Shopping trip frequency and duration in Canada: An analysis of personal trends based on the General Social Surveys of 1998 and 2005

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ABSTRACT

Shopping is an essential aspect of our day to day lives, as it is necessary in order to fulfill numerous needs and desires. Evidence suggests that the proportion of travel for retail and service is increasing, such that traffic congestion can no longer simply be attributed to work related travel. The restructuring of the commercial sector and automobility has increased competition between outlets, such that stores are now competing against merchants across a large spatial region. As a consequence, many consumers are required to travel long durations to accomplish shopping activities.

Discrete/continuous models can determine the likelihood that an individual will engage in a shopping activity, followed by the analysis of the travel duration. The models can overcome the sample-selectivity bias, since shopping is only accomplished by a subsample. Traditionally, the models have been estimated disjointly, however, they are increasingly being estimated jointly.

Using the General Social Survey, the objectives of this study are twofold. First, the study aims to analyze the shopping frequency and travel duration of Canadians by comparing the one day behaviour of residents of non-Census Metropolitan Areas (non-CMA) and Census Metropolitan Areas (CMA) for 1998 and 2005. Second, it will investigate the potential of a newly developed discrete/continuous model for the joint analysis of shopping travel behaviour. The results of the analysis suggest that shopping travel behaviour is similar regardless of region, and that the joint model provided consistent and realistic estimates.

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CHAPTER 1 INTRODUCTION

Travel is an essential aspect of life today. As individuals strive to meet needs, whether they be social, health or work related, the setting for those activities are in general distributed across space (Ortuzar and Willumsen 2001). Consequently, with few exceptions (e.g. sight-seeing), the demand for travel is derived from the need to participate in activities (Ortuzar and Willumsen 2001). Travel is accomplished on the transportation system, which according to Miller (2000) consists of:

- network – physical infrastructure such as roads, highways, rail lines, etc, and also stations, control systems and etc;
- service – public transportation, taxi, etc;
- automobile - ownership and access.

Miller (2000) describes the role of the transportation system as "to provide the means by which people and goods can move from point to point … to participate in the broad range of activities" (p.173). The transportation system is necessary because it provides a method by which individuals and goods can travel between locations.

The transportation system has experienced great change during the later part of the 20th century. The change is caused by such factors as socio-economic change (e.g. women in the workplace), increasing household affluence and automobile ownership (Kanaroglou and Scott 2002; Vande Walle and Steenberghen 2006), along with the growing complexity of the urban form. This urban form is increasingly less monocentric, as many places can be characterized as polycentric (Miller 2000; Kanaroglou and Scott 2002). These changes have been accompanied by growing automobile use and an increase in the daily vehicle kilometre travelled (VKT) (Maat and Timmermans 2007). The automobile offers its users greater mobility and speed (Alvort 2000) which allows individuals to travel farther within a certain time period (Limtanakool et al. 2006). Therefore, individuals are able to travel longer distances to accomplish their activities, and likewise firms and activities are not required to locate near housing. The automobile, however, is also associated with numerous negative externalities such as congestion, pollution, accidents, and financial deficits from increased infrastructure and maintenance costs (Miller 2000; Alvort 2000; Ortuzar and Willunsem 2001; Belzer and Aulter 2002; Kanaroglou and Scott 2002; Zhang 2005). With increased demand on the road network and emerging concern for the environment and climate change, there is a growing need to manage the transportation system in order to maximise its benefits and to minimize its adverse impacts.

Traditionally planners believed transportation problems, such as congestion, needed a transportation solution. Therefore the problem was solved by investing in transportation infrastructure, most notably increasing road capacity by building new roads or widening existing ones (Miller 2000; Maat et al. 2005). However, the expansion of the road system was only a temporary solution, as improved roadways usually generated more traffic due to latent demand (Alvort 2000; Maat et al. 2005; Frank et al. 2008). Consequently, improvements to the road system or technological modification to the automobile are not sufficient solutions to transportation problems (Alvort 2000; Maat and et al. 2005).

To enhance the understanding of the transportation system and travel demand, transportation planners and researchers have been employing mathematical and/or computer based models for decades. A model is a simplified representation of a part of the real world (Ortuzar and Willumsen 2001) and its purpose includes describing the current situation and predicting the outcome of 'what if' scenarios (Wilson 1997; Kanaroglou and Scott 2002). Consequently, a model can be used to estimate the potential impacts of a policy before it is implemented (Wilson 1997; Kanaroglou and Scott 2002). The role of models is to assist a planning agency or government official in the decision process. As Ortuzar and Willumsen (2001) state "[t]ransport modeling is not transport planning; it can only support planning".

Traditionally, transportation demand models were performed using a trip-based approach, in particular the Urban Transportation Modeling System (UTMS) (Kanaroglou and Scott 2002; Páez et al. 2006). Trip-based approaches, however, are criticized for their lack of flexibility and limited behavioural capabilities. Travel demand research is increasingly concerned with the underlying reasons behind the trip generated (Bhat and Misra 1999). Consequently, a modeling paradigm known as activity-based travel analysis or activity analysis is emerging. Activity analysis recognizes explicitly that travel is a derived demand from the need to participate in out-of-home activities which are dispersed over space and time (Miller 2000; Kanaroglou and Scott 2002). In activity based modeling approaches, allocation of time is a key component, as opposed to trip-based approaches where time is simply a "cost" of making a trip (Bhat and Koppelman 1999; Pendyala and Bhat 2004). According to Zhang (2005), analyzing how individuals decide to allocate their time to activities provides insight on the subsequent demand for travel.

The shift from traditional trip-based to activity-based approaches has motivated a growth of new statistical and econometric techniques (Lee and Timmermans 2007) such as discrete/continuous models, and also has allowed more detailed examination of specific aspects of travel demand. Methodologically, discrete/continuous models have become a standard tool for studying travel behaviour. Although models had been estimated disjointly or sequentially they are increasingly being estimated simultaneously. Discrete/continuous models are particularly germane to the study of activity patterns, since they can be applied to activity generation to estimate the likelihood that an individual will engage in an activity under examination, followed by the analysis of the duration of the activity. Consequently the analysis involves a discrete (activity generation) and continuous (activity duration) process. In most cases, activity participation is only accomplished by a subsample of the population, subsequently, if activity duration is studied independently using only this subsample, the results could be influenced by self-selection or sample-selectivity bias (Train 1986).

In terms of substantive aspects of travel behaviour, travel for shopping activities has garnered attention in recent years (e.g. Bhat 1996; Hamed and Easa 1998; Bhat and Steed 2002; Rosen et al. 2004). Shopping is an essential aspect of our day to day lives as it is necessary in order to fulfill numerous biological (i.e. food) and other needs (e.g. clothing, etc) but it can also be a leisure or social activity. Despite the rise of online shopping (e.g. Moktarian 2004; Farag et al. 2006), shopping continues for the most part to be carried out away from home. As a result shopping activities induce travel. The study of shopping travel behaviour is growing in transportation research since there is evidence that the proportion of travel for retail and service activities is increasing such that traffic congestion can no longer simply be attributed to work related travel (Bhat and Steed 2002; Zhang 2005). Bhat and Steed (2002) state that the flexibility of shopping travel is likely to be influenced by such factors as socio-demographic characteristics and transportation control measures. From a technical perspective, a complicating factor in the analysis of shopping travel behaviour is the fact that on any day, shopping is only accomplished by a subsample of the population. The application of discrete/continuous modeling approaches is key in this situation to contribute to the understanding of shopping travel behaviour due to the high risk of sample-selectivity bias.

From a Canadian perspective, shopping travel behaviour is believed to be different for small urban or rural residents and residents of large urban areas. Historically, it has been assumed that residents who live in rural areas spend more time travelling in order to engage in different activities compared to residents who reside within urban areas (e.g. Pucher and Renne 2005). However, this statement has not been thoroughly researched. Rural areas have experienced a continual increase in automobile ownership and improvements to the transportation network (in particular arterial highways and the expressway system), allowing residents to travel longer distances in less time. Meanwhile, similar improvements to transportation technology and infrastructure have facilitated the decentralization of activities and sprawl, which in turn, has increased the need for travel.

The commercial sector is highly dynamic and always in a state of change as stores open, move and close (Jones 2000). The sector is responsive to the changes in urban form, the transportation system, socio-demographic characteristics and economic competition between firms (Jones 2000; Hernandez and Simmons 2006). Currently, the shopping behaviour of metropolitan and non-metropolitan residents is being modified, as the commercial sector is being restructured. Large format retailers and power centres commonly associated with large metropolitan areas are increasing their presence in smaller markets (Gomez-Insauti 2006). Gomez-Insauti (2006) states that between 2000 and 2004 large firms displayed two main tendencies:

> 1. In large urban markets, firms are increasing the number of large format stores - most notably in power centres - and decreasing the number of location in malls.
>
> 2. Increasing the number of locations in smaller urban markets, in particular in cities under 100,000 residents.

Consequently, the commercial sector in Canada is changing such that the proportion of large format retailers is increasing not only within large metropolitan areas but are also expanding into smaller markets.

The current restructuring of the commercial sector has resulted in fewer, but larger retail outlets, in decentralized areas (Bromley and Thomas 1993; Gomez-Insauti 2006). The result of the new commercial environment is increased competition between outlets, such that stores are no longer simply competing against other stores within the same neighbourhood, but often against stores across the entire community or even across an entire region (Vias 2004; Hernandez and Simmons 2006). Although, the current system has been mostly problematic for smaller (independent) retailers, for consumers on the other hand, the system has provided numerous benefits (Vias 2004). These include increased quantities of products available, as the creation of superstores means consumers can do much of their shopping at one location, reducing the number of trips to obtain lower prices for goods and services (Vias 2004). However the trade-off is that most consumers must travel longer distances to access them. As such, the benefits are generally only available for individuals who own an automobile (Bromley and Thomas 1993). Individuals with poor mobility, such as those without access to an automobile, are at a disadvantage since they cannot easily travel longer distances. Thus they are dependent upon stores that are easily accessible by foot or public transit (Bromley and Thomas 1993). Furthermore, Bromley and Thomas (1993) suggest that the greatest disadvantage is suffered for convenience goods. In the CMA of Greater Sudbury, Ontario, a senior had such difficulty in fulfilling her shopping needs that she wrote a letter to the local paper voicing her displeasure with the current layout of the shopping sector (The Sudbury Star 2004). She states that the increasing dominance of big box stores is fine for automobile owners, but makes shopping nearly impossible for seniors such that they require transportation assistance.

The in-fill of stores and shopping centres in the inner city and the downtown core suggest a possible reduction of automobile dependency. However the type of commercial formats returning to the core are increasingly large format and power centres. The result is what architecture critic Christopher Hume describes as the 'inner-city suburbanization' (Jones and Doucet 2001). According to Jones and Doucet (2001), the new stores supply ample free parking and are open long hours, which negatively impact the existing traditional and sometimes historic shopping centres.

The restructuring of the commercial landscape is such that automobile ownership is becoming a necessity for consumers in order to fulfill their shopping needs. Automobility increases the volume on roads, thereby placing greater demand on transportation networks. Accordingly, many metropolitan areas suffer from congestion, which increases travel time for its residents. Meanwhile, rural residents have access to roads with higher speed limits, which allows individuals to travel greater distances in less time. As a result, Pucher and Renne (2005) state that net impact on accessibility between rural and urban areas is not clear.

The objectives of this study are twofold. First, the study aims to analyze the shopping frequency and travel duration of Canadians for 1998 and 2005 using the General Social Survey. And second, the study will contribute to the growing body of econometric research by investigating the potential of a newly developed discrete/continuous model for the joint analysis of ordered (i.e. generation) and continuous (i.e. duration) outcomes. Analysis of shopping behaviour will describe the one day attributes for residents of non-Census Metropolitan Areas (non-CMA) and those living in Census Metropolitan Areas (CMA) and investigate the claim that consumers in rural areas tend to travel longer durations to satisfy their shopping needs. Disjoint discrete/continuous models are used to construct models to determine possible factors that influence shopping travel behaviour, in particular the propensity to perform shopping tours and the total duration spent travelling for shopping. The models compare non-

CMA and CMA residents for two different periods, 1998 and 2005, to examine whether, and if so how, shopping behaviour has changed over time. Next, shopping frequency and travel duration will be modelled using a joint discrete/continuous approach. The joint approach, which estimates the discrete and continuous models simultaneously, will be compared to a disjoint approach to investigate its potential for single discrete activity generation and continuous time allocation applications.

The remainder of the thesis is organized into five chapters.

Chapter 2 provides contextual information concerning approaches to transportation research. Land-use and time use are of particular interest to researchers since they are two important aspects that influence travel, namely distance and travel time. In particular, time is a key element in activity-based approaches because it represents an absolute constraint to mobility. Meanwhile land-use and destinations are considered locational or contextual constraints (Bhat and Koppelman 1999). Section 2.3 provides background information on activity-based approaches describes why an activity-based approach is ideal for studying shopping behaviour.

Chapter 3 presents an overview of the commercial sector along with background information on metropolitan and non-metropolitan regions. The analysis of shopping behaviour is complicated by the dynamic nature of the commercial sector. The commercial sector is currently undergoing restructuring such that the traditional spatial markets are largely indistinguishable and the automobile is increasingly required to undertake shopping trips.

Chapter 4 begins by introducing the datasets employed along with some definitions. Section 4.2 provides background information on key concepts of econometrics and section 4.3 describes the methodologies used which consist of three parts. First is the descriptive analysis of the observed shopping behaviour. Next, is the description of the discrete ordered and continuous models used to analyze shopping travel behaviour for 1998 and 2005. The discrete model consists of an ordered probit specification to analyze shopping tour generation. The continuous model, which estimates shopping trip duration, consists of a linear regression estimated using the three stage least squared method. Last, is the development of a joint discrete/continuous model where the discrete model is also an ordered probit, but the continuous model consists of a hazard model. This model also specifies the potential correlation between its discrete and continuous components; in order to account for endogeneity in activity generation and duration.

Chapter 5, 'Results and Discussions', begins by presenting the findings of the descriptive analysis and discusses trends in shopping behaviour. Afterwards the results of the disjoint discrete/continuous models for 1998 and 2005 are presented starting with the results of the ordered probit or tour generation analysis, followed by the duration analysis. At the end, the result of the joint discrete/continuous model is discussed.

Chapter 6 concludes the study. An overview of the results is presented and highlights how travel for non-work activities such as shopping impacts the transportation system. Limitations of the study are discussed, along with possible future research directions.

CHAPTER 2 CONCEPTS OF TRANSPORTATION MODELLING

In this section an overview of key aspects of transportation modelling are presented. Transportation and urban form are believed to be semi-dependent systems as supply and demand in one often results in a response in the other (Miller 2000). However, despite numerous researches there is still no consistent evidence that changes in the urban form could be employed as a strategy to reduce congestion and automobile dependency. This has led some researchers such as Miller (2000) and Maat et al. (2005) to state that time is a central factor for travel decisions. These two aspects are briefly discussed in the present chapter.

2.1 Transportation and Urban Form

The spatial distribution of activities (work, shopping, education, etc) along with the location of people (where they reside) is referred to as urban form. Urban form is defined by Kanaroglou and Scott (2002) "as the spatial configuration of fixed elements within a metropolitan area" (p.45). Urban form is a key concept because as described in the introductory chapter, individuals must participate in out-of-home activities and the spatial distribution of activities (residence, work, shopping, discretionary, etc), which in turn influences the number of vehicle kilometre travelled (VKT) (Bento et al. 2005).

Since the end of World War II urban planning has largely focused on accommodating the automobile (Miller 2000; Bento et al. 2005). Increased automobile ownership reduced the necessity of proximity between destinations (Miller 2000). As a result of increasing automobility and other factors, contemporary urban landscapes are largely characterized by low density and high land-use segregation, in particular in the newer suburban areas of cities (Miller 2000). Consequently, it takes a significant amount of travel in order to accomplish a series of activities. As a result, individuals have tended to become dependent on the automobile because the distances are too great to realistically walk and the density too low to efficiently service using public transportation (Miller 2000; Maat et al. 2005). In this situation, Miller (2000) suggests that land-use may place "too heavy a burden on the road system." (p.178)

While low density sprawl induces automobile dependency, high density and mixed-use are believed to reduce reliance on the automobile and promote transportation alternatives (Miller 2000; Krizek 2003a; Maat and Timmermans 2007). Urban developments which have a goal to reduce automobile dependency have been given various labels such as, New Urbanism, including smart growth, neotraditional development, transit-oriented development (TOD) (Krizek 2003a). It is generally assumed that if the number of possible destinations near to home increases, the distance travelled decreases, since individuals are more likely to select nearby locations (Maat et al 2005; Maat and Timmermans 2007). Therefore, it is believed that shorter distances between activities will result in a reduction in the vehicle kilometre travelled by making it more likely that individuals will walk or bike (Maat et al. 2005).

There is a growing amount of research concerning the relationship between land-use and transportation (Maat et al. 2005). However, the results have been inconsistent and there are counterclaims for studies demonstrating a relationship between land-use and travel (Krizek 2003b; Maat et al. 2005; Maat and Timmermans 2007). While one study will find evidence that dense land-use will result in the reduction of travel distances, another may conclude that it generates a greater amount of trips and thus more overall travel (Badoe and Miller 2000; Krizek 2003b). The urban form approach to transportation demand attempts to reduce motorized mobility by decreasing the distance travelled or VKT.

Maat and Timmermans (2007), however, state the relationship between land-use and travel is not straightforward but rather travel behaviour is the result of a complex process. The decision process is subject to numerous factors, including individual and household characteristics, land-use (locations of activities) and constraints due to the time available and mandatory activities (work, eating, sleeping, etc) (Maat and Timmermans 2007). As a result, Miller (2000) believes that the distance between destination (or activities) is no longer the primary factor when selecting a destination, but rather it is the relative ease of travel. The ease of travel is determined by travel time, cost, reliability of service, etc (Miller 2000) and travel time consists of not only the travel distance but also the speed that an individual can travel (Maat et al. 2005). In other words, travel behaviour is constrained not only by space but also and more importantly by time (Maat et al. 2005).

2.2 Time Use Approach

Time is of particular importance because unlike other factors such as price, it is considered an absolute constraint since there is a fixed amount available per day (Bhat and Koppelman 1999; Golob 2000; Pendyala and Bhat 2004; Zhang 2005; Vande Walle and Steenberghen 2006). An individual cannot increase the time available on a given day. As a result an individual can only perform a limited amount of activities per day

(Pendyala and Bhat 2004; Zhang 2005). Each day an individual must allocate time for various activities in order to satisfy personal and/or household needs. In addition, because activities are spatially distributed an individual must also allocate time for travel. Confirming this, Frank et al. (2008) found time to be the most important factor in the decision making process.

The allocation of time is also subject to various constraints which Hägerstrand (1970) classifies into three groups. The first is *capability constraint* which is due to biological needs (such as the need to sleep and eat) and physical characteristics by which humans are constructed. This includes physical limitations, such as an individual can only travel a limited distance in a given time-space and can only be at one location at a time (indivisibility). The second is *coupling constraints* which happen when an individual must perform certain activities with another person. Coupling or bundled activities may reduce the time available to engage in personal activities. The last constraint is called *authority constraints* which are limitations on how an individual can spend his time set by authority agents (i.e. governments, institutions, parents, etc). These constraints are restrictions set by general rules, laws, economic barriers, etc. For shopping, an example of authority constraint would be the hours of operation since a consumer can access the store during designated times. As a consequence of the time budget and the set constraint, there exists a trade-off between activities. If an individual increases the time performed on one activity he or she reduces the time available for other activities.

An individual's travel time is dynamic and the changes are often reflected in his or her travel behaviour. The result of a change in travel time could be the modification of the choice set (addition or withdrawal) of possible destinations and/or the duration for activities. An increase in travel speed, which reduces travel time, allows the individual to visit destinations that were previously not possible. Saved time (obtained from reduction in travel cost) can be allocated to a new preferred location situated further away with a higher travel cost (Chen and Mokhtarian 2006), in which case the reduced travel cost would lead to an increased amount of travel. Alternatively, saved time could be allocated for activities (Maat et al. 2005). An increase in travel time on the other hand may result in a reduction of available destinations because some are no longer within reach in the time budget available and/or decreases the duration for activities (Chen and Mokhtarian 2006). The change in travel time can be voluntary or involuntary. Voluntary is a change induced by the individual, such as using a faster means of transportation or traveling to nearer destinations. Involuntary is a change that occurs outside the individual's control such as a modification in transit schedule or construction on the road network.

In addition to the travel time, the duration of the out-of-home activity is also an important factor when selecting a destination. If travel time is such that after traveling there is not any time available to spend at the destination, then this destination is not a practical alternative for the activity (Dijst and Vidakovic 2000). Chen and Mokhtarian (2006) state that travel time necessary to reach the destination is an influential factor on the amount of time available to spend on flexible activities (i.e. discretionary activities). Chen and Mokhtarian (2006) therefore believe lower travel time implies that more time can be allocated to activities, meanwhile, higher travel time implies less time is allocated to activities. Hamed and Mannering (1993) also believe that travel time and activity duration are related; however, they found travel time and activity duration were positively correlated. Therefore, individuals who travel longer durations to participate in an activity are more likely to spend more time in that activity. Dijst and Vidakovic (2000), however, believe the relationship between travel time and activity duration is unclear as they are usually studied separately and few studies explore their relationship.

