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Regional Outlook

EXPLORING HOUSEHOLD-BASED RETAIL TRAVEL BEHAVIOURS IN BEIJING: AN APPLICATION OF THE SPACE-TIME DECISION MAKING APPROACH

Tiebei Li, Yanwei Chai and Wenjia Zhang

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1. Introduction

Research into urban consumer and retail travel behaviour has received greater attention in urban geography and transport planning than in other study areas. This is because the increasing transport demand generated by retail activities has placed increasing pressure on urban transport systems. With urban growth continuing, long distance travel and transport congestion is an ongoing problem that has imposed increasing energy consumption, worsened greenhouse gas emissions and constrained mobility in urban areas (Weisbrod et al., 2003). In addition, the increase in retail travel demand in large Chinese cities has placed them at greater risk of potential adverse social and economic outcomes arising from increasing transport cost. Retail travel has placed increased pressure on urban transport systems and raised concern about social equity for households. Thus there is growing concern about how to optimise and restructure urban retail development alongside fast urban growth to better manage and reduce the increasing social and transport inefficiency of urban retail travel. Therefore, developing an improved understanding of household retail travel activity, its relationship to patterns of retail development, and its variation according to the socio-economic environment in a city is extremely valuable in helping craft appropriate policies to achieve improved economic activity, efficient transport systems and better quality of life.

Previous research to understand retail travel behaviours used mainly aggregate analysis of the spatial structure of economic activities and retail development in an urban area, based on an assumption of relationships between retail travel behaviour and urban spatial structure. For example, a gravity-based travel demand analysis has been a fundamental approach for understanding retail travel patterns based on the relative distance and attractiveness of retail destinations (e.g., shop density) to retail travellers. The traditional paradigm is the trip-based models, which have been used fundamentally in urban planning and transportation forecasting to predict transport demand and evaluate the consequences of spatial policies. In the 1990s, urban policy shifted from long-term investment strategies to short-term market-oriented solutions. The need to develop transport demand models that could predict behavioural responses to policy measures was expressed in the academic research community. It led to the development of activity-based models, which view travel as the result of people organising their activities in time and space. Activity-based models are founded in behavioural theory and focus on the interdependencies between travel activity generation, transport mode choice, destination, stop pattern and route choice, in the context of multiple constraints that limit the choices of individuals and households.

In addition, activity-based analysis deems retail travel is a consequence of the household decision-making process, which has involved interactions and interdependence patterns between household members. Activity-based approaches have augmented our conceptualisation of travel behaviour by including mutual dependencies, for example, between the activity-travel schedules of different household members. Although the need to include multiple households' members has been identified from the very beginning of activity-based analysis, the topic of household decisions has still received relatively scant attention. According to Gliebe and Koppelman (2002), employment commitments and childcare responsibilities have significant effects on trade-offs between joint and independent activities. Chandraskharan and Goulias (1999) found that joint activities are appreciably affected by household size and age of the household members.

To assess the impact of intra-household dependence on retail travel activity and consequent transport patterns, this study developed an activity-based model to explore household retail travel behaviour using metropolitan Beijing as a case area. A conditional multi-nominal logit model (MNL) was developed to simulate household decision making on retail travel activities, including travel departure time and destination choices. In addition, the effects of household residential locations on retail travel frequency and trip chain patterns were evaluated. The models were then used to predict retail travel demand for evaluating alternative urban retail development and planning policies in Beijing.

2. An Activity Based Approach

The fundamental principle of the activity approach is that travel decisions are driven by a set of activities that form an agenda for participation and, as such, cannot be analysed on an individual trip basis. Thus, the choice process associated with any specific travel decision can be understood and modelled only within the context of the entire agenda. Activity-based models are founded in behavioural theory and focus on the interdependencies between activity generation, transport mode choice, destination, stop pattern and route choice, in the context of multiple constraints that limit the choices of individuals and households. Activity-based models aim at predicting on a daily basis and for a household what activities are conducted, with whom, for how long, at what time, the location, and which transport mode is used when travelling is involved (Arentze and Timmermans, 2000, 2005, and Miller and Roorda, 2003). The activity-based approaches that McNally and Rindt (2008) characterised generally reflect one or more of these factors:

(1) travel is derived from the demand for activity participation;
(2) the unit of analysis is sequence or pattern of behaviour;
(3) household and other social structures influence travel and activity behaviour;
(4) temporal, spatial, transportation and interpersonal interdependencies constrain activity/travel behaviour; and
(5) activity-based approaches reflect the scheduling of activities in time and space.

