Cervero, 1995b; Hui & Lam, 2005; Lee & Ahn, 2005; Merlin, 2014; Pakzad et al., 2007; Yigitcanlar et al., 2008). Non-working trips are said to account for a majority of total commuting trips in metropolitan areas, for example approximately three-quarters of all trips in American metropolitan areas and Europe (Richardson and Gordon, 1989, cited from Cervero, 1995b; Salomon et al., 1993), and hence, some studies have recently focused on the issue of self-containment with the aspect of non-working trips. Lee and Ahn (2005) state that five newtowns and nearby residential areas in the Seoul metropolitan have a fairly favorable degree of self-containment in terms of non-working trips. Merlin (2014) also examines measure of urban form cross a range of community scales relating to self-containment with respect to nonwork trips and tours. Since working trips constitute a minor portion of all travels in aging newtowns in Japan where a number of residents are retired, this paper focuses on trips with non-mandatory activities, namely shopping, volunteer, recreation and so on to examine the self-containment status of newtown, which can be understood as a collective nature of each individual's destination choice.

Social network of people are formed through family relations and friendships, as well as through various activities and places, which shows that social contact among people is crucial (Páez & Scott, 2007; Páez et al., 2006). The impacts of social relations on travel decisions has been widely studied in the field of transportation (Harvey & Taylor, 2000). According to Dugundji and Walker (2005), decision makers are influenced by both social (e.g. interactions with other people) and spatial (e.g. locations where they live) networks. Social networks often create demand for traveling (Carrasco & Miller, 2009; Farber & Páez, 2009), and hence travel behavior and mobility are coupled with social bonds and locations (Ryley & Zanni, 2013). In particular, social networks may be important factors for destination choices of non-mandatory activities, since these activities are often done with family members, relatives and/or friends and thus he/she may not be able to decide the destination based solely on his/her preferences. This

would be especially true in Asian society where social ties might be stronger than Western countries.

In this purview, this paper explores the self-containment status of newtown for non-mandatory activities with a focus on the impacts of social networks. For this purpose, a panel mixed logit model of destination choice is developed and the impacts of social networks and other relevant factors on destination choice are empirically examined by using a multi-period and multi-day panel survey data, collected in Koyo Newtown located in Hiroshima, Japan. We then focus on the impacts of their destination choice and social networks on subjective well-being to understand whether or not having more self-contained neighborhood contributes to having a better quality of life. Answering these questions would be crucial for anticipating the possible impacts of urban planning policies, such as the "compact city" policy. For example, when residents are encouraged to move from the current neighborhood to others, their social networks and activity locations could be mismatched, potentially causing negative impacts on their quality of life, especially for those who have higher mobility constraints.

The sections of the paper are as follow. The next section is a description of a multi-period and multi-day panel survey conducted in Koyo Newtown, some definitions of choice set for destination choice model and social network groups, followed by aggregate analysis based on the panel data. The following section introduces a panel mixed logit model to represent destination choice behavior with a focus on the impacts of social networks. The fourth section presents and discusses the model estimation results. In the fifth section, the relationships among destination choice, social network and subjective well-being are discussed. The final section summarizes the findings of this study and potential directions for future research.

2. SURVEY AND DATA

(1) The survey area and data used in this study

The survey area is Koyo Newtown located in a hilly suburban area of Hiroshima city. Koyo Newtown (current 17,000 population) was built about 11 kilometers north-east of the CBD of Hiroshima city. The newtown is a typical aging newtown in Japan with a rapid rate of aging (people over 65 years of age account for approximately 26.7% of the newtown's population in 2013). While railway and bus are variable to the CBD of Hiroshima city, public transport within the newtown is relatively poor. Koyo New-

town has a better self-containment than other ones in Japan: Community hall, shopping center, post office, banks, hospital and sports club are located in the neighborhood center.

