Exploring Rental Housing Market in Kitchener-Waterloo, Ontario

by

Xinyue Pi

A thesis

presented to the University of Waterloo

in fulfilment of the

thesis requirement for the degree of

Master of Environmental Studies

in

Planning

Waterloo, Ontario, Canada, 2017

AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Intensification is the key planning policy and growth management approach in Ontario, as well as across most of North America. Under this larger context, the Region of Waterloo, Ontario is building a Light Rail Transit (LRT) to provide alternative public transit option and help reshape land development, with the goal of increasing the development density in core areas, increasing mixed-use development, and curbing urban sprawl. To better understand how the upcoming LRT will influence housing choices and development patterns, this thesis explores households' location choice decision and perceptions of LRT from a renters' perspective. From June to November 2016, a random sample of 2912 households renting in Kitchener-Waterloo were invited to participate in a survey on residential location choice, renting behaviours and perceptions towards the upcoming LRT, after which a total of 290 surveys were analyzed. After a descriptive analysis of the survey results, a hedonic model was also developed to investigate the relationship between rental housing prices and corresponding household, residential, neighbourhood and behaviour characteristics. Unlike other aggregate level models, this hedonic model is implemented using individual level household information collected through the customized survey. The structure of rental housing demand is unveiled regarding different resident groups, as well their perceptions and preferences towards different residential and neighbourhood characteristics. Findings from this study could also be applied to inform housing polices, regarding housing development and housing affordability.

Acknowledgements

First, I would like to thank my advisor Dr. Dawn Parker for the mentorship, motivation and insights that contributed to all aspects of this research. I would also like to thank Dr. Xiongbing Jin for providing strong technical support throughout this study. In addition, I would like to thank Dr. Kevin Curtis for taking the time to be my reader and offer great advice. I would also like to thank my research team members for the collaboration and brainstorming.

I am also grateful for the financial support from Social Sciences and Humanities Research Council: SSHRC Partnership Development Grant (SSHRC # 890-2013-0034) entitled *"LIGHT RAIL TRANSIT AND CORE-AREA INTENSIFICATION: Unpacking Causal Relationships,* and SSHRC Insight Grant (SSHRC # 435-2012-1697) entitled *"Urban intensification vs. suburban flight: An integrated residential land-use and transportation model to evaluate residential land-market form and function".*

My thesis would not have been possible without the support of my parents and friends. I would like to thank my parents for being supportive throughout all my years of education. I would also like to thank all my friends, especially my roommates in Waterloo, for all the positive influences.

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List of Abbreviations

aBRT - Adapted Bus Rapid Transit

AIC - Akaike information criterion

CMA - Census Metropolitan Area

CMHC - Canada Mortgage and Housing Corporation

CT – Census Tract

DA – Dissemination Area

GRT - Grand River Transit

GTHA - Greater Toronto and Hamilton Area

KW - Kitchener-Waterloo

KWC – Kitchener-Waterloo-Cambridge CMA

LRT - Light Rail Transit

MLL - Maximum Likelihood

NHS - National Household Survey

OLS - Ordinary Least Square

PLUM - Waterloo Region's Population and Land Used Model

PUMF - Public Used Microdata Files

RMS - Rental Market Survey conducted by CMHC

SQFT - Square Feet

VIF – Variance Inflation Factor

WTP - Willingness to Pay

Chapter 1. Introduction

1.1 Intensification

Intensification is the key planning policy and growth management approach in Ontario, as well as across most of North America. According to the newly released *Growth Plan for the Great Golden Horseshoe* ("Growth Plan"), to "prioritize intensification and higher densities to make efficient use of land and infrastructure and support transit viability" is a guiding principle of land development and resource management (Ontario Ministry of Public Infrastructure Renewal, 2016). As one of the four provincial land use plans in Ontario, *Growth Plan for the Great Golden Horseshoe* works together with the *Greenbelt Plan* (2005), the *Oak Ridges Moraine Conservation Plan* (2002), and the *Niagara Escarpment Plan* (2005) to manage growth, control curb sprawl and protect the natural environment in the Greater Golden Horseshoe region in Ontario.

The *Growth Plan for the Greater Golden Horseshoe,* 2006 was the first growth plan in Ontario that established a long-term framework for where and how the region will grow. Starting from 2006, the provincial government has made significant investments in transit projects in the Greater Toronto and Hamilton Area (GTHA), including the creation of Metrolinx. Since the introduction of the Growth Plan, the region has experienced a shift to more compact development patterns, more various housing types and more mixed-use development (Ontario Ministry of Public Infrastructure Renewal,

2016). Compared to the 2006 Grown Plan, the 2016 Growth Plan proposed some changes related to intensification:

- Introducing a new term "**strategic growth areas**", which would replace the term "intensification areas".
- Increasing the **minimum intensification target** (the minimum percentage of residential development occurring annually that need to be within the built-up area) from 40 percent to 60 percent.
- Improving transit connectivity at existing "office parks" (concentrations of offices with high employment densities), providing for an appropriate mix of amenities, and encouraging **intensification of employment uses**.