The need to incorporate household decision making in an activity-based approach has been acknowledged from the beginning. However, this topic has only recently received attention, the attention has been minimal, and a comprehensive model system at this level is still missing (Zhang et al., 2005, for a review paper). Several studies have been conducted on the interactions of individuals within households (Gliebe and Koppelman, 2002, 2005; Scott and Kanaroglou, 2002; Srinivasan and Bhat, 2004) but fewer attempts have been made to integrate the interactions in activity-scheduling models. Activity-scheduling models share an objective to predict the sequence of decisions that leads to an observed activity pattern of a household/individual. Incorporating mechanisms of household decision making should substantially improve the consistency and interdependencies in activity-travel decisions as an alternative to the more or less arbitrary breakdown of the multi-faceted decision problem, typical of the trip-based models.

3. Household Retail Travel and Decision Making

Retail activity production is a multi-level decision-making process. An activity-based approach to travel demand forecasting represents an attempt at improving the integrity of travel demand models by explicitly modelling various dependencies. These dependencies are not only concerned with the various choice facets (including travel time, destination, and transport mode), but also with dependencies between members of a household. Focus on the household as opposed to the traditional focus on the individual is especially important in the context of task and resource allocation and joint activities (Anggraini, 2009).

3.1 A Conceptual Framework of Household Retail Travel Decisions

Based on the sequences of decision making and interactive relationships, the process of household retail activity decision making can be divided into five decision phases, as illustrated by Figure 1. The first phase is household retail-activity generation. The outputs are the frequency of retail activity and number of household members required in the retail activity. In the second phase, the generated household retail activities (shopping tasks) are assigned to one or more household members based on their role in the family and household responsibility such as gender, age or head of household. In the third phase, the individual(s) with the retail task will decide on the possible travel chain (stop patterns) to complete the retail activity based on their own socio-economic characteristics and space–time constraints (e.g., employment commitment or childcare duty). The travel chain may involve three major modes:

(1) home–shop–home travel;
(2) home–work–shop–home travel; and
(3) home–others–shop–home travel.

Then in the fourth phase the retail traveller will plan travel time (travel departure time) and the amount of time spent on the retail activity that fits into his (her) own agenda. In the last phase, the individual retail traveller will choose travel destination (location of shops) and transport mode. Therefore, retail travel can be viewed as the consequence of multi-level household decision-making processes. In many cases, the retail travel decision at a single phase is not independent but is often influenced by the decision outcome of other phases, especially the adjacent decision phases. For example, if retail travel activity takes place at peak commuter hours in the day, the time spent on retail activity tends to be longer. Similarly, retail travel departure time and retail travel distance can be influenced by the different travel chains.