A multi-period (two waves) and multi-day (two weeks) panel survey was carried out in 2010 and 2011. Two-week diary survey was employed to capture the infrequent irregular trips, because after retiring, travelers tend not to make daily regular trips. In addition, in the second wave, with the support of the local government, a social experiment was implemented and provided personal mobility vehicles (i.e. PMVs) to some respondents, in order to investigate the changes in the elderly activity and travel decisions.

The survey was designed based on a sampling strategy which selected households that had at least one elderly member (60 years old and over). Nearly 50 households participated in the survey for each wave (38 households remained in both waves). The respondents not only filled out a paper-based trip diary, but also recorded each trip trajectory using a GPS device for two consecutive weeks. Particularly, the paper-based questionnaire included questions relating household structure (number of household members, members' individual attributes, their relationship with household head, etc.), social networks (number of friends inside and outside the newtown, number of relatives), vehicle ownership (number and type of vehicles owned), travel behavior (trip purpose, departure/arrival time, destination, and travel mode), and especially in 2011 level of respondents' happiness was asked to report.

Among 38 panel respondents, the valid samples which are available for both waves is 31 for GPS data and 26 for paper-based data. While paper-based data provide trip purpose and travel mode information which cannot be collected through GPS devices, GPS data provide the precise activity location information. Thus, in this study, to utilize these advantages of two data sources, GPS data and paper-based data were merged. For GPS data processing, first, trip ends were detected within GPS data stream by searching for time periods of non-movement. The GPS data (decomposed to trips) and paper-based data are then merged based on departure and arrival time information. There are a lot of literature reviews to identify thresholds in detecting trips and merging GPS data with paper-based data. These thresholds vary primarily depending on the characteristics of local activities. Wolf et al. (2001) state that two-minute threshold yielded the best prediction of the true trip ends. It is considered as a gap whenever the time interval or the distance between consecutive points is greater than two minutes or 250 meters (Chen et al., 2010), while a

trackpoint is removed when distance between two consecutive trackpoints less than 10 meters (Bohte & Maat, 2009). Schüssler and Axhausen (2008) also use two minutes threshold to assume as stopped activities. Based on the findings of existing studies, in the current paper, we consider a movement is regarded as a trip when it is more than 100 meters within two minutes, and use a time-interval condition with 30 minutes threshold to merge two kinds of data.

Here, we would like to define the terms used in this study. First, to analyze destination choice behavior, two destinations are set in this study: destination is classified into "inside newtown" when the destination is located within the Koyo Newtown's buffer which extends 200m from the Koyo Newtown's administrative boundary (Fig.1). In the same way, when the destination is outside of the boundary, the destination is labeled as "outside newtown". Another important classification in this study is that, to represent respondents' social network status in a simple manner, respondents are divided into two groups: those who have more friends inside the newtown compared to the outside is grouped into "inside-network" group, and those who have more outside friends is classed as "outside-network" group.

(2) Aggregate analysis

Based on the available samples existed in both waves, destinations of mandatory trips (working, school, medical treatment and pick-off/drop-off) and non-mandatory trips (shopping, volunteer, meeting with friends/acquaintance, club activities, eating out, taking around, leisure activities, and so on) are shown in Table 1. First, it is confirmed that non-mandatory activities are dominant activities in the current sam-

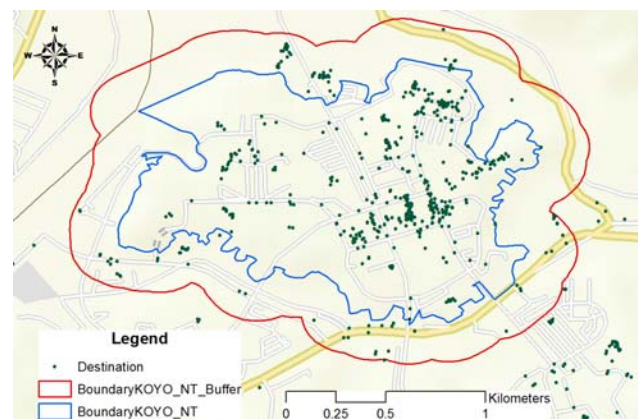


Fig.1 Trips with destinations inside/outside the Koyo Newtown ples. This would be because most respondents are already retired, and thus, in this study the non-mandatory activities are examined. Second, for all activities, "inside newtown" trips outnumber "outside newtown" ones, implying that resident's activity locations tend to be inside newtown after

retirement. Since self-containment status has been measured based on residents' actual behavior (i.e., how many residents do activities inside/outside the neighborhood) in most existing studies, these results indicate that progress in aging could result in more self-contained neighborhood. Meanwhile, self-containment is as an aggregation of destination choice analysis.