Travel time is also a significant factor when selecting one's transportation mode (Vande Walle and Steenberghen 2006). Maat and Timmermans (2007) state that individuals will select a transportation mode that will allow them to reach the desired activities within the time available. Meanwhile, according to Vande Walle and Steenberghen (2006) if all relevant factors are constant an individual will usually select a transportation mode which gives the lowest travel time. Vande Walle and Steenberghen (2006) further suggest that travel time should be seen as consisting of more than travelling or in-vehicle time, since it also includes preparation time, walking time, waiting time, and transfer time. Preparation time is the time used getting ready for the journey. Walking time consists of access and egress time spent walking to/from parking spot or transit stop. Waiting and transfer times are the duration spent waiting for the arrival and between vehicles and is most common for public transit. Vande Walle and Steenberghen (2006) describe how each of these times is viewed differently by each individual. They state that typically out-of-vehicle times are perceived more negatively compared to in-vehicle time. Frank et al. (2008) state for transit and auto users a minute of walking is much more irritating than a minute in the vehicle. In general, transfer time is perceived the most negatively and the perception increases the less familiar and frequent the trip (Vande Walle and Steenberghen 2006). Consequently, individuals may have a negative perception of public transportation because the users are more likely to be affected by out-vehicle times such as walking, waiting, and transfer times. Frank et al. (2008) suggest that a reduction in travel time for the automobile would induce more driving and subsequently less transit and walking.

2.3 Activity-based Approaches

The trip-based approach, in particular the Urban Transportation Modeling System (UTMS) or four-step model (FSM) is the most frequently used method for assessing urban transportation systems in Canada (Kanaroglou and Scott 2002; Paez et al. 2006). Since the UTMS is widely used today it is referred to as a state-of-the-practice (Kanaroglou and Scott 2002). The UTMS is employed to forecast the future demand on the transportation system and also to investigate its performance. The UTMS was initially developed for assessing large-scale infrastructure projects such as the construction of an intercity expressway (McNally 2000). These methods are usually focused on a certain period of the day, usually morning or evening peak, while ignoring the remainder of the traffic generated throughout the day.

Since the early 1980s, there has been increased effort to reduce congestion and harmful environmental emissions (Kanaroglou and Scott 2002). In order to reduce pollution and to improve the efficiency and effectiveness of the transportation system, Travel Demand Management (TDM), such as peak-period pricing or transit-use incentives, have been implemented. To apply the most effective TDM, according to

Shiftan and Suhrbier (2002), the authorities must know the response to various enquiries such as:

- How travelers will respond to a given TDM?
- What reduction in travel and emission can be expected from each TDM?
- What are the costs and benefits of each TDM?

However, Shiftan and Suhrbier (2002) go on to state that the current available tools are incapable of efficiently evaluating many TDMs and therefore can not effectively answer these questions. According to McNally (2000), the UTMS is policy relevant for predicting alternative methods for major capacity improvements and not effective for forecasting policies which control or restrict demand on the existing infrastructure. Bhat (1998) argues that state-of-the-practice models can not accurately estimate the number of trips and properly evaluate numerous transportation control measures. Consequently, it is increasingly argued that trip-based approaches can not significantly forecast the relationships between the transportation system and the consequences of alternative policies.

Trip-based approaches analyze the trip decisions without taking into account the time-use context in which activities and travel occur (Bhat and Koppelman 1999). Consequently according to Bhat and Koppelman (1999), they do not take into consideration the broader process in which travel decisions are made. Critics of trip-based approaches claim that individuals initiate the trips. It is argued that travel is not a mean in itself but derived from the need to participate in activities across space (Bhat 1996; Bhat and Misra 1999; Kanaroglou and Scott 2002; Pendyala and Goulias 2002).

Consequently, the transportation researcher's interest to model the behavioural response to transportation policies has motivated the development of a new modeling paradigm known as the activity-based approach (Pendyala and Goulias 2002).

Activity-based approaches explicitly recognize that travel is derived and attempt to improve the understanding of the behavioural basis for the individual's activity pattern (Bhat and Koppelman 1999). The principal difference between trip-based and activity-based approaches is the treatment of time. In a trip-based approach, time is simply a cost of making a trip. Meanwhile, in an activity-based approach time is the central element in which individuals perform their activity and travel episodes (Bhat and Koppelman 1999). Activity-based approach also takes into consideration that the individual's time use decisions are subject to various other factors such as socio-demographic and spatial characteristics, along with other contextual constraints (Bhat and Koppelman 1999; McNally 2000). It is believed that activity-based approaches can overcome the shortcoming of the current planning practice (Pendyala and Goulias 2002) and in hopes that it can eventually replace current trip-based models and the tradition 4-stage UTMS (Miller 2000; Scott and Kanaroglou 2006). As a result, activity-based travel analysis has expanded and has experienced significant progress over the past decade (Bhat and Koppelman 1999; Yee and Niemeier 2000; Scott and Kanaroglou 2002).

Shopping activities are necessary, however they are considered flexible in terms of frequency, time and choice (Hamed and Easa 1998; Rosen et al. 2004; Maat and Timmermans 2007). Furthermore, Hamed and Easa (1998) discuss how shopping activities are not only performed during the a.m. and p.m. peaks but also at different times throughout the day and different places throughout an urban area. The flexibility of shopping trips makes them difficult to understand and to forecast using the current state-of-the-practice modelling approaches. However, Arentze and Timmermans (2005) argue that activity analysis provides an ideal framework to study shopping behaviour. They suggest that recent developments in activity theory, such as improvements in analytical techniques and technological advances have improved data collection such that the number of datasets available and their reliability have improved (i.e. activity-travel diaries). As a result, Arentze and Timmermans (2005) believe that activity-based approaches are more capable of capturing the interrelated factors which influence shopping behaviour such as the choice of destination, transportation mode, timing and duration of the episode. Numerous studies on shopping or shopping behaviour have used activity analysis methods (e.g. Bhat 1996; Hamed and Easa 1998; Bhat et al. 2004; Lee and Timmermans 2007).

Shopping behaviour is complex and dynamic and not well-understood. Numerous factors are believed to influence shopping behaviour, including socio-demographic, household and work characteristics, the mode of transportation available, individual preferences, external constraints, and day of week, among many others. To further add to the complexity the shopping behaviour is the interaction with the supply-side of the commercial sector (Arentze and Timmermans 2005). As described above the commercial sector is dynamic and recently has undergone dramatic changes. The resulting landscape is large outlets, in fewer and more peripheral location (Bromley and Thomas 1993; Arentze and Timmermans 2005; Gomez-Insauti 2006). Meanwhile on the demand side, lifestyles change, such as increasing participation of females in the workforce, and enhanced competition from entertainment activities and technology (cell phones, cable TV, Internet, etc) have modified shopping behaviour (Bulter 2004; Arentze and Timmermans 2005).

In Chapter 3, there is a description of the trade-off between travel time or distance and price or quality. However, shopping decisions are not exclusive of the result of this relationship but rather are made in the larger daily context. Maat and Timmermans (2007) state that it is often assumed that individuals will attempt to organise their activities in such a manner that will reduce their travel to a minimum. A method used to reduce the time traveling is to organise or link several activities into a single tour, thus forming what is describe as trip chaining (Maat and Timmermans 2007). Although the concept of trip chaining is widely recognised by transport planners, there is no universally accepted definition (Primerano et al. 2008). In general, a trip chain or tour is defined as successive trips performed by an individual, starting at a place of reference or anchor and ending at a reference place. Therefore a tour consists of numerous stops where the individual performs an activity (Vande Walle and Steenberghen 2006). The ability to perform tours also influences the mode of transportation used by the individual, as automobility increases the ease of performing complex tours (Golob 2000; Vande Walle and Steenberghen 2006; Maat and Timmermans 2007).

As a result, the choice of shopping destinations is selected based on convenience within the individual's daily activity schedule (Jackson et al. 2006). Consequently, an individual shopping trip duration is likely to be influenced by other daily activities. The time available for shopping is constrained by other activities, along with the nature and flexibility of both prior and subsequent activities. As a result, since shopping is often flexible it can be modified according to daily conditions (Maat and Timmermans 2007) and accordingly an individual may adjust their shopping trip duration to ensure he arrives on time for a subsequent appointment (Arentze and Timmermans 2005). For example, Hamed and Easa (1998) found that commuters who accomplished a shopping episode on the home to work trip were more likely to have a shorter episode duration compared to work to home journey because of the penalties imposed for being late for work.

In activity-based modelling approaches, work characteristics are an important factor since they influence the time available for other activities. Bhat and Koppelman's (1999) overview of time-use research indicate many studies which found a negative correlation between employment and out-of-home discretionary activities. Bhat (1996) states that the longer the work duration, the less time is available for participation in other activities and subsequently less time is available for shopping. In addition, Srinivasan and Bhat (2005) found that employed individuals prefer not to shop, and the longer the duration at work, the less likely they are to perform a grocery shopping episode during the day. For shopping behaviour, numerous studies including Hamed and Mannering (1993), Bhat (1996), Bhat (1998), Hamed and Easa (1998), Bhat and Steed (2002), Bhat et al. (2004), Arentze and Timmermans (2005) and Srinivasan and Bhat (2005) include some type of work characteristics as a part of their analysis.

Employment not only influences time available for shopping but also helps determine the departure time for shopping trips. Bhat (1998) and Bhat and Steed (2002) found that employed individuals were less likely to shop in the midday period because of work constraints and consequently found that they primarily accomplished their shopping activities in the evening. Furthermore, Bhat (1996) states that a significant number of individuals performed shopping episodes during the work to home trip. Results found by Bhat (1996) include the mode of transportation and with who, along with the work characteristics of the spouse, affect shopping behaviour. Also, if the spouse is also employed, then the shopping duration for the individual increases, because of shared household responsibilities. Bhat (1996) did not find commuting time to be a significant factor for shopping duration and Srinivasan and Bhat (2005) results suggest that men who commute longer duration are less likely to undertake a shopping episode. In contrast, Hamed and Mannering (1993), Hamed and Easa (1998) and Rosen et al. (2004) found a positive relationship between commuting distance/time and shopping behaviour. Hamed and Easa (1998) state that individuals with a higher commuting time were more likely to perform shopping activities, while Hamed and Mannering (1993) and Rosen et al. (2004) found that travel time for shopping tends to increase with the distance between home and the workplace. The higher travel time during the work to home trip is believed to be the result that travel is accomplished during a peak period and when congestion is at its maximum.

While employment is a significant aspect of most studies on shopping behaviour it is not the only influential activity (Arentze and Timmermans 2005; Maat and Timmermans 2007). Discretionary or leisure activities, which consists of numerous social, entertainment and recreational activities, are other possible activities accomplished by individuals. These activities can also impose restrictions on shopping behaviour because of what Hagerstrand (1970) describes as coupling constraint. Discretionary activities are considered flexible compared to work related activities, however their arrangements such as meeting time and place are often planned in advance, meanwhile, other events such as movies, fitness classes or hockey games for example have fixed start times and locations.

The presence of children is believed to influence shopping behaviour as they place additional constraints on out-of-home activities (Hamed and Easa 1998). Meanwhile, Hamed and Mannering (1993) found results which support the notion that the presence of children induced the need for out-of-home activities and hence the need for travel (day care, school, recreational activities, etc…). Furthermore children are dependent on an adult for travel and consequently, an individual maybe required to modify their shopping trips to ensure that they drop off and/or pick up a child at day care, school, after school activities, etc, at the designated time. Bhat and Steed (2002) suggest that departure times for shopping are affected by the presence of children in the household. Srinivasan and Bhat (2005) suggest the presence of children impacts the women in-home time, thus influencing the time available for shopping. However, in conventional travel demand analysis, the effect of children within a household is usually captured using a dummy variable indicating the presence of children (or within a certain age group). While the duration of child care activities (if included in the analysis) is aggregate into larger categories such as maintenance or in-home activities that include numerous other activities such as personal, food preparation, domestic maintenance among many others. As a result the effects of the time spent on child care activities and its subsequent effects on travel and shopping behaviour are largely overlooked.

CHAPTER 3 OVERVIEW OF THE COMMERCIAL SECTOR

At the moment there is growing concern regarding the transportation system as indicated by the consistent growth in the literature on travel demand over the last 30 plus years (Zhang 2005). Zhang (2005) states that the literature on work-related travel is extensive because of its noticeable peaking effects which can result in congestion. Consequently, work-related travel has attracted most of the attention from policy makers and the general public. For example, trip based approaches are usually focused on either the morning or evening peak which corresponds to the highest proportion of work related travel. However, there is growing evidence that travel is increasing not only for non-work activities but also for other types of activities. Zhang (2005), for example, notes that in the United-States the VKT for activities such as shopping and services are increasing. In addition, Bhat and Steed (2002) indicate that the proportion of non-work related trips in urban areas is increasing such that traffic congestion can no longer simply be attributed to work related travel. Rosen et al. (2004) further believe that an increased understanding of travel for non-work activities would also imply a greater understanding of travel in general.

Commercial activities or shopping is a topic of growing interest from a transportation research perspective because of the travel implications of these activities. In society today an individual must purchase a mixture of items in order to satisfy basic and biological needs and desires. The most common example is food because individuals must eat at a regular interval in order to survive and currently food is less and less "grown" at home, but rather purchased at remote locations called "stores". However, not all shopping activities are considered essential, and it has been suggested that shopping can help to satisfy leisure or social activity needs (Jones 2000).

Maat and Timmermans (2007) state that while shopping activities are often necessary, they are considered flexible in terms of frequency, times, and location since they do not typically take place on a set schedule, as opposed to work or education which usually takes place at fixed times and locations. As a result, travel peaks for shopping and services are not as pronounce as those for work related travel (Zhang 2005) and consequently, shopping behaviour is considered complex and difficult to explain using traditional trip-based modelling approaches.

Shopping behaviour is defined by van der Waerden et al. (1998) as "behaviour resulting in a choice of a shopping destination" (p.310). According to Arentze and Timmermans (2005), studies often hypothesize that shopping behaviour is the function of physical attributes and travel time or distance. van der Waerdan et al. (1998) also say that shopping behaviour is not only a function of distance/travel time but includes additional factors such as the quality and quantity of the goods available, the price of goods, and the parking available. An overview of the shopping literature suggests that indeed shopping behaviour is much more complex than other forms of travel behaviour and is affected by the evolution of the commercial landscape, changes in consumers' characteristics and behaviour, and increasing competition between spatial markets. In this chapter, some important trends concerning these points are identified and discussed.

3.1 Classification of the Urban Commercial Landscape

The contemporary commercial landscape in Canada is dynamic and complex (Jones 2000). At the moment commercial areas can largely be classified into two major forms: strips (or ribbons) and centres (Jones and Simmons 1993; Jones 2000; Reimers and Clulow 2003). Strips are a collection of stores or services which usually have their own entrance located along a transportation route (Meyer 2004) and include street front shop (Jones 2003). Commercial strips are often included in New Urbanism development (Belzar and Autler 2002), however, Jones (2003) found that in commercial strips retail activity was being replaced by services and other non-retail activities such as restaurants.

A commercial centre or shopping centre is a collection of commercial activities at a single location. The shopping mall or enclosed or indoor shopping centre is the most common shopping centre in Canada and was the dominant retail structure for over forty years. Defined by Jones and Simmons (1993) as a collection of stores, usually five or more, that occupy a single building that is owned and managed by a single firm. The resulting structure is a centrally located building surrounded by a parking area (Newmark et al. 2004; Lorch 2005). Typically, the enclosed shopping mall is a suburban phenomenon due to the large space available and suburbanization of its clientele (Jones 2003). As a consequence, they are largely automobile dependent.

A relatively new form of shopping in Canada is big box stores and power centres, which began to appear in the late 1980s and experienced considerable growth through out the 1990s. Power centres are defined by the Centre for the Study of Commercial Activity (CSCA) at Ryerson University as "three or more big box stores sharing a common parking lot" (Hernandez and Simmons 2006, p. 471). Big box stores are also defined by the CSCA "as retail outlets that are several times larger than the average store in the same retail sector" (Hernandez and Simmons 2006, p. 468). According to Hernandez and Simmons (2006) and Buliung et al. (2007) power centres can also be locations of food services and a variety of other commercial services such as personal, financial and medical. These services are attracted by high consumer volumes generated by the big box stores. Power centres are largely a suburban phenomenon given their size and the large amount of affordable land available at the periphery or in the new development of cities. As a result, power centres dominate the periphery of cities and serve the ever-growing suburban markets (Jones and Doucet 2001; Jones 2003; Hernandez and Simmons 2006).

Power centres, as with the enclosed shopping malls, tend to be located at highly accessible areas for the automobile, in particular, at the intersection of arterial highways or the interchange of major expressway (Filion et al. 2000). The resulting effect is a large catchment area, particularly in the case of the expressway interchange where the catchment area becomes the entire region that is serviced via the expressway (Filion et al. 2000). An expressway allows people to travel long distances quickly such that a shopping centre can service an entire region rather than a single or collection of neighbourhoods. As a result, stores and shopping centres now face competition from other centres from as far away as 50 km or even 100 km (Hernandez and Simmons 2006).

Bodkin and Lord (1997) attempted to describe the trade area of power centres in order to compare with that of traditional enclosed shopping malls. Bodkin and Lord

(1997) state that based on size (i.e. sq. ft of gross leasable area) the trade area should be between that of community and regional shopping malls. However, their analysis suggests that the trade area for power centres is extensive and larger than enclosed shopping malls of comparable size. Wang et al. (2000) compared the entertainment facilities of a power node to that of a regional mall in the Greater Toronto area and found that for the power node 75 percent of its customers came from an 18 km (11.18 miles) radius compared to 8.3 km (5.16 miles) for the regional mall. As a result, Wang et al. (2000) concluded that power nodes have a much larger market area compared to regional malls. According to Wang et al. (2000) possible reasons for the larger market of power centres are the novelty of facilities and the proximity of the highway system. However, Bodkin and Lord (1997) along with Hernandez and Simmons (2006) state that because power centres are a relatively new form of commercial activity not much is known about the shopping behaviour of its consumers.

In Canada, big box stores and power centres are largely a metropolitan phenomenon. Hernandez and Simmons (2006) found that the fifteen Canadian cities with a population larger than 300 000 have an estimated 62 percent of the stores and floor area whereas rural areas (population under 10 000) have only an estimated 5.5 percent of floor area. In Canada, the big box stores in rural areas consist of, for the most part, Canadian Tire and Wal-Mart. The clustering of power centres in larger centres is more significant, with 80 percent of the floor area for power centres located in the 15 largest centres compared to only one power centre in a rural area (Hernandez and Simmons 2006).

3.2 Shopping Behaviour by Commercial Structure

Commercial structure and shopping behaviour are often studied separately and consequently the travel behaviour for each commercial structure is not well known. There is evidence that shopping behaviour differs between each type of commercial structure (Buliung et al. 2007). Newmark et al. (2004) studied how the construction of new shopping centres at the urban fringe in Prague, Czech Republic, changed shopping behaviour for many of the city's residents. Newmark et al. (2004) found that patrons to the new centres made fewer but longer trips and changed their transportation mode.

It is believed that downtown shopping centres and enclosed shopping centres have a higher degree of cross-shopping. Consumers at these shopping centres are often required to walk longer distances (from parking spot to store or along the interior corridor). Consequently, the individual may wander and visit multiple stores on a single shopping trip. Wang et al. (2000) suggest that the regional shopping mall is more of a leisure shopping destination and eases comparison shopping because the structure facilitates cross-shopping between different retail categories.

Meanwhile, Bodkin and Lord (1997) and Wang et al. (2000) suggest that consumers at power centres visit fewer stores. Bodkin and Lord (1997) found that on average consumers visited only 1.67 stores per trip to the power centres, 53 percent of shoppers only visited one store and only 16.3 percent visited three or more stores. The principal reason found by Bodkin and Lord (1997) for the lack of cross-shopping at power centres was that consumers were visiting a particular store for a specific product. Other possible reasons include the spatial layout of the centre, such as its distribution and size which increase the effort of traveling between stores (Wang et al. 2000; Lorch 2005) and complementarities of the stores (Wang et al. 2000). As a result, power centres are believed to have a more specialized purpose and Wang et al. (2000) believe for each purpose (shopping, social, entertainment) an individual may perform different trips and at different times in the day.

The distance between the home and the shopping destination is believed to have an influence on shopping behaviour. It is argued that there exists a relationship between travel time and number of shopping episodes performed. Maat and Timmermans (2007) suggest that individuals want to minimize their travel time and accordingly are more likely to perform a trip chain by accomplishing several shopping episodes on a single tour. Krizek (2003) found that households with high accessibility performed a greater number of tours, however made fewer stops during each tour. While Bodkin and Lord's (1997) study of power centres found a correlation between cross-shopping and distance, their results were inconsistent as residents from distant areas did not exhibit the same behaviour.

3.3 Influential Factors Shaping the Canadian Shopping Landscape

The shopping landscape in Canada is diverse, complex and the result of many different factors and to add to the complexity, the landscape is dynamic as it changes over time. Jones (2000) states that the commercial sector is the product of four principal factors: demographics, technology, entrepreneurial decisions and consumer behaviour.