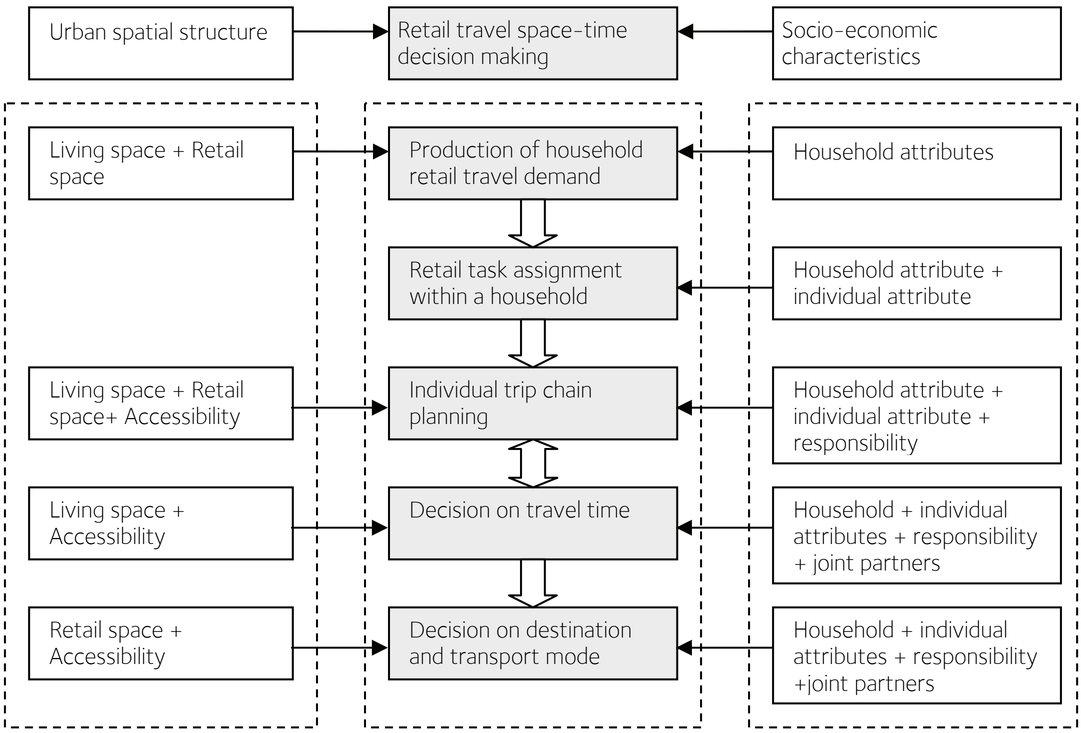


Figure 1: A Conceptual Framework of the Household Retail Travel Decision Process

3.2 Household Attributes and Retail Travel

One would expect that household characteristics such as the structure and the number of persons in a household influence the number and type of retail activities conducted in the household and therefore task allocation and travel decisions. Lee and Hickman (2004) examined time allocation of households within trip chains using simultaneous doubly censored tobit models. In particular, they compared trip chaining behaviour, among five types of households: single non-worker households, single worker households, couple non-worker households, couple one-worker households, and couple two-worker households. They found that household types, defined by the number of household heads and work status, strongly influence activity time allocation in trip chains. The presence of children in the household has a positive effect on the duration of all out-of-home activities in household trip chaining, except for the duration of out-of-home activities of households having children under five years old. This suggests that the presence of children induces more chaining of trips and more time allocated to these trip chains.

Retail activity participation and destination choice also depend on the transport modes that are available to individual household members. Car use often means that more destinations can be visited during a single trip or that destinations further away from home can be reached within a given time budget. Especially in car-deficient households in which the number of cars is less than the number of drivers, car allocation and usage is a household decision that impacts on many other choice facets of individual activity-travel patterns. Golob, Kim and Ren (1996) analysed how drivers are allocated to vehicles in multi-driver/multi-vehicle households. They found that gender, income, work status, age and the presence of small children influenced the number of vehicle miles travelled with the various vehicles. Hunt and Petersen (2005) also found evidence of gender differences.

3.3 Intra-household Dependency and Joint Participation

Joint participation in activities represents a substantial portion of non-work activities. It is an important component of retail travel during certain time periods and affects individual travel schedules. Joint participation in household retail activities and the provision of rides to family members constrain individual choice sets and affect the saliency of attributes that contribute to the generalised cost of travel alternatives. Therefore, this choice problem has generally attracted the most interest (Anggraini, 2009).

Several studies have examined the effect of household attributes on joint activity-travel behaviour. Kostyniuk and Kitamura (1983) and Chandraskharan and Goulias (1999) found that joint activities involving household heads are significantly affected by the presence of children. Couples without children living at home are more likely to pursue joint out-of-home activities than couples with children. In households with children, most joint activities between adults are at home. In addition, the employment status of the household heads influences whether a joint activity originated from home or from an out-of-home location.