In case of non-mandatory activities, the status of social network may influence destination choice. **Table 2** shows destinations of non-mandatory activities by the status of social network. The results indicate that the respondents who belong to inside-network group did 71.1% of activities inside newtown, while those who are in outside-network group tend to do activities outside newtown. These results indicate that their activity spaces would be

Table 1 Destinations of mandatory and non-mandatory activities

	Destination		Total
	Inside newtown	Outside newtown	
Mandatory activities	93 51.7%	87 48.3%	180 100%
Non-mandatory activities	477 67.7%	228 32.3%	705 100%

formed based on their social network distributions.

3. MODELLING DESTINATION CHOICE

In order to examine the impacts of social networks on destination choice under the control of other influential factors, a destination choice model is developed based on a panel binary mixed logit model (also called random-parameters or error components logit) to account for unobserved heterogeneity

Table 2 Destinations of non-mandatory activities by the status of social network

	Destination	
	Inside newtown	Outside newtown
Inside-network group	315 71.1%	128 28.9%
Outside-network group	162 61.8%	100 38.2%

among respondents and the correlations in unobserved utility over repeated choices by each indi-

vidual. In fact, a variety of studies developed mixed logit model for modelling location choice. Bhat and Gossen (2004) use a mixed logit model to analyze in-home, out-of-home, and pure recreational activities; while resident's trips-making propensity to urban parks is estimated by a mixed logit model (Kemperman et al., 2005). The model is also applied to location-related choice (Bhat & Guo, 2004), and migration to urban and rural areas (Dé-tang-Dessendre et al., 2008).

In this study, a destination choice model is developed based on a simple panel mixed logit model specification, since the sample size may not be large enough to develop the full random-coefficients model. Concretely, we only deal with the constant term as a random term which varies over respondents but being constant over choice situations for each respondent. In this case, utility U_{njt} that an individual n ($n = 1, 2, \dots, N$) associates with a destination j ($j = 1, 2$) in day t may be written as:

$$U_{njt} = \alpha_j + \beta x_{njt} + \eta_{nj} + \varepsilon_{njt} \quad (1a)$$

where α_j is a constant term for destination j , β is a vector of parameters, x_{njt} is a vector of explanatory variables (including the status of social networks), η_{nj} is a random term which is normally distributed with mean 0 and variance σ_η^2 capturing unobserved heterogeneity among respondents, and ε_{njt} is an error term which is Gumbel distributed.

Conditional on η_{nj} , the probability that individual n chooses destination i in day t follows the standard logit formulation:

$$L_{nit}(\beta | \eta_{nj}) = \prod_{t=1}^T \left[\frac{e^{\beta x_{nit} + \eta_{nj}}}{\sum_j e^{\beta x_{nit} + \eta_{nj}}} \right] \quad (1b)$$

The unconditional probability is the integral of the conditional probability over all possible value of η_{nj}

$$P_{nit} = \int L_{nit}(\beta | \eta_{nj}) f(\eta_{nj}) d\eta_{nj} \quad (1c)$$

The model estimation is done by using Software R with package lme4 (Bates, 2010). It is hypothesized that a greater number of friends within the newtown leads to increasing non-mandatory activities in the newtown, and vice versa. It should be noted that in this paper facilities variables are not used for the modelling. Since accessibility to the facilities do not really vary across local residents, since almost all facilities are located in the neighborhood center,

including community hall, shopping center, bank, post office, hospital, sport club, and so on. To explore the impacts of facilities, two or more newtowns should be simultaneously examined.