3.3.1 Socio-Demographic Characteristics

According to Jones (2000), socio-demographic characteristics of the individual are an influential factor in determining where to shop. Socio-demographics consist of numerous characteristics including age, gender, income, employment status, and household size among many others. Age is believed to be an important factor since it can influence the mobility of individuals and determine which stores are accessible. Bromley and Thomas (1993), Bhat and Misra (1999) and Mercado and Páez (2007) state that age may act as a mobility constraint and consequently reduce the ease in which the individual can travel. Bromley and Thomas (1993) found that individuals 60 years of age or older shopped less at a superstore and relied more frequently on local shops largely because of their lack of mobility. In addition, Bromley and Thomas (1993) also believe the young may suffer from a lack of mobility as they may not have access to an automobile. Wang et al., (2000) found a regional mall attracted a greater percentage of teenagers and students compared to a power node because the mall was more accessible by public transit, while the power node attracted a greater percentage of adults between 30 and 50 years of age. Furthermore, the spending pattern is different for each age group. Bromley and Thomas (1993) believe that the elderly spend less on goods since their children moved out of the household and there is no longer a need to purchase a large quantity of food and as a result the importance of superstores is reduced.

Gender is also considered an influential factor of shopping behaviour as females exhibit a longer shopping duration compared to males (Hamed and Easa 1998; Yee and Niemeier 2000; Newmark et al. 2004; Srinivasan and Bhat 2005; Lee and Timmermans

2007). Dholakia (1999) states that shopping is a "gendered activity" and in general, females are still the primary shoppers in the household, meanwhile most men do not enjoy shopping. Currently, however, there is an increasing proportion of females in the workforce which is influencing the shopping behaviour because time previously available for shopping is replaced by work related activities. Consequently, Dholakia (1999) and Butler (2004) state that there is a gender revolution. Dholakia (1999) found that for married households a greater proportion of males are participating in grocery shopping and this trend is particularly noticeable for younger couples.

Income is stated by Bromley and Thomas (1993) to have a recognizable influence on shopping behaviour. Simmons (1996) states approximately half of individual income is spent on commercial activities (30 percent on retail activity, 13 percent on consumer services and 9 percent is invested in the financial sector). A high income household can therefore consume significantly more than a low income household (Jones and Simmons 1993). Jones and Simmons (1993) also believe that income is an important factor in determining where retail activity locates. They argue that different income classes locate in noticeable clusters within cities and as a result shopping centres locate in areas that are more accessible for high-income neighbourhoods. Meanwhile, low-income households are often restrained to unattractive areas of the city devoid of prime shopping centres and consequently, are required to shop at small independent stores or discount supermarkets that offer inferior services and higher prices (Bromley and Thomas 1993).

In addition, Bromley and Thomas (1993) believe low income can constrain mobility. Low-income earners may have less access to a private vehicle since they may not be able to afford an automobile or must share the automobile between household members. Subsequently, they are more likely to be reliant on public transit for longer trips. Newmark et al. (2004) noticed low income earners experience a lower frequency of shopping trips to the shopping centres on the urban fringe.

The presence of children is also believed to influence the shopping behaviour of the household (Hamed and Mannering 1993; Yee and Niemeier 2000; Bhat and Steed 2002; Srinivasan and Bhat 2005). Srinivasan and Bhat (2005) found that men in households with children spent longer duration shopping compared to those without children in the household. Likewise Yee and Niemeier's (2000) model suggests that the presence of school-age children in the household resulted in shorter shopping duration for women and longer duration for men. A possible reason for the increased shopping duration for men is they undertake a larger proportion of the shopping trips because the women are occupied with child-caring responsibilities. Bromley and Thomas (1993) and Newmark et al. (2004) state that larger households are often at a disadvantage compared to smaller households, as a large number of children in the household affect the time available for shopping.

3.3.2 Technological Innovation

Technology influences the spatial distribution of commercial activities as it changes the mobility of consumers and improves the efficiency of firms. Recent technological development in transportation has increased mobility as individuals can travel farther within a certain time period (Limtanakool and Schwanen 2006).

Technology determines how far (travel distance) and in how much time (travel time) an individual can travel.

For the commercial sector, Jones (2000) states that when mobility is poor, shopping activity will cluster while when mobility is high, the activities can scatter over a larger geographical area. It is documented that as automobile ownership increased encouraging greater mobility, the spatial distribution of the commercial sector in Canada also increased. The location of shopping centres became increasingly focused on automobile accessible areas, first along key transportation arteries and even more at the interchange of expressways (Filion et al. 2000; Jones 2000). The resulting spatial structure of the commercial sector is such that it is advantageous for automobile owning individuals (Bromley and Thomas 1993; Alzubaidi et al. 1997).

3.3.3 Entrepreneurial Decisions

Entrepreneurial decisions are how the choices of firms influence the spatial distribution of the commercial sector. The most significant type of ownership in the commercial sector is the chain. Jones and Simmons (1993) define a chain as a series of stores (generally four or more) in the same sector and owned by the same firm. Jones and Simmons (1993) describe how as early as the late 1980s the chain was the most dominant type of retail and according to Vias (2004) the retail sector is increasingly controlled by fewer and fewer firms and subsequently the number of independent shops are decreasing. The consolidation of retail firms is a continuing process that has numerous impacts on the commercial sector, developers and small retailers (Gomez-Insausti 2006). Currently firms are increasing the size of their stores which allows the company to sell a wider range of products, in many different retail categories (food, clothing, electronics, etc) (Vias 2004). The resulting superstore allows a greater amount of cross-shopping and leads to "one stop" shopping (Vias 2004), as individuals can fulfill all their shopping needs at a single store. While the size of the stores is increasing the total number is decreasing. This resulting trend on the Canadian retail landscape is changing the relationship with consumers (Gomez-Insausti 2006), while shoppers can now buy products at a lower price, many consumers must, however travel longer distances to obtain them.

3.3.4 Consumer Behaviour

Consumer behaviour is the result of the individual's tastes and preferences which determine the goods the individual wants to purchase, the price he is willing to pay, at which store and the distance he is willing to travel (Jones 2000). The consumer preferences are largely defined as lifestyle by Jones (2000) and consequently are difficult to capture using secondary panel data. Individuals with the same characteristics will often exhibit different shopping behaviour (Ortuzar and Willumsen 2001). Consumer preference is a reason why certain shopping areas will prosper and others will struggle (Jones 2000).

In general the consumers want their shopping episodes to be performed with relative ease. Bodkin and Lord (1997) along with Jackson et al. (2006) found that the principal reason for selecting a particular destination was "convenience". However, Jackson et al. (2006) asked what does convenience mean for consumers. Reimers and Clulow (2004) stated "convenience occurs when the barriers to the undertaking of an activity are reduced or eliminated." For shopping, Reimers and Clulow (2004) argue that convenience is determined by the spatial attribute of the destination, temporal attributes of the trip and the physical effort required to perform the trip. Lorch and Smith (1993) found that consumers exhibit steep distance decay and are reluctant to walk excessive distances. Accordingly, power centres were stated to be convenient by consumers (Bodkin and Lord 1997) possibly because each store is directly connected to the parking lot giving the consumer quick access and reducing the perceived walking distance (Lorch 2005; Hernandez and Simmons 2006). This contrasts with enclosed shopping malls which have a limited number of entrances and require the consumers to traverse the interior corridor to access the store in question. Reimers and Clulow (2004) state that on a typical shopping episode to a shopping mall very few individuals actually walk the entire mall and non-shopping locations between destinations act as dead space and only increase the physical effort required and reduce the convenience of the store. Whereas Bodkin and Lord (1997) state that convenience is complex and consists of more than travel time and distance but also includes some measures of satisfaction such as finding the product in question. Meanwhile, Jackson et al. (2006) believe that convenience also includes the ease with which the shopping episode is included within the daily activity schedule. Other factors that were stated to influence convenience include greater selection of goods (Stabler 1987; Yeates and Montgomery 1999; Broadbrige and Calderwood 2002) and ample (free) parking (Alzubaidi et al. 1997; van der Waerden et al. 1998; Broadbridge and Calderwood 2002).

In addition to convenience, price is believed to be an important factor on consumer decision making. According to Coughlan and Soberman (2005) consumers are sensitive to price and time. Price sensitivity suggests that different people are more willing to pay a higher price on a certain product compared to others, whereas time sensitivity is the time a consumer is willing to spend travelling in order to purchase a certain product. Coughlan and Soberman (2005) go on to state that price and time sensitivity are negatively correlated. Therefore individuals who exhibit a high time cost are less price sensitive and vice versa. This theory suggests that consumers who are not time sensitive, will be highly sensitive to price consequently are more likely to travel long durations in search of better deals. Hernandez and Simmons (2006) confirmed the fact that consumers will travel long distances for lower prices by stating the success of outlet malls in the United-States. Brennan and Lundsten (2000) found that price was the most frequently stated reason why individuals shop at a discount store. Coughlan and Soberman (2005) hypothesize that price is of growing importance to consumers, the reason being the growth in success of large format stores over the last 15 years.

3.4 Overview of Census Metropolitan Areas

Throughout the latter half of the twentieth century the urban landscape in particular metropolitan areas has experienced a significant change and consequently has become increasingly complex (Kanaroglou and Scott 2002). The urban landscape transformed from a traditional monocentric form to a polycentric layout. As opposed to monocentric form where travel flows are concentrated along a few transportation corridors, in a polycentric form travel flows are dispersed all over the network because there are many origins and many destinations.

The current urban landscape was made possible because of the preferable treatment given to the automobile (Miller 2000). The change in the urban landscape and the adoption of the automobile changed the accessibility within the city as proximity between amenities became less of a restriction (Filion et al. 2000). The suburban landscape is consistently segregated into single-use land type, according to Miller (2000), and therefore completion of daily activities by individuals (or households) tends to require increased amounts of travel. Partridge and Nolan (2005), parting from the observation that the large metropolitan areas of Calgary and Edmonton have greater suburban development, subsequently found that these cities had longer commuting distances compared to the mid-size prairie urban areas of Saskatoon, Regina and Winnipeg. As a result they argue that as the distance from the downtown (or the central business district) increases so does the commuting distance. However, the relationship between suburbanization and commercial activities is not clearly known.

The commercial sector in metropolitan areas has experienced significant change in Canada. Traditionally, commercial activity was centred in the downtown because it was the most accessible location within the city and extended outwards along key transportation arteries (Jones 2000). After World War II, large portions of commercial activity followed the residents to suburbs resulting in a decline in the number of commercial establishments within the core. Shopping centres and large format retailers often located at the periphery of cities on greenfield sites (Jones and Doucet 2001) because of the vast amount of space available at a the low cost and the ease of accessibility for the automobile in comparison to central city locations (Brown and Baldwin 2003). The infrastructure in the suburbs is adapted to service the automobile, with larger roads and more parking available. Within an urban location, a 15 minute drive from an interchange of an expressway is considered highly accessible (Filion et al. 2000). An urban expressway allows residents to travel throughout a metropolitan area in search of a favourite store or better deals (Hernandez and Simmons 2006). Consequently, these locations are preferential sites for commercial development (Filion et al. 2000; Miller 2000).

As a result of the decentralization of manufacturers and industries, many North American cities now have numerous underutilized or abandoned properties (brownfields) (Jones and Doucet 2001). According to Jones and Doucet (2001) many of these properties are suitable for large format retailers. In numerous American cities, suburban type shopping centres, in particular big box stores and power centres, are locating on brownfield sites (Jones and Doucet 2001). In Canada, the trend of developing power centres in the inner city is growing and is most noticeable in the largest metropolitan cities. Jones and Doucet (2001) describe how numerous large format retailers have opened in downtown Toronto since the mid 1990s.

Metropolitan areas, compared to rural and smaller municipal areas, have a public transportation system which is more developed (Pucher and Renne 2005). However the current polycentric form of cities makes them more difficult to efficiently service using public transit. The "many to many" relationships between origins and destinations of urban areas disperse the traffic flows all over the road network. Although it results in a large amount travel and congestion at different nodes in the system, the resulting flows along any corridors are usually not dense enough to make mass transportation efficient and cost effective (Miller 2000). In addition, Miller (2000) and Filion et al. (2000) note that for many neighbourhoods within CMAs, alternative transportation modes (e.g. walking, public transit) are not viable options, as a result, automobile ownership has become a necessity rather than a luxury for many urban residents. Consequently there is an increase in automobile reliance and in the daily vehicle kilometres travelled (VKT) (Maat and Timmermans 2007). The outcome is that many metropolitan areas are suffering from congestion, which in turn increases travel time for its residents.

3.5 Overview of Rural Areas

While over the 20th century Canada has become increasingly urban, there is evidence that with suburbanization, rural areas are once again experiencing a population increase. Henry et al. (1999) and Pucher and Renne (2005) describes that many rural communities around fast growing metropolitan areas are experiencing "spin-off". This increases their population as young professionals (rural-based commuters) and retirees are choosing to reside outside the urban area. Vias (2004) states that changes in the economy have broad impacts on the well being of rural areas and continues by stating that relatively little is known on the retail sector in these areas because the research is largely focused on metropolitan areas.

The continual decentralization of activities, such as manufacturing plants, office complexes and regional shopping centres to the edge of cities in concurrence with continual improvement to the highway system, which decreases the travel time, is changing the travel pattern (Pucher and Renne 2005). As a result, Pucher and Renne (2005) state that rural residents are not as disadvantaged as they were in previous decades. However, the level of accessibility of rural residents is largely dependent on access to an automobile because rural residents have limited transportation services and the distance between activities is too great to walk or bike (Pucher and Renne 2005).

3.6 Market Areas and Spatial Competition

Currently, the academic literature on retail and consumer services is largely focused on metropolitan areas (Yeates and Montgomery 1999) with particular interest on the development of large format retailers. According to Simmons and Jones (2003), in Canada, commercial activity is mainly located within metropolitan areas since they have the highest population. However, Yeates and Montgomery (1999), along with Simmons and Jones (2003), state that a significant portion of Canada's population is located in small centres that would be classified as non-metropolitan. Traditionally, the size of a retail market has been calculated as the product of population and income per capita (Simmons 1996). However, Yeates and Montgomery (1999), argue that economic activities are now highly interconnected and consequently, the size of a given market can no longer simply be measured by population and income, because as Simmons and Jones (2003) argue some commercial centres serve larger markets because they attract shoppers from nearby communities. Yeates (1998) discusses how commercial nodes are in competition with other nearby nodes and the competition occurs regardless of size differential. According to Yeates (1998) and Brennan and Lundsten (2000), larger nodes in particular with big box stores have greater geographical markets meanwhile small nodes have a localized market. Therefore smaller nodes, such as the downtown area of a rural community, must compete with larger nodes, such as regional or power centres in nearby metropolitan areas.

Marjanen (2000) states that large format retailers have in general a positive effect for the city in which they are located; however, they have an inverse effect on the surrounding communities, such as sparsely populated areas and small town centres. A town can refuse to develop large format retailing; however, the resulting effect is usually the loss of consumers to the nearest market with big box stores (Hernandez and Simmons 2006). Silcoff (2000) discusses how the southern Ontario CMA of Oshawa initially refused the entry of big box stores, however, residents travelled to the big box stores in adjacent communities. Consequently, the city had no choice but to allow the entry of large format retailers in order to keep their consumers. As Godhar (the owner of First Professional Management Inc., a developer of power centres in Canada) states:

> "People have cars, they are highly mobile and they will exercise that mobility for the right price and service. You don't need a passport to shop in neighbouring municipalities" (as cited in Silcoff 2000).

As Godhar states currently consumers are free to shop where they choose. There is no system or policy which prevents consumers from shopping outside their city boundaries. Consequently, communities often compete with each other to attract large format retailers in order to keep to their consumers and improve their local economy (Marjanen 2000).

Yeates and Montgomery (1999) studied the commercial structure of five non-metropolitan communities in Ontario which were located within the reach of larger metropolitan areas and found a negative correlation. They found that the vitality of the commercial sector of the non-metropolitan areas suffered since a greater selection of goods at a lower price was available in a nearby metropolitan area. Yeates and Montgomery (1999) state that because of the small population of non-metropolitan communities, local shops and malls cannot compete with larger shopping centres in bigger urban areas.

Consumers are able to travel greater distances within a given time budget because of the adoption of the automobile and the expansion of the transportation systems such as arterial highways and expressways. As a result, distance or proximity is less of a determining factor when selecting a shopping destination. Thus the opportunities available to individuals, or in other words, their choice sets, have greatly increased (Filion et al. 2000), particularly for rural residents (Limtanakool et al. 2006). Stabler (1987) and Partridge and Nolan (2005) discuss the travel behaviour of residents in rural areas in the Canadian prairies and how improved accessibility, and in particular the presence of "good roads" such as multi-lane highways, is associated with increases in the distance travelled by rural dwellers. Stabler (1987) states that shopping patterns of rural residents in Saskatchewan changed during the 1960s and 1970s with the improvement of the province's intercity road network. Residents of small urban areas experienced an increase in the distance that they were willing to travel to purchase their goods and services such that they often bypassed intermediate size centres for regional centres or larger metropolitan areas (Stabler 1987).

An example of a metropolitan area trying to attract consumers from nearby rural and smaller communities can be found in the city of Greater Sudbury. Jones and Simmons (1993) suggest that cities typically undergoing a period of growth will experience an increase in retail activities. The Greater Sudbury CMA, however, experienced a population loss of 6.0 percent between 1996 and 2001 (Statistics Canada 2007), nevertheless, during the latter stage of this period the city's retail sector was in a state of growth as numerous large format stores opened. In 1999, Costco opened a store in the city and the CMA's first power centre opened quickly thereafter. According to Cotton and Cachon (2005), the reason for the retail expansion despite a net population loss is that developers and firms are hoping that residents from the surrounding communities will travel to Sudbury to fulfill their shopping needs. Retailers believe the total market of the metropolitan area also includes surrounding rural communities, and nearby cities such as Timmins, North Bay and even Rouyn-Noranda, therefore the total population of the market is approximately 550 000 (Cotton and Cachon 2005). The isolated northern location of Greater Sudbury CMA signifies that for the majority of the nearby northern communities larger metropolitan areas such as Toronto and Ottawa are simply too far to travel to satisfy their shopping needs.

CHAPTER 4 DATA AND METHODS

4.1 Data

The datasets used for this research are extracted from cycle 12 (1998) and cycle 19 (2005) of the General Social Survey on Time Use (GSS-98 and GSS-2005). Funded by the Canadian federal government, the objective of the survey is to collect data on social trends to monitor the welfare of Canadians and to provide data on social policies of emerging importance. The data for both surveys were collected over a 12-month period, for GSS-98 between February 1998 and January 1999 and GSS-2005 between January and December of 2005. The surveys were administered using Computer Assisted Telephones Interviews (CATI), and aimed at individuals older than 15 years of age throughout Canada, excluding the Territories and fully institutionalized individuals. The GSS-98 survey consisted of 10,749 individuals and the GSS-2005 had 19,597 respondents (Statistics Canada 1999; Statistics Canada 2006).

The General Social Survey (GSS) consists of two files: the Main file and the Episode file. In the Main file, the data is aggregated such that each respondent has one record that displays his/her socio-demographic characteristics along with the total time spent for each activity. The Episode file displays the time use diary of the respondents and the number of records for each respondent depends on the total number of activities performed (Statistic Canada 1999). The Episode file contains information such as start and end time, duration, location and the social context for all activity episodes recorded by the respondent. This study employed both the Main and Episode files: the Main file to gather socio-demographic information, while the Episode file was used to gather information on the activities performed by each respondent, such as the type (work, education, organization, etc...), the duration and location (home, work, etc...). Furthermore the Episode file was used to collect information on the observed shopping behaviour such as the duration of shopping trips, the number of tours performed, and the transportation mode employed.

The final dataset did not include respondents from Prince Edward Island, as no distinction between Census Metropolitan Area and non-Census Metropolitan Area was provided for this province. In this research there is a one–to–one correspondence between shopping tours and episodes, consequently, all respondents have a trip and at least one corresponding episodes. Cases where the individual had a shopping trip but no shopping episodes or vice-versa were removed from the analysis. Furthermore, the data file was cleaned of coding errors that could not be corrected due to the lack of contextual information required. The final dataset used for this study contains a total of 10 302 respondents for 1998 and 18 164 respondents for 2005 and the distribution is displayed in Table 4.1.

Table 4.1: Distribution of the datasets

	1998				2005			
	Total	CMA	non-CMA		Total	CMA	non-CMA	
			CA	Rural			CA	Rural
Number of individuals	10302	5828	1834	2640	18164	11133	2928	4103
Performed a shopping tour	4055	2416	741	898	6072	3794	1019	1259
Percent	39.36	41.46	40.40	34.02	33.43	34.08	34.80	30.68

The GSS cycle 12 and cycle 19 define urban differently. Consequently the classification for urban and rural needed to be reclassified such that the definition was consistent for both cycles. In order to accomplish this task access to the private version of the GSS (for both cycles) was obtained. The private dataset provided a code which corresponded to a Census Metropolitan Area or a Census Agglomeration and a zero value if the respondent resided in neither. The list of CMAs and CAs along with their corresponding urbanity code was provided by the census (1996 census for cycle 12 and 2001 census for cycle 19). Consequently, the type of urban area to which the respondent belonged was determined.