The relative importance of joint activity participation is evident in that joint activities tend to have a longer duration than independent activities, and persons tend to stay out later and travel further from home (Kostyniuk and Kitamura, 1983). Moreover, Fujii et al. (1999) found that time spent on activities jointly with other household members, particularly with children, was incremental to individual feelings of satisfaction and in decisions to allocate time to joint and independent activities.

Nevertheless, the components of intra-household dependency and joint participation in retail activity decision making have not been fully examined by previous studies. In order to identify the influence of intra-household interactions on household retail travel patterns, we model the household responsibility and joint participation on retail travel. Many travel decisions can be influenced by intra-household dependency, including the plan of travel chain, duration of retail activity, and transport mode. Because this study focuses on household retail travel consequences on urban transport systems, our specific attention is to assess the influences of household joint participation on retail travel time and travel destination decisions (the fourth phase and the fifth phase of retail travel decision making).

4. Data and Method

4.1 Study Area and Data

Our collaborators at Peking University in China conducted an urban residents' activity survey in the Beijing metropolitan area in 2007. A stratified sampling strategy was used to select ten major residential areas in Beijing with different socioeconomic/demographic characteristics. Within each selected residential area, 60 households were chosen based on a systematic sampling approach. The survey was conducted based on a 48-hour activity diary (for a Sunday and the following Monday) with all activities performed by individuals of at least 16 years old in the sampled households. Among the 600 participating households in this survey, 520 households (with a total of 1,107 individuals) returned complete and valid responses. The dataset consists of a total of 19,691 activities including retail activities, household duties, employment and education activities, leisure, and other activities. This activity diary survey also collected data concerning the location and time associated with each activity, along with socioeconomic/demographic characteristics of all respondents. The data for retail business location and distribution was derived from the Beijing Business Survey for 134 major business blocks in the Beijing metropolitan area.

4.2 Variables

Based on the conceptual framework (Figure 1) discussed in Section 3, we use four groups of variables to estimate random utility functions of household space–time decision making on retail travels. As provided in Table 1, the variables in the first group represent individual and household socio-economic attributes. These include age, gender, individual income, driver's licence possession and so forth. The variables in the second group are intra-household dependency attributes, such as the role and household responsibility of individuals and joint participation factors of retail travel. The third group variables are spatial attributes, including information on people's residential locations, retail destination attributes and home–shop accessibility. The variables in the fourth group represent other factors that influence space–time retail decision making (e.g., variables describing outcomes from different household travel decision phases). Variables are selected for each model based on their significance to the space and time decision making.

Table 1 Variables for Random Utility Function of Retail Travel Space–time Decision Making

Variables (*X*)	Description	Time decision model	Location decision model
Individual and household attributes			
Gender	1: male, 0: female	√	√
Young	1: 18 < age < 40, 0: other	√	√
Old	1: age >–60, 0: other	√	√
Driver's licence	1: yes, 0: no	√	√
Low income	1: individual income –< 2000RMB, 0: other	√	√
Medium income	1: 2000RMB < individual income –< 6000RMB, 0: other	√	√
Children	1: have children over 6 years old, 0: other	√	√
Vehicle owner	1: yes, 0: no	√	
Household interdependency attributes			
Senior	1: yes, 0: no	√	√
Junior	1: yes, 0: no	√	√
Joint participation in retail activities	1: yes, 0: no		√
Spatial attributes			
Inner suburban living	1: yes, 0: no	√	√
Outer suburban living	1: yes, 0: no	√	√
Low business density	1: business density – 10~100/km^2, 0: other		√
Medium business density	1: business density – 100~200/km^2, 0: other		√
High business density	1: business density >– 200/km^2, 0: other		
Home–shop distance	1: 0~2 km 2: 2~4 km 3: 4~6 km 4: 6~8 km 5: 8~12km 6: 12~16km 7: 16~20km 8: > 20km		
Distance of travel	Distance between point of departure and shop		√
Decision-making attributes			
HSH	1: Retail travel mode is HSH, 0: other	√	√
HWSH	1: Retail travel mode is HWSH, 0: other	√	√
Departing hour	1: peak AM 2: off peak 3: peak PM 4: night		√
Retail activity duration	min	√	√
Travel time	min	√	
Non-motorised travel	1: retail travel by walk or bicycle, 0: other	√	√
Travel by public transport	1: retail travel by public transport, 0: other	√	√
Total shopping travel distance	km	√	