4. ESTIMATION RESULTS

The estimation results are shown in **Table 3**. The impacts of status of social network are captured by the number of friend variables. It is confirmed that the more number of friends inside [outside] increases the number of activities inside [outside], indicating that the status of social network statistically influences the self-containment status of the newtown. It is also found that the non-motorized variable is indeed significant at the 1% level with the positive sign, indicating that owning non-motorized vehicles would result in the increase of inside activities. This finding is basically consistent with Fujiwara's (2012) finding that the introduction of personal mobility vehicles increases activities inside newtown. The motorized vehicle ownership variable is not statistically significant, but it shows the negative sign as

expected: those who have a car tend to do activities outside newtown. The age variables are significant at the 1% level. The negative sign of age squared variable indicates that age impacts follow the quadratic function (upward convex) with a maximum at around 70 year olds. Job and gender variables are not significant, but the signs are as expected: males those who are working tend to do activities outside newtown. In addition, as can be seen in the result of chi-squared test, the differences between with and without random terms σ^2_{η} are statistically significant at 0.1% level, illustrating that there is a heterogeneity among respondents.

5. DISCUSSIONS

In the previous sections, it has been confirmed that social network has a significant impact on destination choice decisions. We found that, when residents have more friends inside, they tend to conduct activities inside, and vice versa. According to Gagliardi et al. (2007) and Spinney et al. (2009), the elderly' ability to travel and participate in mobility and social interaction is positively associated with their cognitive subjective well-being. But what will happen when they have more friends outside the neighborhood, but actually cannot engage activities outside due to mobility constraints? Answering this question would be crucial for implementing compact city policies, where the residential relocation from suburban areas to the central areas would be involved: after relocation, social network distribution and activity space could be mismatched, implying that social contacts would become more difficult. This could cause negative impacts on their quality of life, especially for those who have higher mobility constraints. As mentioned in the sub-section (1) for section 2, in 2011 the level of respondents' happiness was asked to report, thus, this section attempts to provide some additional insights on the impacts of the mismatching on quality of life by comparing the subjective well-being among different groups: (1) those who belong to inside-network group with more activities inside, (2) those who belong to outside-network group with more activities inside, (3) those who belong to inside-network group with more activities outside, and (4) those who belong to outside-network group with more activities outside. Our particular interest is in the group (2): if their subjective well-being is significantly lower than the other groups, then the mismatching between social network distribution and activity space would be an important aspect of compact city policy debates.

Table 4 presents the level of subjective well-being

Table 3 Binary mixed logit model for destination choice

Variable	Estimate	z value	
Constant	-64.343	-2.931	**
Year (1: 2011, 0: 2010)	-0.247	-0.878	
Log(the number of friends inside + 1)	0.327	1.902	+
Log(the number of friends outside + 1)	-0.420	-1.992	*
Motorized vehicle ownership (1: own; 0: otherwise)	-0.444	-0.976	
Non-Motorized vehicle ownership (1: own; 0: otherwise)	1.395	3.090	**
Age	1.857	3.051	**
Age*Age (divided by 100)	-1.309	-3.130	**
Job (1: having job; 0: otherwise)	-0.690	-1.273	
Gender (1: male; 0: female)	-0.174	-0.329	
Random term σ^2_{η}	0.694	[26.28]	**
Initial log-likelihood	-488.7		
Final log-likelihood	-370.3		
Sample size	705		

Notes: ** $p < 0.01$; * $p < 0.05$; + $p < 0.10$. The value in [] means the results of chi-squared test with/without random term σ^2_{η} .

across four groups. It is confirmed that the respondents belonging to the inside-network group (groups (1) and (3)) get higher subjective well-being than those in the outside-network group. Although activity locations seem not to be really influential on subjective well-being, it is found that the group (2) shows the smallest subjective well-being, indicating that residential relocation policies should be designed with due considerations of maintaining social relationships.