Each respondent, depending on their place of residence was classified as either: Census Metropolitan Area (CMA), Census Agglomeration (CA) or Rural (neither CMA nor CA). The definition for each urban type was provided by Statistics Canada.

- Census Metropolitan Area (CMA) is an urban area which the urban core has a population of at least 50 000 and the area has a population of at least 100 000. Furthermore, once an area is classified as CMA it remains a CMA even if the population of the core decreases below 50 000 or if the total population falls below 100 000.
- Census Agglomeration area (CA) is an area where the urban core has a population of at least 10 000. Therefore are urban areas where the population is between 10 000 and 100 000.
- Rural is the remaining areas which are neither a CMA nor CA. Therefore an area which has a population below 10 000.

Census metropolitan areas and census agglomeration are large geographical areas and as a result not all urban areas within the boundary are contiguous and CMAs or CAs may contain low density peripheral areas (Statistics Canada 2007). In order to distinguish whether an individual resided within the urban core or at the periphery, respondents where sub-classified. The definitions for urban core and periphery were once again obtained from Statistics Canada (2008):

- Urban core is an area where the census has a minimum population of 1 000 or the block has a population density of at least 400 per square kilometre.
- Periphery is all remaining areas.

Note, a respondent classified as Rural can also be sub-classified as urban core because the total population of the community is below the requirement for CA, however the population density is high enough to be classified as urban core.

The unit of analysis is one day (24 hours) since the GSS consists of a one-day time use diary. The designated day varies per respondent in a manner that all days of the week are covered in the dataset and therefore, the research assumes that GSS demonstrates the typical shopping behaviour over a given week including the weekends. Although the availability of multi-day surveys is increasing, the total number available is still limited largely due to increase in cost (Harvey 2004) and the difficulty of obtaining travel diaries from respondents over a long period (Kang and Scott 2007). Consequently, the research is often dependent on the data available. As a result the GSS was selected because it provided detailed time-use diaries for individuals residing in both metropolitan and non-metropolitan areas.

The definition of shopping activity for this research is provided by the General Social Survey on time use (GSS). The GSS shopping consists of not only retail activity but also includes financial, personal, business and government services (see Appendix

A). This definition is consistent with other research on commercial activities including Simmons and Jones (2003).

4.1.1 Activity classification

When analyzing travel from an activity analysis approach it is necessary to aggregate activities into various classes (Golob, 2000). Over the years there have been various methods of aggregation, currently, the most typical methods of classification are two-way: work and leisure or three-way: *subsistence*, *maintenance* (or nondiscretionary) and *discretionary* (or leisure) (Bhat & Misra, 1999; Golob, 2000). S*ubsistence* activities usually pertain to work or work related activities which produce the income. In this study subsistence also includes educational related activities. Maintenance refers to compulsory activities such as eating meals, child care and household work. In many studies some shopping activities, such as grocery, which are required to satisfy the biological needs of the household and would be classified in this category. Discretionary activities refer to social, recreational and cultural activities. Travel time can be either aggregated into these categories dependent on their type or disaggregated in their own specific class (e.g. work-related travel). However various other methods of aggregation have also been used depending on the research objective (Golob, 2000).

4.2 Discrete/Continuous Overview

The shift of modeling approaches from trip-based to activity-based has also changed the emphasis of econometrics from aggregate models which describe an area altogether to disaggregate models which analyse individual (or household) decision making processes (Train 1986). The variables or choices of the individuals can be classified as either continuous or discrete. In this study, the number of shopping tours performed is a discrete variable since an individual cannot perform half a tour. Traditional econometric methods such as regression were designed to analyze continuous variables and are often found to be inappropriate when analyzing discrete variables (McKelvey and Zavoina 1975; Train 1986). Consequently, various methods have been introduced to analyze discrete situations where continuous methods are inappropriate. These situations are often defined as a discrete or a qualitative choice and have the following conditions:

1. the number of alternatives in the set is finite
2. the alternatives are mutually exclusive
3. the set of alternatives is exhaustive

(Ortuzar and Williumsen 2001)

Qualitative choice models estimate the probability that an individual will select a certain alternative from a set of alternatives using observed data. The probability that individual n selects alternatives i from the set J_n (labelled P_{in}) is dependent on the characteristics of alternative i and all the competing alternatives (z_{in}) and the observed characteristics of the individual (s_n). The probability is calculated using the general function

$P_{in} = f(z_{in}, z_{jn}$ for all j in J_n where $j \neq i, s_n, \beta)$

where

f is the function to be estimate
β is a vector of parameters

Examples of qualitative choice models are the logit and the probit. However, qualitative choice methods are, just as with continuous methods, only applicable for certain types of situations (Train 1986).

In order to define or give meaning to the general description, specification of the function is defined using concepts of standard microeconomic theory of utility maximization (Train 1986). Utility maximization assumes that an individual obtains a certain level of happiness or "utility" from each possible alternative and the individual will select the alternatives that provides him with the greatest utility (Train 1986). Utility is a trade-off between the benefits and the cost of accomplishing a particular activity (Maat and Timmermans 2007). Utility theory is based on basic assumptions such as:

- Rational decisions maker: an individual always selects the option which provides the highest utility
- Fully informed: an individual knows all the possible alternatives and the cost of each

(Ortuzar and Williumsen 2001)

In the real world, however, the assumptions stated by Ortuzar and Williumsen (2001) are seldom true. For example, an individual is not usually aware of the entire set of alternatives, and more importantly does not always behave in a "rational" manner. For example, some individuals enjoy traveling (or driving) consequently travel increases their utility.

Travel demand is often modelled using utility-based theory (Maat and Timmermans 2007). In the context of shopping behaviour, utility is the attractiveness of the store (price, quantity and quality of the merchandises) and the disutility is the cost of travelling to the store (time, financial, convenience). In travel demand research it is assumed that travel is a disutility, consequently, individuals attempt to minimize their travel cost. Therefore, in the scenario of two stores at different distances which offer equal utility, an individual should select the nearest store. In a different scenario, an individual can overcome the disutility of travel and consequently maximise his utility by selecting a location farther away in order to obtain a better deal or quality (Maat et al. 2005). Furthermore, Maat et al. (2005) remind us that travel decisions are not made independently, on a trip by trip basis, but rather take into consideration the broader picture, consequently, individuals attempt to schedule activities into a daily pattern. As a result, individuals do not try to maximise utility for a certain trip but rather try to optimize the utility for the entire daily activity pattern.

The decision process of an individual is complex and subsequently choices are often made based on a conditional process. When the choice of the individuals are finite and an exhaustive set of mutually exclusive alternatives, the decision process can be modelled according to Train (1986) using a generalized extreme value (GEV) specification. However in many instances, the choices are not all qualitative. An example is a situation where the first choice is a discrete set of alternatives (e.g. 0, 1, 2, up to a maximum n trip) and the second is a continuous set of alternatives (e.g. 0 to 24 hours). This situation is referred to as discrete/continuous. Train (1986) states that this situation is described by specifying

1. the probability that an individual will select each alternative
2. the demand function for the continuous part

Discrete/continuous models are employed in numerous studies such as Rosen et al. (2004), Srinivasan and Bhat (2006), Habib et al. (2007). The discrete portion of the model is often used to determine whether an individual performs a certain activity and usually consists of a logit or probit model. Meanwhile, the continuous part is used to estimate activity duration and is usually modeled using linear regression or a hazard based approach.

Estimation of the parameters of a discrete/continuous model can be accomplished either sequentially or simultaneously. For sequential estimation (referred to as disjoint discrete/continuous) estimates, first the discrete portion or the choice probability followed by the continuous model or the demand function. In simultaneous methods (or joint discrete continuous), the choice probability and the demand equation are estimated at the same time. Historically, discrete/continuous models were estimated sequentially. Train (1986) states at the time of publication no computer routine was developed for simultaneous estimation. However, with improvements in technology, joint discrete/continuous models are now being developed.

4.3 Methods

For this research, we are interested in two measures of mobility: the propensity to perform shopping tours, and the total travel duration for shopping tours. A shopping tour is any tour performed by the respondent which includes at least one shopping episode. A tour is defined using four different criteria. First, the origin and destination of the tour is the individual's home. Alternatively, a tour may begin at home and end at work or school. The third case is when it starts at work or school and ends at home. Finally, a shopping tour is defined if it begins and ends at work or school. A shopping trip is a trip within a tour which ends or begins at a shopping location. For example, trip from home to a grocery store would be classified as a shopping trip, as would the return trip from the store to home. However, the non-shopping end of a shopping trip does not have to be the home but could also be another location such as work. It is important to note that the origin or the return trip of a shopping episode could be classified as other travel depending on the prior or subsequent activity and its classification in the survey. Therefore, it is possible for an individual to have only one shopping trip. The total duration for shopping tours is the summation of the duration of all shopping trips performed by the respondent.

The analysis is divided into two sections. The first section studied the shopping behaviour for residents of CMAs and non-CMAs specifically shopping tour frequency and shopping travel durations. The section consisted of a descriptive analysis and the estimation of a set of disjoint discrete/continuous. The descriptive analysis examined the observed shopping behaviour to discover possible patterns or trends which differentiate CMAs and non-CMAs. While the disjoint discrete/continuous models were used to investigate possible factors that influence the duration travelling for shopping. The second section of the analysis is an exploration of a joint discrete/continuous model to determine its potential for studying shopping behaviour.

4.3.1Disjoint Discrete/Continuous Model

The disjoint discrete/continuous models were estimated to analyze the influence of various factors on the shopping behaviour of residents of non-CMAs and CMAs. As noted above not all respondents within the sample performed a shopping tour. For 1998 once outliers[1] were removed, 4,051 individuals or 39 percent performed a shopping tour and in 2005, 33 percent or 6,072 respondents performed a shopping tour.

The situation above is described by Train (1986) as a conditional situation since the observed process is only accomplished by a subsample. This conditional situation is a discrete-continuous process, since it must first be determined whether a respondent performed a shopping tour, and if that is the case, then his duration for shopping trips could be estimated. For that reason, a modelling method is required that could be applied to a conditional process. The method selected is a discrete-continuous model which consists of a combination of an ordered probit and a regression model. The basis for selecting this method was research conducted by Train (1986) and Rosen et al. (2004).

4.3.1.1 Discrete: Ordered Probit Model

The first step in the construction of the disjoint discrete/continuous model entails the estimation of an ordered probit model which is used to predict the number of shopping tours (0, 1, 2, 3 or more) performed by an individual. The dependent variable in the model is the frequency class of shopping tours and the model is calibrated using all the individuals in the sample. The probit model is necessary in order to remove the effect of selectivity bias which occurs when a model is estimated from a subsample. In this case, all respondents who performed a shopping tour would "select themselves to be

---

[1] Four respondents were considered outliers since their duration was significantly larger than the nearest duration as a result these individuals were removed from the model calibration. For the estimation of the models the sample consist of 10,298 individuals and 4,051 performed a shopping tour (2,414 for CMA and 1637 non-CMA)

included in the estimation." (Train 1986 p.93) and therefore, using only individuals who performed a shopping tour introduces a bias in the model.

The ordered probit model is used when, like in this case, the outcome variable is ordered. As discussed by Train (2003) in the analysis of ordered outcomes, the different possible alternatives are associated with a certain level of utility. In the case of tour generation, if the utility is below a given threshold λ_1 (i.e. if $U < \lambda_1$), the individual does not travel (i.e. number of tours is zero); if the utility is between λ_1 and λ_2 (i.e. if $\lambda_1 < U < \lambda_2$), the individual performs 1 tour; if $\lambda_2 < U < \lambda_3$, the individual performs 2 tours; if $U > \lambda_3$, the individual performs 3 or more tours. The thresholds are estimable from the data, and that there can be an arbitrary number of ordered categories.

Decomposing the utility of individual i into the usual systematic and random components:

$$U_i = \boldsymbol{X}_i\boldsymbol{\beta} + \varepsilon_i$$

expressions can be derived for the individual's tour frequency probability. For example, the probability of performing 0 trips is:

$$\begin{aligned}&\Pr(0 \cdot trips) = \Pr(U_i < \lambda_1)\\&= \Pr(\boldsymbol{X}_i\boldsymbol{\beta} + \varepsilon_i < \lambda_1) = \Pr(\varepsilon_i < \lambda_1 - \boldsymbol{X}_i\boldsymbol{\beta})\end{aligned}$$

while the probability of making 1 trip is:

$$
\begin{aligned}
&\Pr(1\cdot trip) = \Pr(\lambda_1 < U_i < \lambda_2) \\
&= \Pr(\lambda_1 < \boldsymbol{X}_i\boldsymbol{\beta} + \varepsilon_i < \lambda_2) = \Pr(\lambda_1 - \boldsymbol{X}_i\boldsymbol{\beta} < \varepsilon_i < \lambda_2 - \boldsymbol{X}_i\boldsymbol{\beta}) \\
&= \Pr(\varepsilon_i < \lambda_2 - \boldsymbol{X}_i\boldsymbol{\beta}) - \Pr(\varepsilon_i < \lambda_1 - \boldsymbol{X}_i\boldsymbol{\beta})
\end{aligned}
$$

The probabilities of observing other outcomes are derived in similar fashion. Assuming that the random terms ε_i follow the standard normal distribution, the ordered probit model is obtained. Estimation of this model is discussed at length in Maddala (1983). The ordered probit predicts the probability that an individual i will perform j tours. This predicted probability is then used as a correction term in the continuous portion of the model.

The significance of the variables in explaining the observed pattern is measured by the t-statistics. For discrete choice models it is not possible to determine the overall model goodness of fit by using an index such as R-Squared (Ortuzar and Willumsen 2001). To determine a measure of goodness-of-fit an alternative index was defined as:

$$\rho^2 = 1 - \frac{l^*(c)}{l^*(0)}$$

While, the index is bounded between 0 and 1, it does not have an instinctive interpretation for intermediate values and a value around 0.4 is considered an excellent fit. The ρ^2 index is calculated by measuring the log-likelihood value of the model relative to a null hypothesis or benchmark value (Ortuzar and Willumsen 2001). In this study ρ^2 is the ratio between the log-likelihood value at convergence l*(c) and the benchmark is the log-likelihood with all its coefficients equal to zero l*(0).

4.3.1.2 Continuous: Regression Model

In order to estimate the total duration travelling for shopping, a linear regression model was employed. A simple regression model has the following form;

$$Y_i = \alpha + \boldsymbol{X}_i \boldsymbol{\beta} + \varepsilon_i$$

where

Y: is the dependent variable
α: is the constant or the estimated intercept term
β: is a vector of estimated coefficients
X: is a vector of observed exogenous variables
ε: is a random disturbance

In this case the dependent variable would be the observed total duration for shopping tour. The regression model is applied only to individuals who performed a shopping tour. In order to account for the selectivity bias discussed above the model was expanded to include the predicted probability of the ordered probit which operates as a correction term. The resulting form is:

$$Y_i = \alpha + X_i \beta + \theta \delta_i + \varepsilon_i$$

where

δ is the correction term
θ is an estimable coefficient

The regression was further expanded in order to differentiate between residents of Census Metropolitan Areas and residents of non-Census Metropolitan Areas. The constant and the vector of estimated coefficients for the exogenous variables are disaggregated to include an interaction term to verify whether the respondent resides within a CMA. As a result, constant α and the estimated coefficient β_k now have the following form:

$\alpha = \alpha_1 + \alpha_2 CMA_i$

and:

$\beta_k = \beta_{k1} + \beta_{k2} CMA_i$

where CMA is a dummy variable equal to 1 if a respondent resides within a CMA and 0 otherwise. The resulting form to the regression model is:

$$Y_i = \alpha_1 + \alpha_2 CMA_i + X_i(\beta_{k1} + \beta_{k2} CMA_i) + \theta\delta_i + \varepsilon_i$$

In this case when CMA is equal to 0, $\alpha = \alpha_1$ and $\beta_k = \beta_{k1}$ therefore the reference is considered to be non-CMA residents.

Travel time for shopping and the duration for shopping episodes were found to be interrelated by Hamed and Mannering (1993). Consequently, it is believed that individuals who travel longer durations to undertake an activity are more likely to spend a longer time in that activity than individuals who travel shorter durations. Also individuals are more willing to travel longer durations for activities requiring more time or at which they plan to spend more time. As a result, activity duration will be an explanatory variable or endogenous for the travel duration equation and vice-versa.

Hamed and Mannering (1993) and Rosen et al. (2004) state that if this relationship is ignored and the parameters are estimated using an ordinary least square approach the results are likely to be biased and inconsistent because of endogeneity. Endogeneity occurs because of correlation between the error term (disturbance) and the independent variables (Rosen et al. 2004). In order to resolve the problem Hamed and Mannering (1993) and Rosen et al. (2004) employed the three stage least squares (3-SLS) estimation method and, as such, it is employed in this study as well. The 3-SLS estimates multiple equations simultaneously as one system. The total duration travelling shopping and the total duration for shopping episodes are represented by the following equations:

$$STD = \alpha_1 + \alpha_2 CMA_i + X_i\,(\beta_{k1} + \beta_{k2} CMA_i) + \theta\delta_i + \varphi ASD_i + \varepsilon_{st}$$
$$ASD = \upsilon_1 + \upsilon_2 CMA_i + W_i\,(B_{l1} + B_{l2} CMA_i) + \theta\delta_i + \omega STD_i + \varepsilon_{sa}$$

where

STD is the total duration travelling for shopping
ASD is total duration for shopping episodes
φ is the estimated coefficient for ASD
ω is the estimated coefficient for STD
ε_{st} is the error term for shopping tour duration
ε_{sa} is the error term for shopping episode duration

The distribution of the observed duration travelling for shopping is a negative exponential (see Figure 1). Therefore, the majority of respondents have a short duration and few respondents have a long duration. In many cases, a log transformation is performed to obtain a normal distribution. In this study, a log transformation was investigated but was not selected because it did not improve the model and the linear regression provided more logical estimates which were consistent with previous research. Although, linear regression model did provide some illogical results such as negative travel times, the occurrences were minimal.

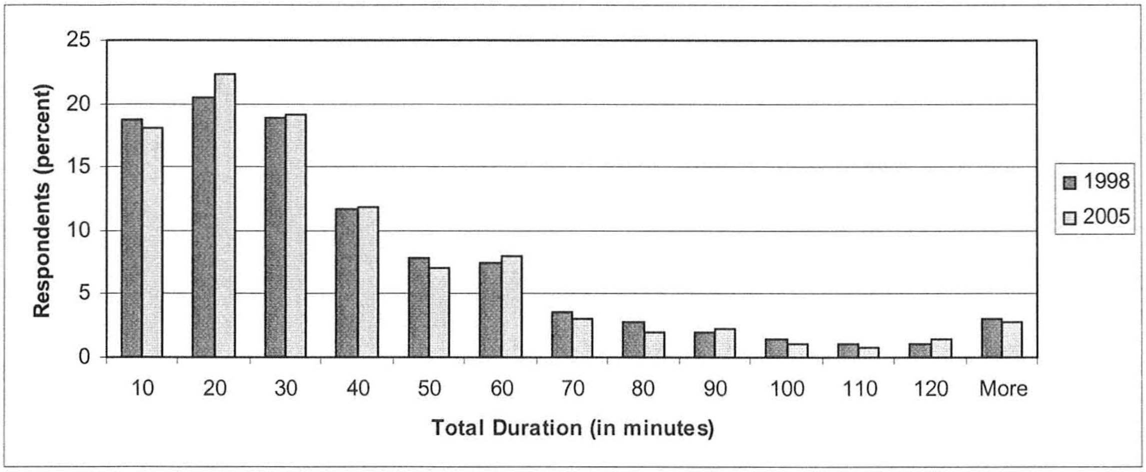

Figure 1: Spatial distribution of the total duration travelling for shopping

4.3.2 Joint Discrete Continuous Model

The recent shift to activity based approaches has led to the exploration of new statistical methodologies (Lee and Timmermans 2007). In the method above the discrete and continuous portion of the model were estimated sequentially and therefore the ordered probit was estimated first to obtain a correction term, followed by the estimation of the regression model. The next step of the research is to develop a joint discrete/continuous model and to investigate whether it can enhance our understanding of shopping behaviour. The joint discrete/continuous model consists of an ordered probit for the discrete model and a hazard approach for the continuous model.