4.3 Method

We employ a multi-nominal logit model (MNL) to explore how certain individual characteristics and spatial characteristics affect household retail travel behaviour. The theoretical basis for the MNL is a random utility model. Random utility models proceed on a number of assumptions. The first assumption specifies that each decision maker is faced with a discrete set of choice alternatives. The second assumes that an individual will settle upon a decision from a set of available options in such a way that the most utility is yielded. The third assumption is that choices are made in a probabilistic fashion, so decision makers have a likelihood of making certain choices.

The MNL model is formulated as:

$$P_{ik} = \frac{\exp[V_{ik}(U_k, S_i)]}{\sum_j^n \exp[V_{ij}(U_j, S_i)]} \quad (1)$$

$$U_j = \alpha + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \varepsilon_j$$

Where U_k and U_j are the choice specific attributes of choices k and j respectively (in terms of retail trip making, this could represent costs, time, etc.); and S_i is the individual-specific attributes of choice k (e.g., decision maker's age, household role, etc.) The model states that the probability of a decision maker choosing an alternative k from a set of available alternatives j (e.g., j represents a set of retail time segments or a set of retail destinations) is a function of the attributes of the available alternatives and the decision maker's own characteristics.

In this study, two MNL models were developed to model the spatial-temporal retail travel decision making for households. One MNL model was developed for travel departure time choice, the other MNL model was for household retail destination choices. Based on the surveyed data, there were seven time segments used to construct the time choice set in the retail departure time decision model: Off-peak 1 (earlier than 7:30am), Peak hour 1 (7:30~9:30am), Off-peak 2 (9:30~11:30am), Peak hour 2 (11:30~2:30pm), Off-peak 3 (14:30~15:00pm), Peak hour 3 (17:00~19:00pm) and Off-peak 4 (after 19:00pm). Each time segment, indexed by j, has attached to it some utility U for the decision maker i. Because there are large numbers of retail businesses in the Beijing metropolitan area, using all retail business blocks will generate very large retail destination choice sets. Therefore, we use business blocks where the retail business density is greater than 10 shops/km^2 as alternative retail destinations (total 101 alternatives) and estimate a utility model using these alternatives.

5. Results

5.1 Retail Travel Departure Time Decisions

Table 2 provides the coefficient matrix of probability odds between all Peak hour retail travel and all Off-peak retail travels (only significant variables for travel departure time choice are included). We found that the retail activity with joint participation tends to have a stronger effect on departure time decisions than the effects of individual attributes. Compared with middle-aged people, young people tend to choose Off-peak time in the evening for retail travel. In addition, low income households and the people with a driver's licence tend to travel to shop in the second Off-peak period (9:30~11:30am) in the morning. As conditioned by other factors, intra-household interactions have shown significant effects on travel departure time decisions. This is evidenced by retail travels with joint participants being more likely to happen during Peak-hours in the evening. Finally, the results have shown the strong influence of the home location of travellers on retail travel patterns. For example, compared with inner city residents, people living in the inner suburbs are more likely to travel at Peak hours in the evening than Peak hours in the morning. On the contrary, people in the outer suburbs tend to choose first Off-peak hours in the day for retail travels.