As can be seen from **Table 5**, there is statistically significant for friend networks, with the representatives of inside-network category ($M = 8.00$) ranking higher in happiness than the members of outside-network one ($M = 7.29$) $t = -3.629$, $p < 0.001$. This proves the level of well-being is significantly influenced by social network existed in residents' location. It is also pointed out significant differences in the group (1) and (2), demonstrating members of the group (1) get higher subjective well-being than those of the group (2). In this context, for the elderly, the existence of friend network far away from daily

Table 4 Level of subjective well-being across four groups

	Those who did more activities inside	Those who did more activities outside
Inside-network group	7.98 [group (1)]	8.08 [group (3)]
Outside-network group	7.20 [group (2)]	7.37 [group (4)]

activity location leads to a decrease in subjective well-being. No statistically significant difference, in contrast, is found in the destination choices between the inside and the outside, indicating that there is not significant impacts of self-containment on subjective well-being. This could be because of the limited sample size, and we may have to reconfirm it with larger scale dataset.

The findings are consistent with the literature reviewed and the hypothesis earlier in this paper. Friend networks affect self-containment of non-mandatory trips (choosing destinations inside or outside the newtown) as well as residents' happiness. In other words, it is thanks to friends in the newtown that the respondents have a higher number of trips within the newtown and a higher level of happiness are obtained. Policy-makers in urban and transportation planning, therefore, should carefully consider policies promoting residents to move out from the aging newtowns.

6. CONCLUSIONS

In Japan, due to population decline and aging, it

becomes an urgent task to reorganize the neighborhoods particularly newtowns, which had been built around 40 years ago in the period of a rapid population growth. Since aging would increase the demand for activities inside newtowns, having more self-contained neighborhood would be more preferable for the elderly people. This paper has examined the self-containment status, which were associated

Table 5 The results of t tests for two groups of social networks based on level of subjective well-being

Variable	n	Mean	t -value
Those who did more activities inside	179	7.87	
Those who did more activities outside	64	7.78	-0.459
Inside-network group	191	8.00	
Outside-network group	52	7.29	-3.629**
inside-network group with more activities inside [group (1)]	154	7.98	
outside-network group with more activities inside [group (2)]	25	7.20	-3.537**

with original concepts of newtowns, of non-mandatory activities in an aging newtown. Many researches assessed self-contained neighborhood based on working trips, while recent study has examined the self-containment bear to non-mandatory trips. By following the latter stream, in this paper the self-containment status has been explored by developing a destination choice model. Since social bonds are considered as important factors of life particularly in Asian countries, effects of social relationships on destination choices also have examined in this paper. We have conducted a series of empirical analysis by using a multi-period (two waves) and multi-day (two weeks) panel survey data collected in Koyo Newtown (Hiroshima, Japan) in 2010 and 2011. The primarily aggregate analysis shows that a greater number of friends within the newtown leads to increasing non-mandatory activities in the newtown. The model estimation results of destination choice behavior also support this finding. These imply that the status of social network significantly influences on destination choice sets, and hence, it is an influential factor of the self-containment status of the newtown. We also confirm that owning non-motorized vehicles would further enhance the self-containment of the neighborhood. Finally, the relationships among destination choice, social net-

work and subjective well-being have been examined particularly the possible consequences of residential relocation policies, which often appears on the agenda of compact city policy debates. The results show that the more friends the respondents have in the neighborhood, the more subjective well-being they would obtain. This indicates that residential relocation policies should be designed with due considerations of the mismatching between social network distribution and activity space.

We have a number of remaining issues that need to be addressed in future studies. First, although we believe that the current study has provided some useful insights for future urban and neighborhood planning, more empirical evidences are certainly needed, since samples used in the empirical analysis is quite limited. Empirical analysis with large scale data and/or in different neighborhoods would be necessary before giving a general conclusion. Second, mainly due to the limited sample size, we have to have simplified our analysis as much as possible: only two destinations and two social network groups are considered. The model could be more generalized with larger scale data.

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