4.3.2.1 Discrete: Ordered Probit Model

In the research of activity generation and duration, respondents who do not participate in the activity are problematic for joint discrete/continuous approaches because the duration value for the activity is zero. Consequently, the cases with no participation or null duration must be overcome. As a result of the possibility of a null value, an ordered probit estimated using cumulative utility approach was not possible. The reason is that the joint probability of the first order class (1 shopping tour) and the corresponding continuous variable is determined by deducting the probability of the zero order class from the joint cumulative probability of the first order and corresponding continuous variable. Since there is no guarantee that the individual accomplished a shopping tour, there is possibility of negative values because the joint cumulative probability of the first order and corresponding continuous variable may not always be higher than the probability of zero order. In order to overcome this issue, a cumulative increasing cost-based specification is employed. The ordered probit is, therefore, estimated using negative utility and is specified as:

$$C^* = \beta x + \varepsilon \qquad (1)$$

where

C^* is the total cost
x is the vector of explanatory variables
β is a vector of estimated coefficients
ε is the unobserved error term

Based on the generalized cost, the probability of participating in a certain number shopping tours becomes:

$$\begin{array}{llcl}
trip = 3+ & if\ C^* \le \lambda_3 & \& & \Pr(trip = 3+) = \Phi(\lambda_3 - \beta x) \\
trip = 2 & if\ \lambda_3 < C^* < \lambda_2 & \& & \Pr(trip = 2) = \Phi(\lambda_2 - \beta x) - \Phi(\lambda_3 - \beta x) \\
trip = 1 & if\ \lambda_2 < C^* < \lambda_1 & \& & \Pr(trip = 1) = \Phi(\lambda_1 - \beta x) - \Phi(\lambda_2 - \beta x) \\
trip = 0 & if\ U^* > \lambda_1 & \& & \Pr(trip = 0) = 1 - \Phi(\lambda_1 - \beta x) = \Phi(\beta x - \lambda_1)
\end{array} \qquad (2)$$

where

λ_1, λ_2 indicates latent threshold values of generalized cost

4.3.2.2 Continuous: Hazard Model

The continuous portion of the model estimates duration data, specifically total duration travelling for shopping. According to Bhat (1996) hazard based duration models "are ideally suited to modelling duration data." Hazard based models are rooted in biometrics and industrial engineering (Ettema et al. 1995; Bhat 1996) and are gradually increasing in transportation demand research (Bhat 1996). Hazard models focus on the probability of an end-of-duration given that the duration has lasted for a certain amount of time (Hensher and Mannering 1994). Consequently, hazard based models recognize that the likelihood of ending the occurrence is dependent on the amount of time already elapsed (Hensher and Mannering 1994; Bhat 1996). However, there are also other determinants for the duration, such as socio-demographic characteristics, that must be taken into consideration in the model (Hensher and Mannering 1994; Ettema et al. 1995).

In hazard models the duration data is usually one continuous value, for example, time between vehicle purchases or length of time a commuter delays a trip departure to avoid congestion. In this study, however, the duration data is total duration travelling for shopping which is the sum of times for multiple shopping trips performed by the respondent. As a result the hazard assumes that the total duration is a single duration or occurrence consequently the individual's activity schedule is ignored.

In this study the total travel duration for traveling for shopping, D, is specified as a logarithmic function (ensuring non-negativity of time allocation), which is defined as:

$$\ln(D) = a\kappa + \eta \qquad (3)$$

where

a is the vector of explanatory variables
κ is a vector of estimated coefficients
η is the unobserved error term

Since the shopping tour generation are classified as 0, 1, 2 and 3+ and the corresponding shopping tour duration are 0, D1, D2 and D3, the joint probabilities of frequencies and corresponding time allocation is specified as:

$$
\begin{aligned}
&\Pr(trip = 3+ \ \& \ Duration = D_3) = \text{Joint} \Pr(trip = 3+ \ \& \ Duration = D_3) \\
&\Pr(trip = 2 \ \& \ Duration = D_2) = \text{Joint} \Pr(trip = 2 \ \& \ Duration = D_2) \\
&\qquad\qquad\qquad\qquad\qquad\qquad - \text{Joint} \Pr(trip = 3+ \ \& \ Duration = D_3) \\
&\Pr(trip = 1 \ \& \ Duration = D_1) = \text{Joint} \Pr(trip = 1 \ \& \ Duration = D_1) \\
&\qquad\qquad\qquad\qquad\qquad\qquad - \text{Joint} \Pr(trip = 2 \ \& \ Duration = D_2) \\
&\Pr(trip = 0 \ \& \ Duration = 0) = 1 - \Pr(trip = 1)
\end{aligned}
\tag{4}
$$

Probability that an individual will perform a shopping tour is defined in equation (2) and the continuous duration specified in equation (1) is expressed as the hazard rate:

$$Hazard\ Rate\ h(D) = \frac{f(D)}{S(D)}$$

Probability of observing any duration D, $f(D) = h(D) * S(D)$

where S(D) indicates Survival Rate

$$\text{So, } f(D) = \frac{1}{D\sigma\sqrt{2\pi}} \exp\left[\frac{-1}{2\sigma^2}\{\ln(D) - a\kappa\}\right] \tag{5}$$

The error term in equation (1), ε is defined as IID Type I Extreme value distribution of zero mean and unit variance. Meanwhile the error for the continuous duration, η is normally distributed with zero mean and a variance, σ. The correlation between the errors, are addressed by setting ε and η as a bivariate normal distribution with zero mean and unit variance, *BVN(0,1)*.

The parameters, β, κ and σ are estimated by deriving the joint probability of shopping tour generation and travel duration as defining in equation (4). Using Lee's (1983) transformation for the random error terms, the joint likelihood (L) is defined as:

$$L = I(3+trips)\times\left[\frac{1}{\sigma D_{3+}}\phi\left(\frac{\ln(D_{3+})-a\kappa}{\sigma}\right)\Phi\left(\frac{\lambda_3-\beta x-\rho((\ln(D_{3+})-a\kappa)/\sigma)}{\sqrt{1-\rho^2}}\right)\right]$$

$$+I(2\,trip)\left\langle\begin{array}{l}\left[\frac{1}{\sigma D_2}\phi\left(\frac{\ln(D_2)-a\kappa}{\sigma}\right)\Phi\left(\frac{\lambda_2-\beta x-\rho((\ln(D_2)-a\kappa)/\sigma)}{\sqrt{1-\rho^2}}\right)\right]\\ -\left[\frac{1}{\sigma D_{3+}}\phi\left(\frac{\ln(D_{3+})-a\kappa}{\sigma}\right)\Phi\left(\frac{\lambda_3-\beta x-\rho((\ln(D_{3+})-a\kappa)/\sigma)}{\sqrt{1-\rho^2}}\right)\right]\end{array}\right\rangle$$

$$+I(1\,trip)\left\langle\begin{array}{l}\left[\frac{1}{\sigma D_1}\phi\left(\frac{\ln(D_1)-a\kappa}{\sigma}\right)\Phi\left(\frac{\lambda_1-\beta x-\rho((\ln(D_1)-a\kappa)/\sigma)}{\sqrt{1-\rho^2}}\right)\right]\\ -\left[\frac{1}{\sigma D_2}\phi\left(\frac{\ln(D_2)-a\kappa}{\sigma}\right)\Phi\left(\frac{\lambda_2-\beta x-\rho((\ln(D_2)-a\kappa)/\sigma)}{\sqrt{1-\rho^2}}\right)\right]\end{array}\right\rangle$$

$$+I(0\,trip)\left\langle 1-\left[\frac{1}{\sigma D_1}\phi\left(\frac{\ln(D_1)-a\kappa}{\sigma}\right)\Phi\left(\frac{\lambda_1-\beta x-\rho((\ln(D_1)-a\kappa)/\sigma)}{\sqrt{1-\rho^2}}\right)\right]\right\rangle$$

where

I is an indicator function
ρ is the correlation between the two random error terms
Φ is cumulative density function
φ is the density function

The goodness of fit of the joint discrete/continuous model is estimated using adjusted likelihood ratio test (Bhat, 1996; Páez et al., 2008):

$$\bar{\rho}^2=1-\frac{\text{Loglikelihood at Convergence - No. of Parameters}}{\text{Loglikelihood of the Null Model}}$$

The disjoint model activities are initially disaggregated in multiple sub-classifications according to the GSS (see Appendix B, Table 1) consequently the influence of numerous sub-categories can be investigated. For the exploration of the joint model a more traditional classification method is used (see Appendix B, Table 2).

Two sets of variables were tested for the model: (1) socio-demographic variables and (2) activity episodes variables. The choice of independent variables was based on previous activity analysis studies including Bhat (1996), Bhat (1998), Bhat et al. (2004), Lee and Timmermans (2007). A complete list of the variables used in each model along with their definitions can be found in Appendix B.

The ordered-probit along with the joint discrete/continuous model were estimated using code written in Matlab. Meanwhile the regression models using the 3-SLS were estimated using Stata.

CHAPTER 5 RESULTS AND DISCUSSIONS

The results and discussion are divided into three sections. In the first section, the results of the descriptive analysis are presented. Next, the results of multivariate analysis are presented and discussed. Finally, the analysis and discussion of the joint discrete/continuous are presented.

5.1 Descriptive Analysis

For the descriptive analysis non-Census Metropolitan Areas (non-CMA) are disaggregated into Census Agglomeration (CA) and rural areas which are the remaining areas not classified as CMA or CA. In addition, Table 5.1 and Table 5.2 are sub-classified depending on the density of the block where the respondent reside as either urban or periphery.

The shopping travel behaviour is presented in Table 5.1. In 1998, the average time spent travelling for shopping was 38.38 minutes with an average 14.90 minutes per trip. In 2005, the average daily duration is reduced to 37.87 minutes however the average trip duration increased to 16.20 minutes. According to Pucher and Renne (2005) it is expected that respondents residing in rural areas will have a higher duration for shopping trips compared to those living in larger urban. Consequently, there is a noticeable difference in duration for residents who live in the denser urban core compared to those who reside in peripheral areas. However, comparing by CMA and non-CMA the shopping durations are similar regardless of the size of the region. The potential exception is residents of CA whose average in 1998 is approximately 4 minutes lower than that of CMAs, however, by 2005 that difference in less than 3 minutes. Meanwhile, the durations for CMAs and rural areas are comparable. In 1998, although rural areas had a higher aggregated total, the urban core and the peripheral areas for CMAs had the highest average for daily and trip duration. The reason for the higher duration for rural areas is the majority of its respondents resided in the peripheral areas where as, for CMAs the majority of the respondents resided within the urban core. In 2005, the urban core of CMAs still has the highest duration, however, the peripheral area now has the lowest duration.

The duration for CMAs, in particular, for the urban core supports statements by Hernandez and Simmons (2006) that some consumers will travel farther for better deals.

Table 5.1: Description of Shopping Travel Behavior per respondent					
	Average Number of Trips	**Average Trip Duration**	**Average Total Duration**	**Average Number of Tours**	**Average Number of Episodes with a Trip**
1998					
Total	2.58	14.90	38.38	1.18	1.62
Urban Core	2.57	14.37	36.93	1.184	1.59
Periphery	2.60	16.71	43.38	1.151	1.71
CMA	2.59	15.03	38.97	1.185	1.61
Urban Core	2.60	14.87	38.62	1.188	1.61
Periphery	2.51	18.05	45.33	1.140	1.65
CA	2.52	13.60	34.21	1.166	1.58
Urban Core	2.48	12.87	31.92	1.168	1.53
Periphery	2.62	15.61	40.87	1.159	1.71
Rural	2.58	15.61	40.22	1.164	1.67
Urban Core	2.52	13.26	33.40	1.19	1.58
Periphery	2.61	16.78	43.76	1.151	1.72
2005					
Total	2.34	16.20	37.87	1.121	1.38
Urban Core	2.35	15.56	36.57	1.128	1.37
Periphery	2.29	18.92	43.27	1.092	1.42
CMA	2.34	16.11	37.66	1.128	1.37
Urban Core	2.35	15.98	37.47	1.131	1.37
Periphery	2.23	18.11	40.30	1.078	1.39
CA	2.39	14.56	34.81	1.123	1.39
Urban Core	2.39	13.70	32.70	1.125	1.38
Periphery	2.41	18.20	45.68	1.108	1.46
Rural	2.30	17.83	40.99	1.099	1.41
Urban Core	2.33	15.81	36.79	1.108	1.38
Periphery	2.28	19.19	43.75	1.093	1.42

CMA's have greater variety and selection of shopping destination compared to rural areas, and residents often do not shop at nearest locations whereas, in rural areas, the choices in shopping location are more limited (Simmons and Jones 2003; Hernandez and Simmons 2006). Meanwhile, the decrease times for peripheral areas could be the result of continual highway improvement and the trend of increased number of outlets in more decentralized areas, especially, in the format of big box stores and power centres which often located near highly accessible areas (Filion et al. 2000; Hernandez and Simmons 2006).

Table 5.2: Description of Shopping Episodes

	Average Number Episodes	Average Duration per respondent	Average Duration per Episode	Average Number Episodes	Average Duration per respondent	Average Duration per Episode
	1998			2005		
Total	1.70	76.59	44.96	1.44	88.37	61.18
Urban Core	1.68	76.74	45.77	1.43	89.17	62.21
Periphery	1.80	76.07	42.34	1.49	85.09	57.10
CMA	1.69	78.76	46.54	1.43	89.77	62.70
Urban Core	1.69	79.60	47.05	1.43	90.58	63.36
Periphery	1.71	63.88	37.46	1.46	78.62	53.74
CA	1.67	77.30	46.42	1.44	87.11	60.30
Urban Core	1.61	72.88	45.26	1.43	87.01	60.69
Periphery	1.83	90.19	49.41	1.50	87.58	58.39
Rural	1.76	70.15	39.77	1.48	85.20	57.45
Urban Core	1.68	62.33	37.08	1.46	82.85	56.71
Periphery	1.81	74.21	41.07	1.50	86.74	57.93

In addition of more isolated areas having longer duration it is also believed that those residing at a further distance from the shopping centre will accomplish more shopping activities, or in other words, will perform more shopping episodes on a shopping tour (Bodkin and Lord 1997). From Table 5.2, it can be seen that there is some evidence supporting this belief as a higher percent non-CMA residents, in particular those residing in rural areas, accomplished a higher number of episodes. In Table 5.2, multiple episodes can take place at the same location (such as an enclosed shopping mall) therefore each episode does not induce a trip. When investigating the number of shopping episodes which require a shopping trip and the total number of shopping trips performed (Table 5.3), all three regions have similar distributions and there is no clear pattern distinguishing each region. Consequently, as with Bodkin and Lord (1997) there is no clear distinction between distance and the level of cross-shopping and as stated by Vande Walle and Steenberghen (2006) there is limited evidence of the quantitative effects of trip chaining.

Table 5.3: Distribution of Respondents

	Number Episodes which Required a Trip			
1998				
Number of Episodes	Total	CMA	CA	Rural
	(percent)			
1	62.37	61.84	63.83	62.58
2	22.96	23.76	22.54	21.16
3	9.30	9.15	8.91	10.02
4 or more	5.38	5.26	4.72	6.24
2005				
1	73.35	73.46	73.11	73.23
2	19.01	19.24	18.94	18.35
3	5.11	5.01	5.10	5.40
4 or more	2.54	2.29	2.85	3.02
Distribution of Maximum Number Episodes on a Tour				
1998				
	Total	CMA	CA	Rural
	(percent)			
1	67.87	67.63	68.83	67.71
2	20.86	22.23	20.11	17.82
3	7.52	6.79	7.56	9.47
4 or more	3.75	3.35	3.51	5.01
2005				
1	77.52	78.41	77.13	75.14
2	16.73	16.37	17.08	17.55
3	3.94	3.58	4.12	4.85
4 or more	1.81	1.63	1.67	2.46

Number of Shopping Trips per Respondent				
1998				
	Total	CMA	CA	Rural
Number of Trips	(percent)			
1	15.17	14.36	15.79	16.82
2	50.06	49.75	51.55	49.67
3	14.77	15.77	13.23	13.36
4	11.22	10.93	11.47	11.80
5 or more	8.87	9.19	7.96	8.35
2005				
1	12.10	12.26	10.89	12.63
2	63.29	63.13	63.20	63.86
3	11.53	11.31	11.78	11.99
4	8.47	8.72	8.83	7.39
5 or more	2.59	4.59	5.30	4.13

Rosen et al. (2004) state shopping behaviour varies according to day of the week. Subsequently when travel was disaggregated by weekday, Saturday or Sunday, it can be seen from Table 5.4 that there are variations in shopping travel duration. In 1998, Sundays had the highest duration for CMAs and rural areas, meanwhile, weekdays had the highest value for CAs. Saturdays, surprisingly, had the lowest duration for all areas. In 2005, however, the duration on the weekends, in particular, Saturdays increased significantly for non-CMA areas and with the exception of Sundays for rural residents where the duration decreased. Where as the duration for weekdays remained fairly stable, with no significant differences were found for any region. The duration for weekdays could be influenced by peak periods and congestion effect, and as many shopping episodes are accomplished during the work to home journey (Hamed and Mannering 1993; Bhat 1996; Bhat and Steed 2002). The increase duration for Saturdays in non-CMAs could be the results of increase number of retail establishments in decentralized locations which increased the travel distance (Bromley and Thomas 1993; Gomez-Insauti

2006) and the consumers who travelled to a larger metropolitan area to accomplish their shopping. The high duration for Sundays could potentially be influenced by people returning from a vacation and the last activity accomplished was a shopping episode, consequently, the return trip home is classified as a shopping trip.

Table 5.4: Duration for shopping trips by weekday

	Number of Respondents	Total Duration (in Minutes)	Duration per Respondent	Number of Respondents	Total Duration (in Minutes)	Duration per Respondent
	1998			2005		
CMA	2416	94160	38.97	3794	142887	37.66
Weekday	1665	64761	38.90	2521	96273	38.19
Saturday	331	12179	36.79	722	26735	37.03
Sunday	420	17220	41.00	551	19879	36.08
CA	741	25346	34.21	1019	35474	34.81
Weekday	547	19182	35.07	749	25550	34.11
Saturday	68	2047	30.10	150	5074	33.83
Sunday	126	4117	32.67	120	4850	40.42
Rural	898	36114	40.21	1259	51607	40.99
Weekday	674	27200	40.36	919	37737	41.06
Saturday	75	2731	36.41	211	9261	43.89
Sunday	149	6183	41.50	129	4609	35.73

The mode of transportation is important when considering the duration for travelling since speeds vary by mode. While that the percentage for each transportation mode is likely to very from city to city or community to community, in general in Canada, that there is an automobile dominance (see Table 5.5). In 1998, 76.37 percent of all respondents accomplished all their shopping trips using only the automobile either as the driver, passenger or a combination of the two and by 2005 that percent increased to 81.06. However, this value understates the importance of automobile since another 7.89 percent in 1998 and 3.75 percent in 2005 used the automobile in combination with walking and does not include multi-mode users who potentially employed the automobile with another mode. The second most used mode is walking but with only 11.20 percent in 1998 and 9.26 in 2005 and subsequently decline for every region with the exception of CA which experienced a slight increase from 6.75 percent to 7.16. Meanwhile, other single modes of transportation have diminutive shares. For instance, public transportation was largely ignored by the Canadian public for shopping as it was employed by less than 3 percent of the respondents.

As expected from Pucher and Renne (2005), when exploring regional differences there is a higher degree of reliance on the automobile for non-CMA residents. From Table 5.5, it can be seen that in 1998, 84.21 percent of CA and 80.73 of rural areas used only the automobile compared to 76.37 for CMA. When you take into consideration individuals who used the automobile in combination with another mode, most notably walking, in 1998 approximately 90 percent of non-CMA respondents employed the automobile compared to about 85 percent for CMAs. In 2005 (Table 5.5), the percent of respondent who exclusively used the automobile increased for all three regions. CMAs experienced the highest increase from 76.37 to 81.06 followed by rural areas which experience a 4.18 percent increased. However, the number of individual who walked and used the automobile decreased by over 4 percent for CMA and CA respondents therefore the absolute number of automobile users remains consistent.

As for non-automobile users, in CMAs, they account for approximately 15 percent of residents. The majority of these respondents, approximately 10 percent, accomplished their shopping needs by walking, however, this percentage decreased between 1998 and 2005. Public transportation, although, rarely used, experienced a minimal increase in the percent of users. In non-CMAs, non-automobile users consist of approximately 10 percent of residents. Nearly all these resident are walkers. For the remaining modes the number of users is such that cannot be disclosed for privacy reasons.