Table 2 Coefficient Matrix of the Probability Odds between Peak Hour Travels and Off-peak Travels

	Peak hour AM				Peak hour PM			
	Off-peak 1	Off-peak 2	Off-peak 3	Off-peak 4	Off-peak 1	Off-peak 2	Off-peak 3	Off-peak 4
Young				−2.57***				−1.56*
Driver's licence		−0.83*						
Low income		−1.35***						
Accompany	2.77**	−1.33***		−3.18***	3.52**			2.43**
Inner suburban living				−2.24**				2.37**
Outer suburban living	−1.85*	1.24**	0.81*		−3.55***			1.58*
HSH				−2.3*	−2.12*			−3.13**
HWSH						2.32***	2.29***	
Retail activity duration		0.02***	0.02***	0.06***	−0.04***		−0.01**	−0.03**
Retail travel distance		−0.13*						
Non-motorised travel		1.24*						
Goodness of fit	Obs = 398; LR chi2 (126) = 358.17 (p=0.0000); Pseudo R2 = 0.25338							

In addition, the results have shown the clear influence of travel chain patterns on travel departure time decisions. Single purpose retail travels (HSH) are more likely to happen at Off-peak hours to avoid busy traffic and congestion. In contrast, multiple purpose retail travels (HWSH) tend to happen at Peak-hour in the evening, which is often combined with work to home commuting travels. Therefore, the probability of multi-purpose retail travel that takes place during Peak-hours is higher than the single purpose travel. This result has useful implications for transport planners. For example, single purpose retail travel will take 10 minutes at Off-peak hours, but this travel time will become five minutes if it is combined within a multi-purpose trip chain. However, because? when? multi-purpose travel takes place at Peak-hours, it will generate additional transport pressure and cost on the existing over-loaded transport systems. Therefore, although a mixed land use development for facilitating multi-purpose travels may reduce the overall single retail travel demand, it may also increase the opportunity for Peak-hour transport traffic and congestion in a city.

The last finding is that the planned household time spent on the actual shopping activity also influences retail travel departure time. For example, in relative to Off-peak periods, the probability of choosing Peak-hour AM for travel is higher for long time retail activities. Relative to choosing Peak-hours, long-distance retail travellers tend to travel in the second Off-peak period in the morning, but these travellers do not include the people who use a non-motorised transport mode.

5.2 Retail Travels Destination Decisions

Results in Table 3 show that household decisions on retail travel destinations are influenced by both retail shop attributes. Relative to the medium density retail destinations, people show a strong preference to shop at high density business blocks (e.g., big shopping centres). In comparison to retail density factors, distance of retail travel presents a stronger effect on retail destination choices. People living within two kilometres of retail shops show the highest probability of travelling and shopping at local stores. This is followed by the probability of people choosing a shop between four and six kilometres from home. The probability of choosing retail destinations that are located greater than six kilometres from home is relatively low and the probability tends to decay as the home–shop distance increases. Compared with home–shop distance variables, the pre-shop distance shows a higher probability impact (significant at 1 per cent level), demonstrating that retail destination choice is influenced more by the distance between the location of an individual (other than a home place) and a shop destination before undertaking retail travel.

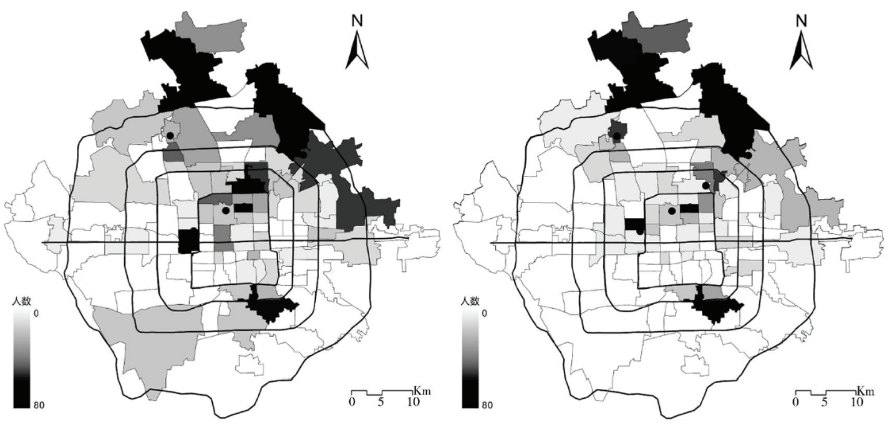
In addition, the socio-economic attributes of an individual show important influences on retail destination decisions. For example, people with a driver's licence tend to travel (four to six kilometres) longer than people who do not hold a driver's licence. The high probability of low income people travelling two to four kilometres to a retail shop indicates that the retail demand of a low income neighbourhood is not well supported by the local retail businesses (e.g., within two kilometres from home). In comparison to mature people, juniors in a household tend to travel a relatively short distance to a shop, two to four kilometres), rather than travelling a long distance. The impacts of intra-household dependency on retail destination choice appear to be significant. Household retail travels with joint participation tend to be longer than retail travels taken by an individual. For example, the probability of a joint retail activity to a remote shop (16~20 kilometres from home) as a destination is 22.4 times higher than choosing a local shop (< two kilometres from home). This indicates that compared with the socio-economic attributes of individuals, the intra-household inter-dependency factor presents a higher influence on retail destination decisions. The involvement of intra-household dependency factors is important for understanding household retail travel behaviour and transport impacts.

Table 3 The Estimated Results of the Shopping Destination Decision Model

Variable	Coefficient	Z value	P value	Odd ratio
Medium business density	−2.43**	−2.16	0.03	0.09
Low business density	0.12	0.12	0.90	1.12
Distance of travel	−0.36***	−10.00	0.00	0.70
Distance 2	−3.84***	−2.29	0.00	0.02
Distance 3	−0.93	−0.68	0.50	0.39
Distance 4	−4.17**	−2.15	0.03	0.02
Distance 5	−4.43**	−2.19	0.03	0.01
Distance 6	−6.19**	−1.96	0.05	0.00
Distance 7	−7.66***	−3.47	0.00	0.00
Distance 8	−4.29***	−3.43	0.00	0.01
Driver's licence (distance 3)	1.07*	1.90	0.06	2.93
Low income (distance 2)	3.04***	3.19	0.00	20.94
Medium income (distance 2)	2.81***	2.99	0.00	16.61
Medium income (distance 4)	2.00**	2.21	0.03	7.42
Junior (distance 2)	1.19*	1.79	0.07	3.28
Junior (distance 3)	−2.99*	−1.74	0.08	0.05
Accompany (distance 7)	3.09*	1.69	0.09	22.04
Inner suburb (low density)	0.94*	1.84	0.07	2.57
Inner suburb (distance 3)	1.79*	3.09	0.00	5.99
Inner suburb (distance 5)	2.52*	2.29	0.02	12.49
Outer suburb (distance 2)	3.15***	5.62	0.00	23.22
Outer suburb (distance 4)	2.00**	2.02	0.04	7.39
Outer suburb (distance 5)	4.11**	3.36	0.00	61.05
Outer suburb (distance 7)	3.60**	2.59	0.01	36.55
HSH (distance 3)	−0.91*	−1.75	0.08	0.40
HSH (distance 5)	2.27**	2.22	0.03	9.67
HSH (distance 6)	2.96*	1.91	0.06	19.35
HWSH (distance 5)	2.69**	2.29	0.02	14.76
Peak hour 3 (distance 3)	−1.68*	−1.75	0.08	0.19
Non-motorised travel (medium density)	1.27*	1.69	0.09	3.56
Non-motorised travel (distance 2)	−1.29**	−1.99	0.05	0.27
Non-motorised travel (distance 3)	−2.31***	−3.09	0.00	0.10
Non-motorised travel (distance 4)	−2.60**	−2.25	0.02	0.07
Non-motorised travel (distance 5)	−4.26***	−4.02	0.00	0.01
Public transport travel (distance 5)	−2.39**	−2.25	0.02	0.09
Goodness of fit	Obs = 398491; LR chi2 (125) = 1892.51 (p=0.0000); Pseudo R2 = 0.5244			