Table 5.5: Transportation Mode Share and Average Total Duration								
	Total		CMA		CA		Rural	
	Percent	Average Duration	Percent	Average Duration	Percent	Average Duration	Percent	Average Duration
1998								
Automobile Only	76.37	37.06	72.35	36.65	84.21	33.36	80.73	41.25
Driver	59.85	35.01	56.50	35.02	63.70	31.69	65.70	37.66
Passenger	13.93	40.58	13.20	38.35	17.95	35.42	12.58	52.95
Car mix	2.59	65.50	2.65	62.84	na	na	na	na
Single Mode	13.79	33.75	16.72	35.77	7.69	36.6	10.91	23.79
Walk	11.20	28.20	12.79	28.86	6.75	33.12	10.58	23.48
Public Transit	2.05	62.51	3.27	61.94	na	na	0.00	0.00
Other	na	na	na	na	na	na	na	na
Automobile & Walk	7.89	48.22	7.99	50.06	7.56	40.59	7.91	49.25
Multiple Modes	1.95	82.73	2.94	84.37	na	na	na	na
2005								
Automobile Only	81.06	37.10	78.47	36.14	85.97	34.45	84.91	41.94
Driver	64.62	34.99	62.60	34.67	68.50	32.10	67.59	38.26
Passenger	13.78	42.48	13.26	39.95	14.82	40.60	14.54	50.97
Car mix	2.65	60.57	2.61	52.23	na	na	2.78	84.14
Single Mode	12.71	35.61	14.89	37.94	9.32	30.12	8.90	28.48
Walk	9.26	27.69	10.38	28.37	7.16	24.88	7.55	27.05
Public Transit	2.37	64.72	3.45	66.15	na	na	na	na
Bus only	2.01	65.61	2.87	67.43	na	na	na	na
Bike	0.51	33.41	na	na	na	na	na	na
Other	0.59	44.42	na	na	na	na	na	na
Automobile & Walk	3.75	48.29	3.43	49.88	3.34	45.12	5.08	46.83
Multiple Modes	2.47	59.06	2.27	61.15	na	na	na	na

Table 5.5 also display the average daily duration by mode. Meanwhile, the average trip duration by mode is presented in Table 5.6. Of the three principal modes of transportation, automobile, walking and public transit, walking had the shortest average

duration per trip and the shortest daily average. A possible reason for the low duration for walking is deduced from Lorch and Smith (1993) and Reimers and Clulow (2004) who state that individuals have a steep distance decay since individuals are reluctant to walk excessive distances. However, this study does not provide any empirical evidence to support this assumption. The following mode with the lowest duration was the automobile. The duration for automobile users varied depending if the users was the driver or the passenger or was both in the same day. Automobile drivers had lower duration compared to passengers, this result is expected and consistent with previous such as (Hamed and Easa 1998; Lee & Timmermans 2007). If an individual travels with a friend, the tour might consist of more social aspects (Habib et al. 2007) as a result they are willing to travel further to stores not often visited. Furthermore, Hamed and Mannering (1993) states that individuals who carpool exhibit similar behaviour as those using public transit. Public transit on the other hand had the highest duration. However, the point of concern is how much higher the duration is for public transit compared to the other modes of transportation. The average trip duration and the total duration are nearly twice as high compared to those for the automobile. Also displayed in Table 5.6 is the average trip duration for additional modes of transportation such as bicycle, taxi and others. However these modes were rarely used, as a result could be skewed by an outlier. The durations for each transportation mode exhibit similar trends for 2005, however, the average trip duration is higher for each mode, suggesting that people are travelling longer distances in order to perform their shopping episodes.

Table 5.6: Average Trip Duration per mode				
	Total	CMA	CA	Rural
	Average Duration			
1998				
Automobile	15.04	14.79	13.91	16.57
Driver	14.31	14.19	13.29	15.40
Passenger	18.01	17.26	16.05	22.35
Walk	10.87	11.40	10.25	9.49
Public Transit	33.51	33.72	30.23	30.00
Bike	18.24	21.77	16.88	6.71
Other	28.24	23.18	0.00	37.50
2005				
Automobile	16.12	15.66	14.63	16.32
Driver	15.32	15.02	14.01	17.28
Passenger	19.54	18.50	17.03	24.70
Walk	12.32	13.05	11.14	10.39
Public Transit	33.06	33.12	31.10	36.67
Bus	32.44	33.14	22.85	36.67
Train	36.38	33.02	142.50	0.00
Bike	14.34	13.16	19.05	12.06
Taxi	17.55	17.64	14.67	20.83
Other	46.62	61.59	26.50	26.15

5.2 Tour generation analysis

The ordered probit was used to calculate the propensity that a respondent will perform a shopping tour. The overall goodness-of-fit of the models denoted by ρ^2 are approximately 0.342 for 1998 and 0.374 for 2005, which suggest a good fit for the models. The model results are presented in Table 5.7. The model results for both time periods are similar with the exception of a few minor differences. In general the variables had a common effect with the exception of household income greater than \$80 000 which was negative, and positive for 2005, however the variable was not significant for 1998. In some cases variables were only significant for one time period (e.g. gender).

Table 5.7: Model results for the propensity to perform shopping tours

	1998		2005	
VARIABLE	Coefficient	p-value	Coefficient	p-value
CONSTANT	16.80562	0.0000	14.22239	0.0000
CMA	0.07180	0.0054	0.06237	0.0033
Socio-demographic characteristics				
Age: 15-24	-0.18270	0.0002	-0.14176	0.0003
Age: 25-34	-0.06349	0.0478		
Age: 35-45		REFERENCE		
Age: 55-64	-0.13348	0.0033		
Age: 65 or older	-0.04903	0.1612	-0.08070	0.0118
Gender: Male			-0.17602	0.0000
Child under 18 years old at home			0.09141	0.0022
Owns the dwelling	-0.07992	0.0054	-0.08375	0.0007
Household Annual Income under $30 000	-0.08310	0.0188	-0.06252	0.0588
Household Annual Income $50 000 - $59 999		REFERENCE		
Household Annual Income Greater $80 000	-0.00329	0.4728	0.05124	0.0403
Household Annual Income not stated	-0.18442	0.0000	-0.18509	0.0000
Education: Secondary school diploma or lower	-0.12478	0.0000	-0.09058	0.0000
Full-Time Worker	0.02660	0.3242	0.04099	0.2003
Part-Time Worker	0.23844	0.0004	0.09632	0.0485
Unemployed or No Regular Employment		REFERENCE		
Dual Worker Household	0.19121	0.0019	0.09615	0.0387
Single Worker Household	0.05701	0.1430	0.06102	0.0773
Living Alone and Employed	0.22018	0.0002	0.17793	0.0003
No Workers in the Household		REFERENCE		
Spent time at someone else's home	0.24403	0.0000	0.2934	0.0000
Spent time at another location	0.19699	0.0000	0.4764	0.0000
Weekday		REFERENCE		
Saturday	-0.33049	0.0000	-0.12182	0.0001
Sunday	-0.12006	0.0016	-0.34726	0.0000

Activity characteristics				
Maintenance activities duration (x 10^{-2})	-1.22227	0.0000	-1.05640	0.0000
Work activities duration (x 10^{-2})	-1.26445	0.0000	-1.11622	0.0000
Child care activities duration (x 10^{-2})	-1.22110	0.0000	-1.09565	0.0000
Educational activities duration (x 10^{-2})	-1.23244	0.0000	-1.12320	0.0000
Organizational activities duration (x 10^{-2})	-1.24397	0.0000	-1.07710	0.0000
Leisure and Recreational activities duration (x 10^{-2})	-1.23504	0.0000	-1.07338	0.0000
Media/communication activities duration (x 10^{-2})	-1.19203	0.0000	-1.00277	0.0000
Duration travelling for work related activities (x 10^{-1})	-0.13953	0.0000	-0.13563	0.0000
Duration travelling for education activities (x 10^{-1})	-0.15948	0.0000	-0.11028	0.0000
Duration travelling for child caring activities (x 10^{-1})	-0.10389	0.0000	-0.09952	0.0000
Duration travelling for the remaining activities (x 10^{-1})	-0.13243	0.0000	-0.12761	0.0000
Threshold values				
One and two shopping tours	2.20648	0.0000	2.43219	0.0000
Two and three shopping tours	3.61694	0.0000	3.85073	0.0000
Summary Statistics				
no of case	10298			18165
L*(c)	-5856.474			-8695.39
L* (0)	-8896.2			-13891
ρ^2	0.342			0.374
Deviance (-2*LogL)=	11712.948			17390.78

In the models, the residents of CMA variable was found to be significant, subsequently CMA resident have a higher propensity to perform a shopping tour. The socio-demographic characteristics that were found to be significant are age, household income, employment status, education and the presence of children. For age, compared to the reference category (age of 35 to 44), the youngest age groups along with the eldest had negatives values. This effect is consistent with Bromley and Thomas (1993), Bhat and Misra (1999) and Mercado and Páez (2007) who found that age may act as a mobility constraint and thus reduce the amount out-of-home activities accomplished. In 1998, age 55 to 64 was negatively significant and while age 65 or greater had a negative effect but was not statistically significant. In 2005, age 55 to 64 was no longer significant, however, age 65 or greater was negatively significant. This demonstrates that shopping trips are increasingly difficult for the elderly. For 2005, males were found to perform fewer shopping tours, this suggests that shopping is still a gendered activity, dominated by females. Also, the presence of children under the age of 18 in the household was found to increase the probability of an individual performing a shopping tour.

Annual household income was found to be influential factors for shopping tour generation. For 1998 household with an annual income below $30 000 were negatively significant therefore were less likely to perform a shopping tour. This result is consistent with previous research such as Bromley and Thomas (1993), which states that the poor can usually be classified at disadvantage consumers because in the current restructuring of the commercial sector it may be more difficult for low income earners to fulfill their shopping needs. In addition, Bhat and Koppelman (1999) state that low income individuals have longer stay-at-home duration. In 2005, the effects household income below \$30 000 remain negative, however was no longer significant. This finding does not necessarily indicate that households with low income are no longer at a disadvantage in term of mobility but rather average income households may be shopping less frequently. In 2005, the households with the highest annual income were found to have a positive impact however, only marginally significant, which suggest they have the resources necessary to perform tours more frequently. Household who did not state their income were found to have a negative influence for both periods. Education displayed similar trends, compared to highly educated, less educated were less likely to perform a shopping trip.

Employment status of the respondent was largely found to be insignificant, only those employed part-time in 1998 was positively significant. However, household labour force status was found to be more influential. Compared to unemployed household, dual working household along with working individuals who live alone were determined to be positive significant. Individual who reside alone and is employed has the disposable income to spend on goods in addition they are totally responsible for all the household needs. Meanwhile, dual income households also have the resources but may also share the shopping responsibility depending the on the work schedule of the spouse. Single worker household, on the other hand, had a positive effect but was not significant possibly because they do not have the resources of a dual working household and the non-working member is more likely to shoulder the majority of the shopping responsibility.

Whether the individual spent time at out-of-home location such as friend's home or another location (besides, home, work or shopping destination) also increase the propensity of performing a shopping tour. Possible reason includes the social aspect of shopping and trip chaining. If an individual undertakes a shopping tour with a friend it is possible that he will also spend some time socializing at his home. Furthermore, while the individual is performing an out-of-home activity it is likely according to Maat and Timmermans (2007) that on the journey between destinations he will make multiple stops and undertake other activities such as shopping.

Rosen et al. (2004) state that shopping behaviour vary according to different period during the week, the models suggest that weekends reduce the propensity for performing a shopping tour. For the mode of transportation, as expected, respondents who only travelled using the automobile had a positive effect. Bromley and Thomas (1993) emphasize the importance of the automobile for shopping, the researchers state that those without an automobile are likely to be at a disadvantage because many cannot easily access stores which offer lower prices. Of particular interest is how the significance increased substantially between 1998 and 2005, suggesting increased automobile dependency for shopping activities.

As expected the propensity to perform a shopping tour is influenced by other activities. The models clearly indicate a trade-off between time-use variables, the more time was spent on a particular activity the less time was available for others. Subsequently, all other activities time-use variables have a negative effect on shopping tour generation since they reduce the time available for shopping. Consistent with existing research such as Bhat (1996) and Srinivasan and Bhat (2005), work duration strongly reduces the propensity of performing a shopping tour. Furthermore, discretionary activity such as recreational and leisure also have a strong negative impact. In addition, the time spent travelling also decreases the probability of performing a shopping tour. For example, the duration travelling for work and educational related activities had negative impact on the propensity to perform tours. The model results suggest that the effect of travel for discretionary activities on tour generation is substantial, however, it is largely ignored in the literature.

5.3 Duration Analysis

The model results for shopping travel duration are presented in Table 5.8 for 1998 and Table 5.9 for 2005. The models have an R-Squared value of 0.185 for 1998 and 0.219 for 2005. The tables are divided into three column, non-CMA model, impact of CMA and CMA model. The non-CMA model is the reference model, where the respondent does not reside in a CMA and the CMA variable is equal to zero (see Chapter 4.3.1.2.) The impact of CMA is the interaction of the variables and when the respondent resides within a CMA (CMA variable is equal to 1). The CMA model is the sum of the coefficients of the non-CMA model and the impact of CMA. The duration models were obtained using linear regression and estimated using a three-stage least-squares (3-SLS) approach due to the correlation between shopping trip duration and shopping episodes duration. The 3-SLS approach modeled the travel and episode duration simultaneously. The results for episodes duration are located in Appendix C, Table C.1 and Table C.2.

From Appendix C Table C.1, it can be notice that the shopping episodes duration model for 1998 had a negative coefficient of determination (R-Squared). When using the ordinary least squares estimation approach the R-Squared is bounded between 0 and 1, however, in the three-stage least-squared approach the R-Squared is no longer constraint. The three-stage least-squared approach estimates the entire system of the equations, as a result, some of the explanatory variables enter the equations as instruments or predicted values. Consequently, the values of the explanatory variables used to fit the model and to calculate its residuals may be different. In this case the unexplained variation or residual sum of squares (RSS) as defined by

$$RSS = \sum(Y_i - \hat{Y})^2$$

is no longer constrained to be smaller than the total sum of squares (TSS)

$$TSS = \sum(Y_i - \bar{Y})^2$$

As a result, when calculating R-Squared

$$R^2 = 1 - \frac{RSS}{TSS}$$

since RSS can be larger that TSS, as a result the R-Squared can have a negative value. A negative R-Squared is not ideal, as the shopping episodes model should not be used in isolation for predicting purpose. However, given the estimate parameters, correspondent p-values and the relationship between shopping duration and episode one can remain optimistic of the reliability of the model regardless of the negative R-Squared. Consequently, the models provide realistic estimates of shopping tour duration.

The models displayed the correlation between travel and activity duration stated by Hamed and Mannering (1993). The duration spent on shopping episodes was found to positively influence shopping trip duration for 2005, however was not significant for 1998. Shopping trip duration was highly significant in the episode duration model for both time periods. This result suggests individuals overcome the disutility of travel by spending more time on the shopping activity. If an individual plans to spend a long time shopping, it is more likely that they will spend more time travelling, however, individuals do not usually plan to shop for a specific amount time. Furthermore, shopping as defined by the GSS includes activities such as services and the duration is dependent on external factors (e.g. waiting time), which are not controlled by the individual.

The duration travelling for shopping was largely influenced by time spent on other activities. As expected from previous research, work duration had a negative effect on shopping trip duration. In 2005, the negative effect of work duration for CMA was lower compared to non-CMAs. Work related travel, however, was only found to influence shopping episode duration. The lack of significance for commuting on travel duration could be the result of individuals who travel longer distances, or lengths of time to work, being more likely to perform a shopping episode on the commute. The travel time could also be influenced by congestion effects (Hamed and Mannering 1993; Hamed and Easa 1998; Rosen et al. 2004).

It can be seen from Table 5.8 and Table 5.9 that there exists a trade-off between the time allocated to other activities and that spent on shopping. The duration of other activities such as child care, or other discretionary activities such as leisure, recreational and media, all have negative influences on the duration travelled for shopping and in some instances have a greater impact than work duration. This can possibly be explained by the fact that these activities occur outside of work hours and further reduce the "free time" available for shopping trips.

The influence of socio-demographic characteristics on the duration travelled for shopping was largely insignificant as only gender and full-time workers were significant for both time periods. Age, despite the negative influence for the young and the elderly of performing a shopping tour was not significant in the duration suggesting that their average trip duration is higher compared to middle-aged individuals. This finding is similar to Bromley and Thomas (1993) who suggest that the elderly and the young are at disadvantage in term of mobility and shopping.

The model suggests that males spend more time travelling compared to females. This finding is somewhat contradictory in the duration models, because studies such as Hamed and Easa (1998) and Yee and Niemeier (2000) suggest that females spend more time shopping than males. Consequently from the relationship between activity duration and travel time it is expected that being male would also have a negative impact on travel time. However, from the duration (see Appendix C) males were found to have shorter shopping episode durations compared to females in 1998, yet, in 2005, gender was no longer found to be a significant factor for shopping duration. This result could be linked to an increase of women in the workforce and, as Dholakia (1999) suggests, more men are performing the shopping responsibilities for the household.

Table 5.8: Model results for total duration travelling for shopping, 1998

Variables	Coefficient	p-value	Coefficient	p-value	
	non-CMA Model		Impact of CMA		CMA Model
Constant	55.4387	0.000	4.5283	0.005	59.9670
Probability: One shopping tour	-9.6535	0.002			-9.6535
Probability: Two shopping tours	67.3669	0.000			67.3669
Probability: Three or more shopping tours	119.4420	0.000			119.4420
Gender: Male	3.6011	0.000			3.6011
Owns the dwelling			-3.2786	0.002	-3.2786
Household Annual Income under $30 000			5.9847	0.000	5.9847
Household Annual Income not stated			3.9181	0.002	3.9181
Full-Time Worker	2.2542	0.025			2.2542
Part-Time Worker	-0.9157	0.526			-0.9157
Saturday			-3.6486	0.012	-3.6486
Travel using the only the automobile			-4.5594	0.000	-4.5594
Multiple shopping episode on tour	16.2378	0.000			16.2378
Activity characteristics					
Shopping activities duration	0.0075	0.864			0.0075
Work activities duration	-0.0424	0.000			-0.0424
Child care activities duration	-0.0634	0.000			-0.0634
Educational activities duration	-0.0403	0.000			-0.0403
Organizational activities duration	-0.0456	0.000			-0.0456
Leisure activities duration	-0.0398	0.000			-0.0398
Recreational activities duration	-0.0494	0.000			-0.0494
Media/communication activities duration	-0.0502	0.000			-0.0502
Summary Statistics					
No of Cases	4051				
RMSE	29.75				
R^2	0.2416				
σ^2	1287.75				

For 1998, low income households residing in CMAs were found to have higher travel duration, which is consistent with Bromley and Thomas (1993). Low income earners are more likely to be dependent on public transit which have higher travel times and make trip chaining more difficult. In 2005, low income households were no longer significant. This result does not necessarily signify that low income households are no longer suffering from lack of mobility but rather could be the consequence of behavioural change, including the decision of average income households to shop less frequently. Dwelling ownership was found to be negatively significant for CMAs in 1998, which perhaps amplifies the effect affluence or the preference of homeowners to locate in relative proximity of shopping destinations. The variable, however, is no longer significant in 2005 possibly because of the increase in segregation between activities, consequently, there is an increasing distance between residential areas and shopping destinations, in particular, in suburban areas (Miller 2000).

Table 5.9: Model results for total duration travelling for shopping, 2005

Variables	Coefficient	p-value	Coefficient	p-value	
	non-CMA Model		Impact of CMA		CMA Model
Constant	53.8889	0	-4.1294	0.055	49.7595
Probability: One shopping tour	-8.1533	0.004			-8.1533
Probability: Two shopping tours	60.0276	0			60.0276
Probability: Three or more shopping tours	88.0701	0.007			88.0701
Socio-demographic characteristics					
chld18	-2.2394	0.050			-2.2394
Gender: Male	4.5255	0			4.5255
Household Annual Income not stated	2.3835	0.031			2.3835
Full-Time Worker	-2.2437	0.040			-2.2437
Part-Time Worker	-3.5697	0.023			-3.5697
Saturday			-3.0683	0.028	-3.0683
Travel using the only the automobile			-7.4399	0	-7.4399
Performed a non-shopping activity on tour			3.0400	0.002	3.0400
Multiple shopping episode on tour	14.8676	0			14.8676
Activity characteristics					
Shopping activities duration	0.0877	0.028			0.0877
Work activities duration	-0.0383	0	0.0145	0.003	-0.0238
Child care activities duration	-0.0315	0			-0.0315
Educational activities duration	-0.0389	0			-0.0389
Organizational activities duration	-0.0319	0.001			-0.0319
Leisure activities duration	-0.0348	0			-0.0348
Recreational activities duration	-0.0393	0			-0.0393
Media/communication activities duration	-0.0578	0	0.0260	0	-0.0318
Summary Statistics					
No of Cases	6072				
RMSE	33.00				
R^2	0.192				
$\square^2$	1309.19				

Employment status was found to be an important factor of shopping behaviour. In 1998, full-time workers were found to have positive effect on travel time for shopping, in 2005, however, it had a negative effect. This could be a result of lifestyle change such as increasing women in the workforce. Bhat (1996) and Srinivasan and Bhat (2005), stated that the likelihood of shopping decreases with work duration and employed individuals prefer not to accomplish the household maintenance shopping. In addition, part-time workers also had a negative effect but were only significant for 2005. Consequently, the unemployed had more flexibility and could consequently spend more time travelling for shopping and such is also the case for full-time students (Rosen et al 2004). Furthermore, the unemployed and students are more likely to be transit users and from the descriptive analysis it was demonstrated that public transportation had higher travel times.

As noted by Rosen et al. (2004), the day of week also influenced shopping behaviour. Saturdays were found to be significant for CMA residents, having a lower travel duration compared to weekdays. The lower duration may be the result of congestion effects on weekdays. Meanwhile for residents of non-CMAs, Saturday is most likely the day that they will travel further, to a nearby metropolitan region, to fulfill their shopping needs. Another trend to mention (see Appendix C) is that shopping duration significantly increases for Saturdays between 1998 and 2005.

The mode of transportation is important since it influences the speed which one can travel across space. The model compares respondents who exclusively used the automobile, to those who used another single mode such as public transportation, and those who employed multiple modes of transportation to accomplish their shopping trips. The exclusive use of the automobile was only significant for CMAs, where the automobile was found to decrease duration travelling for shopping. For the non-CMA, the lack of significance could be the result of automobile dependency. The descriptive analysis demonstrates that very few residents used alternative transportation methods to perform shopping activities. As a result there is no variation between transportation modes if everyone or almost everyone uses the same transportation mode. Meanwhile in CMAs, the model suggests that residents can significantly reduce their travel times by using the automobile, even though accessibility and transportation services are supposed to be higher. In addition, the use of the automobile was also found to increase shopping duration, consequently individuals who used the automobile shopped for a longer period of time. With the automobile an individual can easily transport a high volume of goods (Bromley and Thomas 1993; Maat et al. 2005; Srinivasan and Bhat 2005). Consequently, automobile users can spend more time shopping, purchasing more products. Meanwhile, non-automobile respondents are required to physically carry the goods between destinations. Therefore as Bromley and Thomas (1993) and Srivinasan and Bhat (2005) describe, a non-automobile user may need to perform several episodes a week to fulfill their needs, whereas an automobile user may fulfill their weekly needs with a single episode. As a result, an automobile user may shop less frequently and purchase a high volume of goods, as opposed to non-automobile individuals who may perform frequent episodes and purchase a low volume of goods.