The residential attribute factors remain significant in determining the retail destinations. Inner suburban residents tend to shop at low density retail blocks, with medium travel distance (often four to six kilometres and eight to 12 kilometres from home). Comparably, people living in the outer suburbs tend to travel relatively longer distance to shops (six to 12 kilometres from home). Decisions on stop patterns (travel chain) and transport mode are also significant for retail destination choices. First, people on single purpose travel (HSH) tend to travel either short distance (two to four kilometres) or longer distance (eight to 16 kilometres) for retail activities. People on multi-purpose travel (HWSH) tend to travel eight to 12 kilometres to a retail destination. Decisions on retail travel departure time are not significant for retail destination choices, except that people taking retail travel at Peak-hour pm tend to shop at a place within two kilometres of home. Finally, transport mode shows a significant relationship to retail destination choice. People who use non-motorised transport modes are more likely to shop at medium density retail destinations rather than a high density retail destination, and the probability of using a non-motorised transport mode is lower when the home–shop distance increases. Compared with travelling on a non-motorised travel mode and public transport, people using a private vehicle tend to travel longer distances to a shop (eight to 12 kilometres).

In general, people's decision on retail destinations is a consequence of retail spatial demand and retail attributes as well as an individual's socio-economic attributes. The retail location decision model developed in this research can also be used for simulating and predicting the potential impact of urban retail development and restructuring on retail behaviour and activity changes. For example, Figure 2 (a) is the distribution of consumer retail activity from the survey data, and Figure 2 (b) is the simulated number of retail activities using the retail location (destination) choice model based on the assumption (scenario) of balanced retail density in Beijing. It is demonstrated that if the density of retail businesses tends to be evenly distributed across all business blocks in Beijing (i.e., they significantly increase the density of retail development in the suburban areas whilst reducing the retail density in the CBD), the distribution of consumer retail activity tends to be less dispersed and more concentrated around their place of residence. As a result, dispersed long distance retail travels can be largely reduced. Although to our knowledge the retail systems in a large urban area always appear to have a multi-level and hierarchical structure, restructuring of retail development to balance the urban resident–shop relationship may have important effects on reducing urban retail travel demand and improving transport efficiency.



(a) (b)

Notes: (a) survey data, (b) simulated result based on the scenario of balanced retail business density.

Figure 2 Spatial Distributions of Consumer Retail Activities in the Beijing metropolitan area

6. Discussion and Conclusions

Using 2007 Beijing resident travel survey data, this research has developed activity-based household retail travel demand modelling. The MNL model was developed for analysing retail travel behaviour with a focus on retail travel departure time and retail travel destination. The model was also applied to predict the retail activity distribution based on the retail development scenarios.

A number of factors derived from a conceptual household decision framework were used as explanatory variables to develop household retail decision models. These include socio-economic attributes of individuals and households, retail destination attributes and other retail decision factors. In addition, the model has specifically incorporated intra-household dependency factors into the household activity-based modelling framework to model travel decisions. The major finding is that the intra-household dependency factors present a significant effect on retail travel space-time decision making in addition to the impacts of individual socio-economic attributes. Compared with Off-peak hours, people travelling at Peak-hour AM tend to live in outer suburbs with lower income and using non-motorised transport. Those conditions are also associated with people who often spend a longer time on actual retail activities. People travelling to a shop at Peak-hour PM are often inner suburb residents who are often accompanied by other household members for retail travel. Retail travels at Peak hour PM are often combined with their types of travel (work to home trips). Based on the results of retail destination decision model, distance is a more important factor than shop density in determining retail travel destinations. Nevertheless, compared with retail travel on weekdays, more people would choose high density retail destinations for shopping activities on the weekend. Finally, socio-economic attributes were found to be correlated more to the distance of retail travel than to the density of retail destinations.

Results from both retail travel departure time and destination models have strong implications for urban land use and transport planning and for urban policies. The high probability of multi-purpose retail travel taking place at Peak-hours indicates that mixed land use development would also facilitate multi-purpose trips and reduce overall single travel demand, and it may increase the risk of Peak-hour traffic and road congestion in the city. Based on the simulated result using the retail destination model, we found that the decentralisation of retail businesses towards suburban retail centres will lead to less dispersed consumer retail activities and reduced distance of retail travel. Nevertheless, limitations of this research remain and form avenues for future research. First, the differences in retail travel activity behaviours between weekdays and weekend were not compared. Second, other influencing factors such as the relationship of type of goods and price to retail travel pattern were not included in the study. All these issues will be further investigated in future research when necessary data is available.

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