5.4 Discussion on Shopping Travel Behaviour for CMAs and non-CMAs

The analysis suggests that the shopping behaviour between CMAs and non-CMAs are similar and does not demonstrate extensive differences. The descriptive analysis found that rural areas, as expected, had the highest duration, however, the difference over CMAs was only a few minutes. The analysis suggests that size of the region is not a primary factor in influencing the travel time, but rather where the individual resided within the region was more significant. Consequently, as found by Pucher and Renne (2005), individuals residing in less dense or peripheral areas spent more time travelling. For the urban cores, CMA respondents had the highest duration. Possible reasons for this not only include a decreasing number of outlets and openings in more decentralized areas (Bromley and Thomas 1993; Arentze and Timmermans 2005; Gomez-Insausti 2006) but consumers are travelling longer distances across a metropolitan area in search of "better deals" (Hernandez and Simmons 2006). Larger metropolitan areas also have larger spatial areas compared to smaller and rural communities, resulting in CMA residents travelling longer distances with longer durations. The high duration for the urban core of CMAs should be a note of concern for transportation authorities as it increases the demand on the transportation network and raises the amount of mobile-source emissions.

The model estimation also suggests that socio-demographic and time-use characteristics have similar influences on shopping travel behaviour regardless of place of residence (CMA or non-CMA). The tour generation model suggests that CMA respondents are more likely to perform a shopping tour than non-CMA respondents. This is consistent with Pucher and Renne (2005) who found that households residing in denser urban areas performed slightly more trips than their rural counterparts. For the shopping travel duration models for CMAs, in 1998, there was evidence that affluence had an effect on shopping behaviour, such variables as dwelling ownership and low income household were significant. However, in 2005, these variables were no longer significant.

The variables which have greatest differences between the CMAs and non-CMAs were Saturdays and the transportation mode. The model displayed that CMA residents had a lower travel time on Saturdays compared to weekdays and non-CMAs. Reasons include reduction of the congestion effect on Saturdays, in particular compared to individuals who undertake a shopping trip on the work to home commute during peak travel time. Meanwhile, Saturdays are most likely the day which non-CMA residents will travel to larger urban areas to perform a shopping tour because they are less likely to work and consequently have more "free-time" available. The automobile is an important factor of shopping travel behaviour. The tour generation model suggests that those individuals who employ the automobile are more likely to perform more frequent tours. Meanwhile, shopping travel duration models found the automobile is only significant for CMA residents, indicating that CMA residents who used alternative modes of transportation, in particular public transit, spent longer times travelling for shopping. For non-CMAs, the lack of significance could be because few respondents did not use an automobile. In addition, the use of an automobile greatly influenced the shopping durations, as automobile users spend more time shopping. Having saved time travelling, automobile users can spend more time shopping (Chen and Mokhtarian 2006), and the user is not constrained by capacity to carry goods (Bromley and Thomas 1993; Srinivasan and Bhat 2005).

The analysis also demonstrates changes in the shopping behaviour between 1998 and 2005. Compared to 1998, in 2005 respondents have lower total average duration, however, the average duration per trip along with average duration per shopping episode are much higher. As a result, consumers are shopping less frequently and performing fewer episodes, but they are travelling longer to the destination and spending more time per shopping episode. The analysis suggests the influence of the growth of one-stop shopping, as consumers are shopping less frequently and performing fewer episodes per tour. Consequently, they can potentially fulfill all their shopping needs at a single location, reducing the need for numerous stops. In addition, the use of the automobile allows the individual to purchase a higher volume of goods. As stated by Bhat et al. (2004) and Bhat et al. (2005) the likelihood of a shopping episode depends on the length of time since the previous participation. However, if an individual purchases a greater quantity of groceries for example, food depletion takes a longer period of time, as a consequence, the need for the next shopping episode is delayed and therefore the individual needs to shop less frequently.

The results of the analysis are consistent with research of the supply-side of commercial sector. Studies such as Bromley and Thomas (1993) and Gomez-Insauti (2006) state that the growth of decentralized superstores increases travel distance and automobile dependency. In addition, Bokin and Lord (1997), Wang et al. (2000) and

Lorch (2005) demonstrated there are fewer shopping episodes performed in power centres.

5.5 Analysis of Joint Discrete/Continuous Model

In this section, the results of a joint discrete/continuous model are provided in order to determine its potential for studying travel behaviour. As a basis for comparison, a disjoint model was estimated, however the estimation methods for the disjoint and joint models are different. Therefore, the disjoint approach is not directly comparable but rather is used as a reference.

For the joint model, the discrete and continuous parts predict both participation and null cases, therefore, both the activity generation and duration models were estimated using the entire sample. This approach ensures connectivity between the sections. For the disjoint model, the ordered probit was accomplished on the entire sample and the activity duration model was accomplished only for respondents who performed a shopping tour.

In the case of the disjoint model the ordered probit was estimated using utility maximization. The effect of the different variables is such that the sign corresponds with the utility, therefore, positive sign is associated with positive utility or increased propensity to undertake a shopping tour. Meanwhile, the shopping tour generation for the joint model was estimated using a cost function, therefore, the effect of the variables should be interpreted according to equation (1). For this model, a positive sign indicates cost and consequently, as the cost of making a tour increases, the frequency of performing a shopping tour decreases and vice versa. In the case of the duration model, the effects of different variables should be evaluated with reference to equation (3); here a positive effect is associated with the decision to spend longer duration traveling and vice versa. The interpretation for the duration model is therefore the same for both the disjoint and joint model.

The model results are displayed in Table 5.10. The overall goodness-of-fit of the models denoted by ρ^2 are approximately 0.051 for the joint model and for the disjoint model the ordered probit had ρ^2 of 0.123 and the regression model has an R-Squared of 0.1413. The tour generation models were similar and had no contradictory effects. Residents of Census Metropolitan Areas were found to be more likely to engage in a shopping tour. As expected from the literature, age was a mobility constraint, consequently the young and elderly were less likely to accomplish shopping tours because they have a higher cost (e.g. ease and time) compared to adults (25- 64 years old). Also males were less likely to perform a shopping tour. Household income and individual employment status were also significant in both models. Low income households had a low propensity to perform a shopping tour as opposed to high income households who have a positive propensity. In addition, being employed also increases the likelihood of making a shopping tour. Part-time workers and students were also found to be likely to perform a tour possibly because they have more "free time" available, are less constrained by work-related responsibilities, and are more probable to be without an automobile, as a result may perform more frequent tours and purchase less goods.

Weekdays were also found to increase the propensity to perform shopping tours since studies such as Hamed and Mannering (1993) Bhat (1996) and Bhat and Steed (2002) suggest that many shopping episodes are performed on the work to home commute. Also, if the respondent stops for coffee on the way to work or buys take-out food for lunch at a nearby fast food outlet by definition of the GSS these activities would be classified as shopping tours. The transportation mode also influences the propensity of making shopping tours, as the automobile increases the ease of accomplishing trips. In addition, access to public transportation was also found to increase the likelihood of performing shopping tours possibly because many individuals such as the elderly, the young, students and the poor may be dependent on the service for transportation. In addition, the time-use variables once again displayed a trade-off and as duration increases, the probability of performing a shopping tour decreases.

From Table 5.10 one can also notice that some variables were only found to be significant in one of the models. These variables with the exception of dwelling ownership had relatively high p-values (above 0.01). The presence of children under the age of 18 in the household along with dwelling ownership or ownership not stated, was only significant in the disjoint model. Meanwhile, being married or in a common law relationship and dual and single worker households were only significant in the joint model.

The continuous portion of the model was estimated using a different statistic method for the disjoint and joint model. The continuous part in the disjoint model consisted of a linear regression, once again estimated with 3-SLS (the results for shopping activity duration is located in Appendix C, Table C.3). The joint model on the other hand was estimated using a hazard approach. Therefore, only a general comparison can be made. The model results can be seen in Table 5.10. Both approaches produced models which displayed similar trends, individuals under the age of 25 had a negative effect. Seniors on the other hand had contradictory effects in each model, however, the variable was not statistics significant in the regression and had a high p-value in the hazard. Meanwhile males, and whether the individual accomplished a trip chain (shopping or non-shopping activities) were found to increase the duration travelled for shopping. For the influence of other activities, shopping episode duration had a positive effect once again displaying that those individuals who travel longer will also shop for a longer period of time. As expected, the duration of other activities had a negative influence on shopping trip duration. The regression approach, as opposed to the hazard model, only found activity episodes to be significant. The hazard model also found travel duration for subsistence and for remaining activities to be negatively significant.

Other differences included in the regression model, exclusive use of the automobile and access to public transportation, had negative influence on travel time. The automobile allows individuals to travel between destinations relatively quickly, while access to public transit suggests that individuals do not necessarily employ public transit but possibly reside in a denser neighbourhood with a higher number of shopping outlets. Meanwhile, the hazard model found that the presence of children in the household had a negative effect on shopping trip duration.

The statistical significance of the error correlation parameter ρ of the joint approach implies that the tour generation and travel time are related. Consequently, the use of a joint approach is appropriate. The value of ρ is interpreted in reference from equation (6), subsequently a negative value indicates positive correlation, and therefore a higher frequency of shopping tour will result in longer time allocation for shopping travel. In the disjoint approach, the probability for individuals performing one shopping tour was not a significant factor for shopping travel time, meanwhile, the probability of performing two and three or more was positively significant, once again suggesting that when the number of shopping tours increases so does the travel duration.

The significant difference between the modeling approaches is the contradictory effect of residing in a CMA. In the disjoint model CMA has a negative influence, as opposed to the joint model where CMA was found to increase shopping tour durations. The contradictory results for CMAs is problematic since alternative statistical approaches demonstrate different trends. Consequently, additional information is required to strengthen the model estimations. In this case, the ordered probit found that CMA respondents are more likely to perform a shopping tour, in addition, the descriptive analysis suggests that CMA residents (in particular those residing in the urban core) also had a high travel duration, suggesting that the result from the joint model may be more suitable.

Table 5.10: Model results disjoint and joint model; 2005				
Activity Generation	**Disjoint Ordered-Continuous Model**		**Joint Ordered-Continuous Model**	
Variable	Coefficient	p-value	Coefficient	p-value
CONSTANT	0.71463	0.000		
CMA	0.08165	0.000	-0.11275	0.000
Age: 15-24	-0.26447	0.000	0.27185	0.000
Age: 35-65				
Age: 65 or older	-0.16715	0.000	0.17443	0.000
Gender: Male	-0.20587	0.000	0.20277	0.000
Child under 18 years old at home	0.04732	0.036		
Married or common law			0.07343	0.020
Owns the dwelling	-0.0954	0.000		
Dwelling ownership not stated	-0.17566	0.018		
Household Annual Income under $30 000	-0.12017	0.000	0.10395	0.003
Household Annual Income $30 000 - $79 999				
Household Annual Income Greater $80 000	0.09006	0.000	-0.07654	0.003
Household Annual Income not stated	-0.16382	0.000	0.17244	0.000
Full-Time Worker	0.07636	0.045	-0.09996	0.024
Part-Time Worker	0.11668	0.015	-0.14748	0.005
Student	0.14572	0.004	-0.14377	0.009
Unemployed or No Regular Employment				
Dual Worker Household	0.07674	0.059	-0.10356	0.040
Single Worker Household	0.04230	0.133	-0.07936	0.048
Living Alone and Employed	0.20075	0.000	-0.16743	0.000
No Workers in the Household				
Weekday	0.31568	0.000	-0.30983	0.000
Weekend				
Travel using the only the automobile	0.51145	0.000	-0.50271	0.000
Public transit available	0.08780	0.000	-0.09230	0.000
Activity characteristics				
Subsistence activities duration (x 10^{-2})	-0.28783	0.000	0.28275	0.000
Maintenance activities duration (x 10^{-2})	-0.19597	0.000	0.17979	0.000
Discretionary activities duration (x 10^{-2})	-0.16989	0.000	0.16539	0.000
Subsistence travel duration (x 10^{-1})	-0.04952	0.000	0.48521	0.000
Travel for remaining activities duration (x10^{-1})	-0.02402	0.000	0.23405	0.000

Activity Duration				
	Regression		Hazard	
Variable	Coefficient	p-value	Coefficient	p-value
CONSTANT	41.14132	0.000	3.25380	0.000
CMA	-3.70678	0.001	0.05052	0.038
Age: 15-24	-4.71135	0.014	-0.12950	0.000
Age: 65 or older	0.70904	0.584	-0.01979	0.472
Gender: Male	4.65770	0.000	0.07441	0.000
Child under 18 years old at home			-0.07682	0.005
Full-Time Worker	-3.05074	0.008		
Part-Time Worker	-2.87187	0.124		
Weekday			0.11289	0.000
Performed another activity(ies) on the tour	6.96879	0.000	0.15886	0.000
Travel using the only the automobile	-6.66263	0.000		
Public transit available	-2.42136	0.009		
Activity characteristics				
Shopping Activities	0.16982	0.001	0.27101	0.000
Subsistence activities duration*	-0.01462	0.035	-0.10664	0.000
Child care activities duration*	-0.02860	0.006	-0.09460	0.000
Child care activities duration*	-0.02773	0.000	-0.10231	0.000
Subsistence travel duration**			-0.14005	0.002
Travel for remaining activities duration**			-0.07175	0.001
Threshold values				
One and two shopping tours (mu1)	1.55764	0.000	0.60206	0.000
Two and three shopping tours (mu2)	2.62638	0.000	-0.96273	0.000
Correction Terms				
□			-0.28036	0.000
Sigma			0.76823	0.000
Probability: One Shopping Tour	-2.50911	0.741		
Probability: Two Shopping Tours	83.99392	0.009		
Probability: Three or more Shopping Tours	452.48460	0.007		
Summary Statistics				
Ordered Probit			**Joint Model**	
no of cases	18165		18165	
L*(c)	-12179.76		-38894.1	
L*(0)	-13891		-40987.6	
ρ^2	0.123		0.051	
Regression				
no of case	6072			
RMSE	34.00			
R^2	0.1413			
□^{2}	905.12			

* Duration of activities x 10^{-2} ** Duration of activities x 10^{-1} for the Hazard mode

The joint discrete/continuous model in this research was applied to an ordinal nature of a single discrete activity generation and the duration of that activity. The joint model explicitly addresses issues arising from sample-selectivity and endogeneity biases. The use of negative utility or generalized cost to estimates discrete ordered model allowed the joint model to overcome the problems with no participation and the corresponding null duration, therefore, the joint model could be applied to the entire sample. With reference to a disjoint approach, the joint model provided consistent and realistic estimates suggesting the usefulness of the method. The joint model is, however, not without limitation. The approach is computationally intensive and, as a result, as the number of variables in the model increased so did the computing time. In the joint, several variables, in particular time-use variables were aggregated in order to reduce the total number of variables in the model. Furthermore, due to computing time the joint model could not be applied to determine the interaction effects of residing within a CMA.

CHAPTER 6 Conclusion

6.1 Findings and limitations

The objectives of this study were first to analyze the shopping frequency and travel duration of Canadians for 1998 and 2005 using the General Social Survey, followed by a contribution to the growing body of econometrics by investigating the potential of a newly developed discrete/continuous model for the joint analysis of ordered (i.e. generation) and continuous (i.e. duration) outcomes. The analysis of shopping behaviour divided the nation into two regions Census Metropolitan Areas (CMAs) and non-Census Metropolitan Areas (non-CMAs), to examine whether the shopping travel behaviour is a significant difference in each region and to investigate the claim that individuals residing in non-CMAs are travelling longer durations to fulfill their shopping needs.

The analysis demonstrated the influence of various socio-demographic characteristics on shopping behaviour in Canada. From the ordered probit models, age had a noticeable effect on shopping frequency, as it was found to constrain mobility, consequently the young and the elderly were less likely to perform a shopping tour. The overall lack of significance in the shopping travel duration models also suggests that they have longer durations per trip. In addition, the analysis suggests the less affluent are at a disadvantage in terms of mobility since they were found to have a negative effect on the propensity of accomplishing a shopping tour. The analysis also highlights the importance of the automobile for shopping. Regardless of region the majority of the respondents used the automobile, furthermore, the model suggests that the automobile increases the propensity of performing a tour and, compared to other modes, reduces the travel time.

The models emphasized the existence of time constraints and activity scheduling (Hägerstrand 1970; Bhat 1996; Zhang 2005; Chen & Mokhtarian 2006). There is a trade-off between the time spent participating in various activities and shopping tour duration. As expected, work was negatively correlated with propensity to perform a shopping tour and the time spent travelling for shopping. The negative effect of work is well documented in such studies as Bhat (1996) and Bhat and Misra (1999). The time spent on other activities such as child care, media/communication, leisure and recreational activities and duration travelling for these activities were also found to be influential since it further reduced the time available for shopping. The effect of specific discretionary activities, however, is largely overlooked or aggregated into categories classified by type (discretionary) or by location (in-home).

The analysis examined temporal differences between 1998 and 2005. The results suggest that shopping behaviour is changing such that individuals are shopping less frequently, and are spending less total time travelling for shopping, however, the average duration per trip is increasing and the average duration per shopping episode is increasing. Consequently, the analysis indicates the increased trend of one-stop shopping which is often linked with large format retailers or superstores. One-stop shopping is supported by automobility since the stores are locating in more automobile accessible areas (Bromley and Thomas 1993, Gomez-Insauti 2006; Hernandez and Simmons 2006) and the automobile decreases the difficulty of transporting a large number of goods (Bromley and Thomas 1993; Maat et al. 2005; Srinivasan and Bhat 2005).

The retail literature such as Stabler (1987), Yeates and Montgomery (1999) and Hernandez and Simmons (2006) suggest that commercial activities are now highly interconnected and residents in rural and small communities will travel to nearby metropolitan areas to fulfill their shopping needs. This research investigated the shopping behaviour of Census Metropolitan areas (CMAs) and non-Census Metropolitan areas (non-CMAs) to determine whether they were significantly different and attempted to verify the claim that residents of non-metropolitan areas will travel to metropolitan areas in order to fulfill their shopping needs. The results of the analysis, however, suggest that the shopping travel behaviour is similar regardless of region. The descriptive analysis demonstrated that those residing in less dense peripheral areas had higher durations compared to those residing within the urban core of the region. However, more importantly, the analysis demonstrated that duration for urban core of CMAs was higher compared to non-CMAs. The estimation of disjoint discrete/continuous models also suggests similar behaviour for CMA and non-CMA residents. Although, the ordered model found that CMA residents had a greater propensity to undertake a shopping tour, the duration model suggests that socio-demographic along with time-use characteristics had minimal variation between the regions. The most striking difference was the effects of the automobile and whether the shopping activities were performed on a Saturday. In CMAs, the automobile significantly reduced the travel time and increased the duration of the shopping episodes. Meanwhile, Saturday had lower durations for CMAs possibly because on weekdays, the duration is influenced by congestion, while for non-CMA residents it is the day when shopping trips to adjacent larger metropolitan areas is most likely to occur.

Bourne (2000) believes that given the improvements to mobility due to continual improvement to the transportation system, increased automobile ownership and information technology, consumption patterns have become more homogeneous across space. The author goes on to state that traditional differences and lifestyles between rural and urban are not as pronounced as they were in the past, and as a result, believes that currently "almost everywhere and everyone may be considered 'urban'" (Bourne 2000 p.29). As a corollary, it is possible that significant differences in travel behaviour between urban and rural areas no longer exist.

The lack of evidence for non-metropolitan residents traveling to nearby metropolitan areas could be the result of limitations of the study. The General Social Survey provides only duration data and as a consequence, distance is ignored, therefore, the reason for the duration is not known. Non-CMA residents could be travelling longer distances (to a nearby metropolitan) at a high speed or could only be travelling short distances. Meanwhile, CMA residents could be travelling longer distances to accomplish their shopping as suggested by Hernandez & Simmons (2006) or the trips may be taking more time as a result of increased demand on the road network. Regardless, according to this research the daily percentage of non-CMA residents with long duration is small.

In addition, another limitation is the lack of contextual information provided by the General Social Survey. The survey provides a time-use diary, which states the activity type, start and end time, along with the duration, however, there is no information on the underlying decision process. Consequently it is not known why the individual decided to perform a particular activity, at a certain time and place. Ettema et al. (1993) and Maat et al. (2005) believe that travel decisions are made based on the daily (or even few days) scheduled activities and individuals attempt to schedule their activities in order to maximise their time. As a result, the decision of where to shop could be influenced by other daily activities. When individuals perform multiple activities, including a non-shopping activity on a shopping tour, the shopping destination and thus the travel duration could be the result of a non-shopping activity. Krizek (2003) states that when using tours as the unit analysis an important consideration is the principal purpose of the tour, however, this purpose is not provided by the GSS. Consequently, it is not known whether the individual planned to shop at a particular store or the location is the by-product of another activity.

Furthermore, how activities were classified and recall error introduce potential biases for the GSS. There is flexibility in how individuals can record their time-use diaries, in many situations an individual can classify an activity episode under multiple categories. For example, a shopping episode is performed on the work to home journey, one respondent can classify the series of activities as "travel for work – shopping episode – shopping trip" while another respondent can classify the same series as "shopping trip – shopping episode – shopping trip". Consequently, the same situation is recorded two different ways in the GSS. In addition, the data for the GSS was collect up to two days after the day in question. As a result, the individual must recall their activity schedule or what activities they performed. Studies on data collection such as Doherty and Miller (2000), state that individuals often under-report the number of activities actually performed. As a result, individuals may forget to report some shopping episodes.

The GSS is a single day time-use diary, as a result the decision process is assumed to be independent from one day to the next. The use of single day surveys, however, has been increasingly criticized. Bhat et al. (2005) state that one-day analysis "implicitly assume uniformity and/or behavioural independence in activity decisions from day to next". The decision for activity participation may be dependent across many days (Bhat et al. 2005). For example, grocery shopping episodes are not likely to be performed every day, however, the likelihood of the activity increases the longer the individual has not performed that activity (because of food inventory depletion). Consequently, since multi-day surveys can accommodate for day-to-day variation, it is argued that they provide more efficient and unbiased estimation and subsequently a more accurate forecast of travel demand (Harvey 2004; Bhat et al 2004; Bhat et al 2005).

The longer duration spent travelling for shopping by CMA residents must be viewed as a point of concern for transportation analysis. The longer duration suggests that consumers are spending an increasing amount of time on transportation networks putting increased demand on the transportation system and subsequently releasing larger amount of mobile-source emissions. Bhat and Steed (2002) argue that congestion can no longer be purely attributed solely to commute trips, as trips for non-work activities are significant contributors to the total traffic and their proportion is increasing. It is suggested that the effect of non-work trips can not be captured by the state-of-the-practice modeling techniques because they focus on a particular time interval. As a result, transportation officials along with different levels of government cannot install effective policy measures in order to ease congestion and reduce automobile emissions (Bhat 1998; Shiftan & Suhrbier 2002).

6.2 Applications

This research attempts to fill gaps in the shopping behaviour literature. First, it jointly analyzes shopping tour frequency and duration. This research provides information on how various individual characteristics and time-use influences shopping behaviour. And second, investigates the shopping travel behaviour for Census Metropolitan areas (CMAs) and non-Census Metropolitan areas (non-CMAs) to determine whether shopping travel behaviour significantly differs between the regions. This research provides information on the shopping travel behaviour of smaller communities at a time when the majority of the academic literature is concentrated on short distance trips or travel performed within urban areas (Limtanakool et al. 2006) and the resources for small town residents are limited (Horner et al. 2006).

Modeling activity participation is a significant aspect of travel behaviour research. Activity participation consists of conditional outcomes which can be divided into activity generation and duration which constitute a discrete/continuous situation. Activity participation have been separated where activity generation and activity duration have been studied independently, however, these studies often suffer from sample-selectivity or endogeneity bias. Consequently, this research provides two different discrete/continuous modelling approaches that can be applied to ordinal nature of single discrete activity generation and continuous time allocation. The disjoint approach is modelled sequentially or two stage estimation. In this approach, the discrete part is modelled on the entire sample while continuous part is applied to only those individuals with participation and the sample-selectivity bias is corrected using the probability of the discrete model. In this research, the continuous portion is modeled using regression and estimated using the three-stage least-squared approach (3-SLS) which estimates travel and episode duration simultaneous as one system in order to remove the endogeneity effect. The joint on the other hand is a newly developed approach which the discrete and continuous models are estimated simultaneous on the entire sample. This approach explicitly addresses sample-selectivity and endogeneity biases and ensures connectivity between activity generation and duration (Páez et al. 2008). The ordinal discrete model was estimated using a general cumulative cost approach which removed the issues caused by null time allocation arising from no participation.

6.3 Suggestions for Future Research

As stated in chapter 4 shopping behaviour is not only complex, but also dynamic. While the number of studies on shopping is increasing the sector altogether remains understudied, in particular, its travel behaviour. Arentze and Timmermans (2005) state that the commercial sector is largely the result of the interaction between supply-side strategies of firms and developers and the demand-side shopping behaviour of consumers. Consequently, additional research is required on both elements. For the supply-side, Hernandez and Simmons (2006) suggests that further research on power retailing is required, in particular, on the size of their spatial market. They state that since power centres are a relatively new form of shopping centres, there exists no prior knowledge on the extent of their market penetration. Hernandez and Simmons (2006) believe that some power centres serve not only a collection of neighbourhoods or entire metropolitan areas but also extend into the surrounding communities. Furthermore, the results of Bodkin and Lord (1997) and Wang et al. (2000) suggest that consumers will travel longer distances to shop at power centres compared to other shopping structures.

Consumer preferences along with the convenience of shopping destinations, in particular, in terms of time also influence the commercial sector. At the moment, growth of the sector occurs predominantly in large format stores which are largely located in decentralized locations (Bromley and Thomas 1993; Brennan and Lundsten 2000; Gomez-Insausti 2006; Hernandez and Simmons 2006). These centres are most advantageous for families (Alzubaidi et al. 1997) and automobile owning individuals (Bromley and Thomas 1993). However, as age, specifically the elderly, was found to be a constraint for shopping, the cost for them to accomplish a shopping trip is much higher. Consequently, what will happen to the commercial sector as the Canadian population continues to age? Hernandez and Simmons (2006) suggest that the commercial sector could return to a more traditional format, however, there is limited evidence to support this statement.

The demand-side additional research is needed to properly describe shopping travel behaviour. First, future research requires datasets that provide much more detailed information, such as the distance travelled, type of store/shopping centre visited (street front, enclosed shopping mall, big box/power centre, etc), frequency, among many others. Second, the data could be disaggregated by shopping type such as groceries, everyday goods or services, since it is important to consider the statement of Simmons (1996) that consumers will travel further for some products but not for others. Third, the study could be applied to determine regional differences because the population is not distributed evenly across Canada (Simmons 1996), in addition, accessibility and the perception of time differ between areas in the country. For example, southern Ontario and the Greater Toronto Area (GTA) have an extensive expressway system, the 400 series highways allow individuals to travel long distances quickly. Meanwhile, in British Columbia, distance effects are exacerbated by the physical constraint cause by the mountain ranges (Simmons 1996). Additionally, residents of northern Ontario might by willing to travel to GTA to go shopping, however, residents of GTA believe that northern Ontario is too far away for a shopping trip.

Furthermore, the interconnectivity of the decision process is important but remains understudied. Consequently, the decision to undertake a shopping activity is usually not made independently but rather is the result of the larger context. In a utility-based approach, individuals do not attempt to minimise the duration of single trip but rather the total duration of their daily travel given certain restrictions (Ettema et al. 1993; Maat et al. 2005). Coupling and authority constraint affect the time budget and impose spatial constraint on the possible destinations (Hägerstrand 1970; Dijst and Vidakovic 2000). Although, many studies such as Bhat (1996) and Bhat (1998) and Bhat and Steed (2002), investigate the influence of work-related activities on shopping behaviour, the influence of other activities which are fixed at a time and place such as child care responsibilities on shopping behaviour are still virtually unknown. In addition, further research is needed on the influence of household interaction, the social aspect and the inter-dependence across days. Research by Golob (2000), Scott and Kanaroglou (2002) and Srinivasan and Bhat (2006) are contributing to research on the interaction between household members. Meanwhile, research by Bhat et al. (2004) and Bhat et al. (2005) are increasing the understanding of travel behaviour taken into consideration day-to-day variations. Finally, as a result of the complexity of shopping behaviour, continual research on econometric methods are needed to provide a more complete understanding of shopping behaviour.

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APPENDIX A: Definition of Shopping Activities

Grocery	Shopping for food or alcohol at, grocery stores, convenience stores, liquor stores, etc Ex: shopping for food, bought a six-pack of beer, picking strawberries
Every day goods	Shopping for every goods and products except food, includes shopping special occasions (Christmas, birthdays, etc) Ex: picking up a newspaper, shopping at mall, Buying: music, books, gas, school supplies, etc
Take out Food	Buying food from take-out food restaurant Ex: McDonald's, Wendy's
Rentals of Video	Shopping, renting and returning videos
Durable Household Goods	Shopping for house, automobile, large appliance, etc Ex: visiting apartments for rent, met contractor
Personal Care Services	Personal care outside the home: barbers, beauticians Ex: haircut, tanning booth, getting a massage
Financial Services	Activities related to financial business Ex: going to the bank, using ATM, tax office, insurance office, etc
Government Services	Municipal, local, provincial or federal Ex: post office, driver's license, marriage license, police station, public library, collecting employment insurance, etc
Adult Medical and Dental Care	Medical and dental care outside the home, includes making appointments and going to the chiropractor and podiatrist Ex: Physio, had blood work done, etc
Other Professional Services	Lawyer, veterinarian, home designer, travel agency, counseling, photographer Ex: Meeting with minister for wedding plans, had family pictures done, dog groomer, etc
Car Maintenance and Repair	Auto services Ex: car wash, oil change, tire change, etc
Other Repair Services	Clothing repair or cleaning; Laundromat, dry cleaning Appliance repair or cleaning; furnace, water heater, watch, etc
Waiting*	Duration for waiting for purchases or services Ex: stood in line at grocery store, waiting at airport for flight
Other Shopping or Services	Other services not describe above Ex: yard sales, borrowing goods, checking out halls for wedding

* only in 2005, GSS cycle 19

APPENDIX B: Variable Definitions

Table B.1: Independent variables for Disjoint analysis

Variables	Definition
CMA	1 if respondent reside is within a CMA; 0 otherwise
Socio-demographic characteristics	
Age	1 if individual between certain age range; 0 otherwise
Sex	1 if respondent is male; 0 if female
MS Couple	1 if individual is married or living common-law; 0 otherwise
MS unknown	1 if individual married status not stated; 0 otherwise
Child	1 if respondent has a child(ren) under the age of 18 living in the household; 0 otherwise
Household 4 or more	1 if 4 or more household member(s); 0 otherwise
Dwelling own	1 if respondent owns his dwelling; 0 otherwise
Dwelling not stated	1 if respondent dwelling ownership status not stated/unknown; 0 otherwise
INCHSD under 30 000	1 if respondent's household annual income is below $20 000; 0 otherwise
INCHSD	1 if respondent's household annual income between a certain range; 0 otherwise
INCHSD Greater 80 000	1 if respondent's household annual income is 80 000 or higher; 0 otherwise
INCHSD not stated	1 if respondent's household income was unknown; 0 otherwise
Edu Low	1 if respondent high level of education is a high school diploma or below; 0 otherwise
Full-Time worker	1 if respondent is a full-time work (30 or more hours per week); 0 otherwise
Part-Time Worker	1 if respondent is a part-time worker (less than 30 hours per week); 0 otherwise
Student	1 if respondent is a student; 0 otherwise
No Regular Work	1 if respondent has no regular employment; 0 otherwise
Work not stated	1 if respondent did not state labour force status; 0 otherwise
Dual Worker Household	1 if respondent and spouse/partner are both employed (full-time or part-time); 0 otherwise
Single Worker Household	1 if only respondent or spouse (not both) is employed; 0 otherwise
Live Alone and Employed	1 if respondent employed and live alone (no spouse or partner in household; 0 otherwise

No Workers in the Household	1 if no employed individual in the household; 0 otherwise
Household labour not stated	1 if employment status of household not stated
Transportation characteristics	
Travel using the only the automobile	1 if respondent travelled driver, passenger of a car or both; 0 otherwise
Location characteristics	
At somebody else's home	1 if respondent spent some time at someone else's home; 0 otherwise
Another out-of-home location	1 if respondent spent some time at another place (excluding work, shopping location); 0 otherwise
Type of Day	
Weekday	1 if respondent's day is a weekend day; 0 otherwise
Saturday	1 if respondent's day is a Saturday; 0 otherwise
Sunday	1 if respondent's day is a Sunday; 0 otherwise
Shopping characteristics	
Non-shopping activity	1 if respondent performed a non-shopping activity during at least one shopping tour; 0 otherwise
Multiple shopping	1 if respondent performed more that one shopping episode on a tour; 0 otherwise
Shopping Trip only by Car	1 if respondent accomplished all his shopping trips using only the automobile; 0 otherwise
Activity characteristics	
Work	Work duration of respondent in minutes *
Maintenance	Duration of domestic and personal activities of respondent in minutes *
Child care	Duration of child care activities of respondent in minutes *
Education	Duration of educational activities of respondent in minutes *
Organizational	Duration of organization/volunteering activities duration of respondent in minutes *
Leisure	Duration of entertainment activities of respondent in minutes *
Media	Duration of media/communication activities of respondent in minutes *
Commute	Commute time for work of respondent in minutes **
Educational travel	Time travelling for educational activities of respondent in minutes **
Child care travel	Time travelling for child care activities**
Travel other	Total Duration for remaining activities **
* x 10^{-2} for ordered probit model, ** x 10^{-1} for ordered probit model	

Table B.2: Independent variables for Joint analysis

Variables	Definition
CMA	1 if respondent's residence is within a CMA; 0 otherwise
Socio-demographic characteristics	
Age: 15-24	1 if individual between 15 and 24 years of age; 0 otherwise
Age: Senior	1 if individual 65 years of age or older; 0 otherwise
Sex	1 if respondent is male; 0 if female
MS Couple	1 if individual is married or living common-law; 0 otherwise
MS unknown	1 if individual married status not stated; 0 otherwise
Child	1 if respondent has a child(ren) under the age of 18 living in the household; 0 otherwise
Household 4 or more	1 if household has 4 or more members; 0 otherwise
Dwelling own	1 if respondent owns his dwelling; 0 otherwise
Dwelling not stated	1 if respondent dwelling ownership status not stated/unknown; 0 otherwise
INCHSD under $30 000	1 if respondent's household annual income is below $30 000; 0 otherwise
INCHSD	1 if respondent's household annual income between $30 000 and $79 999; 0 otherwise
INCHSD Greater $80 000	1 if respondent's household annual income is $80 000 or higher; 0 otherwise
INCHSD not stated	1 if respondent's household income was unknown; 0 otherwise
Full Time worker	1 if respondent is a full-time work (30 or more hours per week); 0 otherwise
Part-Time Worker	1 if respondent is a part-time worker (less than 30 hours per week); 0 otherwise
Student	1 if respondent is a student; 0 otherwise
No Regular Work	1 if respondent has no regular employment; 0 otherwise
Work not stated	1 if respondent did not state labour force status; 0 otherwise
Dual Worker Household	1 if respondent and spouse/partner are both employed (full-time or part-time); 0 otherwise
Single Worker Household	1 if only respondent or spouse (not both) is employed; 0 otherwise
Live Alone and Employed	1 if respondent employed and live alone (no spouse or partner in household; 0 otherwise
No Workers in the Household	1 if no employed individual in the household;

	0 otherwise
Household labour not stated	1 if employment status of household not stated
Transportation characteristics	
Travel using the only the automobile	1 if respondent travelled driver, passenger of a car or both; 0 otherwise
License	1 if respondent possess a driver license; 0 otherwise
License not stated	1 if respondent driver license not stated; 0 otherwise
Public Transit	1 if respondent has access to public transit; 0 otherwise
Public Transit not stated	1 if respondent access to public transit is not stated or unknown; 0 otherwise
Type of Day	
Weekday	1 if respondent's day is a weekend day; 0 otherwise
Shopping characteristics	
Chain	1 if respondent accomplished another activity(ies) (shopping or non-shopping) on a tour; 0 otherwise
Shopping Trip only by Car	1 if respondent accomplished all his shopping trips using only the automobile; 0 otherwise
Activity characteristics	
Shopping Duration	Duration for shopping activities in minutes *
Subsistence	Duration for work and educational activities in minutes *
Maintenance	Duration for domestic, personal and child care activities in minutes *
Child care†	Duration for child care activities of respondent in minutes *
Discretionary	Duration for restaurant, organizational, entertainment, recreational and media activities in minutes *
Sub Travel	Duration travelling for subsistence activities in minutes **
Travel other	Duration travelling for the remaining activities in minutes **
* x 10 -2 for ordered probit and hazard model, ** x 10-1 for ordered probit and hazard model	
† only in continuous model	

APPENDIX C: Model Results for Shopping Episode Duration

Table C.1: Model results for shopping activities duration,1998

Variables	Coefficient	p-value	Coefficient	p-value	
	non-CMA Model		Impact of CMA		CMA Model
Constant	13.7395	0.094	4.97594	0.049	18.7155
Probability: One shopping tour	14.3429	0.064			14.3429
Probability: Two shopping tours	43.9234	0.040			43.9234
Probability: Three or more shopping tours	6.6653	0.852			6.6653
Age: 15-24			10.11773	0.012	10.1177
Gender: Male	-5.7089	0.021			-5.7089
Household Annual Income under $30 000			-11.61244	0.003	-11.6124
Dual Worker Household	-9.1368	0.000			-9.1368
Spent time at someone else's home	-8.5292	0.000			-8.5292
Sunday	9.6983	0.000			9.6983
Travel using the only the automobile	12.9981	0.000			12.9981
Performed a non-shopping activity on tour	6.9345	0.001			6.9345
Activity characteristics					
Total duration travelling for shopping	1.8664	0.000			1.8664
Work activities duration	-0.0472	0.000			-0.0472
Educational activities duration	-0.0625	0.000			-0.0625
Organizational activities duration	-0.0581	0.006			-0.0581
Recreational activities duration	-0.0600	0.000			-0.0600
Media/communication activities duration	-0.0354	0.000			-0.0354
Duration travelling for work activities	-0.0957	0.014			-0.0957
Duration travelling for child care activities	-0.2168	0.000			-0.2168
Duration travelling for remaining activities	-0.1462	0.000			-0.1462
Summary Statistics					
No of Cases	4051				
RMSE	73.00				
R^2	-0.0843				
$\square^2$	1188.48				

Table C.2: Model results for shopping activities duration, 2005

Variables	Coefficient	p-value	Coefficient	p-value	
	non-CMA Model		Impact of CMA		CMA Model
Constant	70.3445	0.000	12.5778	0.000	82.9224
Probability: One shopping tour	18.4939	0.002			18.4939
Probability: Two shopping tours	186.6422	0.000			186.6422
Probability: Three or more shopping tours	293.2507	0.000			293.2507
Age: 15-24	15.0838	0.000			15.0838
Age: 25-34			5.8432	0.025	5.8432
Household Annual Income not stated	7.1592	0.001			7.1592
Full-Time Worker	6.2064	0.005			6.2064
Dual working household			-9.6823	0.000	-9.6823
Spent time at someone else's home			-6.8263	0.004	-6.8263
Saturday	14.1583	0.000			14.1583
Travel using the only the automobile	10.5481	0.000			10.5481
Multiple shopping episode on tour	15.6793	0.000			15.6793
Total duration travelling for shopping	0.9119	0.000			0.9119
Activity characteristics					
Work activities duration	-0.1049	0.000			-0.1049
Child care activities duration	-0.1083	0.000			-0.1083
Educational activities duration	-0.1017	0.000			-0.1017
Organizational activities duration	-0.1192	0.000			-0.1192
Leisure activities duration	-0.0582	0.000			-0.0582
Recreational activities duration	-0.1122	0.000			-0.1122
Media/communication activities duration	-0.1038	0.000			-0.1038
Duration travelling for work activities	-0.1467	0.000			-0.1467
Travel for remaining activities duration	-0.1576	0.000			-0.1576
Time travelling for child caring activities			-0.1222	0.002	-0.1222
Summary Statistics					
No of Cases	6072				
RMSE	69.12				
R^2	0.2298				
□^{2}	2292.45				

Table C.3: Shopping episode duration for Joint analysis, 2005		
Variable	Coefficient	p-value
CONSTANT	90.1135	0.000
Probability: One shopping tour	84.3182	0.000
Probability: Two shopping tours	430.4777	0.000
Probability: Three or more shopping tours	1228.1600	0.000
CMA	7.0666	0.002
Socio-demographic characteristics		
Age: 15 to 24	19.9235	0.000
Age: 25 to 64	Reference	
Age: Senior	-5.9965	0.027
Household Income not stated	10.6752	0.000
Full-Time Worker	10.0920	0.006
Part-Time Worker	-0.7779	0.866
Student or Unemployed	Reference	
Dual working household	-14.2707	0.001
Single Worker Household	-6.2497	0.043
Living Alone and Employed	-9.1385	0.023
No Worker in Household	Reference	
Performed another activity(ies) on the tour	11.9542	0.000
Activity characteristics		
Shopping Travel Duration	0.4548	0.063
Subsistence activities duration	-0.1100	0.000
Child care activities duration	-0.1236	0.000
Discretionary activities duration	-0.1112	0.000
Subsistence travel duration	-0.1090	0.005
Travel for remaining activities duration	-0.1169	0.000
Summary Statistics		
No of cases	6072	
RMSE	68.09	
R^2	0.2526	
$\square^2$	1822.49	