Under this large context of intensification, the Region of Waterloo, Ontario is building a Light Rail Transit (LRT) system to provide alternative public transit option and help reshape land development, with the goal of increasing the density of development in core areas, increasing mixed-use development, and curbing urban sprawl. The LRT is currently under construction along the central corridor; the first phase will operate between the north end of Waterloo and the south end of Kitchener with service estimated to start in early 2018. To better understand how the upcoming LRT may influence housing choices and development patterns, this thesis explores households' location choice decision and perceptions on LRT from a renters' perspective.

Another motivation of this thesis is a lack of rental housing market knowledge and data. The quality and scale of the data supply are limited. Canada Mortgage and Housing Corporation (CMHC), a crown corporation of Government of Canada, is the main source of rental data in the region. However, the scale of the released CMHC rental data is very aggregated. In CMHC's rental housing report, the market in Kitchener-Cambridge-Waterloo is divided into only 6 zones, and the City of Waterloo is analyzed as one zone; this greatly limits the potential of further studying the rental marketing (CMHC, 2016). Moreover, CMHC does not collect secondary rental market data for KWC. This means that their rental market report for KWC only contains information on the privately initiated rental housing buildings, and information of the secondary market such as single-detached rental houses are not available.

Considering the intensification context and limited rental housing data availability, this research aimed to build a better picture of the current rental housing market through conducting a renters' survey. Quantitative methods including descriptive statistical analysis and hedonic rental price models are also developed to help better understand the complexity of rental housing market.

1.2 Thesis Objectives and Research Questions

Four major research objectives have been defined, along with research questions that address each objective. Many of the questions are exploratory; therefore, their hypotheses are generally open ended. Most research questions pertaining to the perceptions and preferences of residential and neighbourhood characteristics will be investigated based on resident subgroups of:

- **Household types**: couple with children, couple without children, lone-parent family, one-person household, and "other household"
- **Age groups**: 18-24, 25-34, 35-54, and 55+.
- **Household income:** less than $29,999, $30,000-$49,999, $50,000-$74,999, $75,000-$99,999, and $100,000-$249,999.
- **Employment status**: employed, retired, student, and unemployed.

Objective 1: To understand the structure of demand in the current rental market in Kitchener-Waterloo.

- What are the distributions of renter subgroups in terms of household type, age group, household income and employment status?
- What are the differences and competition among renter subgroups?

Objective 2: To investigate the relationship between renters' preferences and urban residential pattern.

- What are renters' preferences for residential and neighbourhood characteristics?
- How do renters' current residences compare to their ideal location in terms of residential characteristics?
- How do different household, residential and neighbourhood characteristics influence rental price? Are renters willing to pay for neighbourhood characteristics?

Objective 3: To understand renters' renting behaviours and the renting process.

- What factors have motivated renters to move to their current residence and neighbourhood?
- How do renters rent?
- What are renters' attitudes towards buying a home?

Objective 4: To investigate the potential influence of the pending development of LRT on the rental market in Kitchener-Waterloo.

- What are renters' general attitudes towards CTC and LRT?

1.3 Research Method Overview

There are mainly two methods implemented in this thesis: 1) conducting a renters' survey and descriptively analyzing the survey results; 2) building a hedonic rental price model using collected survey data. A hedonic rental price model is a statistical regression that identifies the relationship between rental prices and housing related characteristics. A random sample of 2912 renters living in Kitchener-Waterloo (KW) were invited to participate in a renters' survey, after which 290 responses are analyzed. Microsoft Excel and the statistics software R were used to derive the descriptive statistics. Then, a hedonic rental price model was developed using collected survey data along with data obtained other sources in a spatial data analysis software, GeoDa.

1.4 Thesis Layout

This thesis is organized into eight chapters and proceeds as follows. Chapter 2 describes the study area of this thesis as well as the policy context. Chapter 3 explains the survey methodology and summarizes preliminary survey results. Chapter 4 presents descriptive statistical analysis of the survey responses in terms of different respondent and household groups. Chapter 5 is a literature review of the hedonic modelling method. Chapter 6 uses exploratory analysis to analyze the dependent and candidate independent variables in preparation of the final model specification. Chapter 7 specifies the hedonic rental price model and presents model results. Chapter 8 summarizes thesis findings, presents recommendations and suggests next steps and areas for future work.

Chapter 2. Study Area

Chapter Overview

This chapter describes the study area of this thesis, the cities of Kitchener and Waterloo, in terms of their locational and demographic characteristics. The policy context in KW is also presented, covering various topics including housing tenure, affordable housing, and the complexity of the rental housing market.

2.1 Location

The study area of this thesis is the cities of Kitchener and Waterloo, which are often referred to as "Kitchener-Waterloo" (KW). Located in Southern Ontario, the "twin cities" are approximately 100 kilometers west of Toronto. Although Kitchener and Waterloo have separate municipal governments, they are connected urban areas and both are located in the Regional Municipality of Waterloo. In addition to Kitchener and Waterloo, the Region also consists of the City of Cambridge and four townships including Woolwich, Wellesley, Wilmot, and North Dumfries. The cities and the surrounding rural municipalities together comprise Kitchener-Waterloo-Cambridge (KWC) Census Metropolitan Area (CMA). It is the 10th largest CMA in Canada and 4th largest in Ontario.

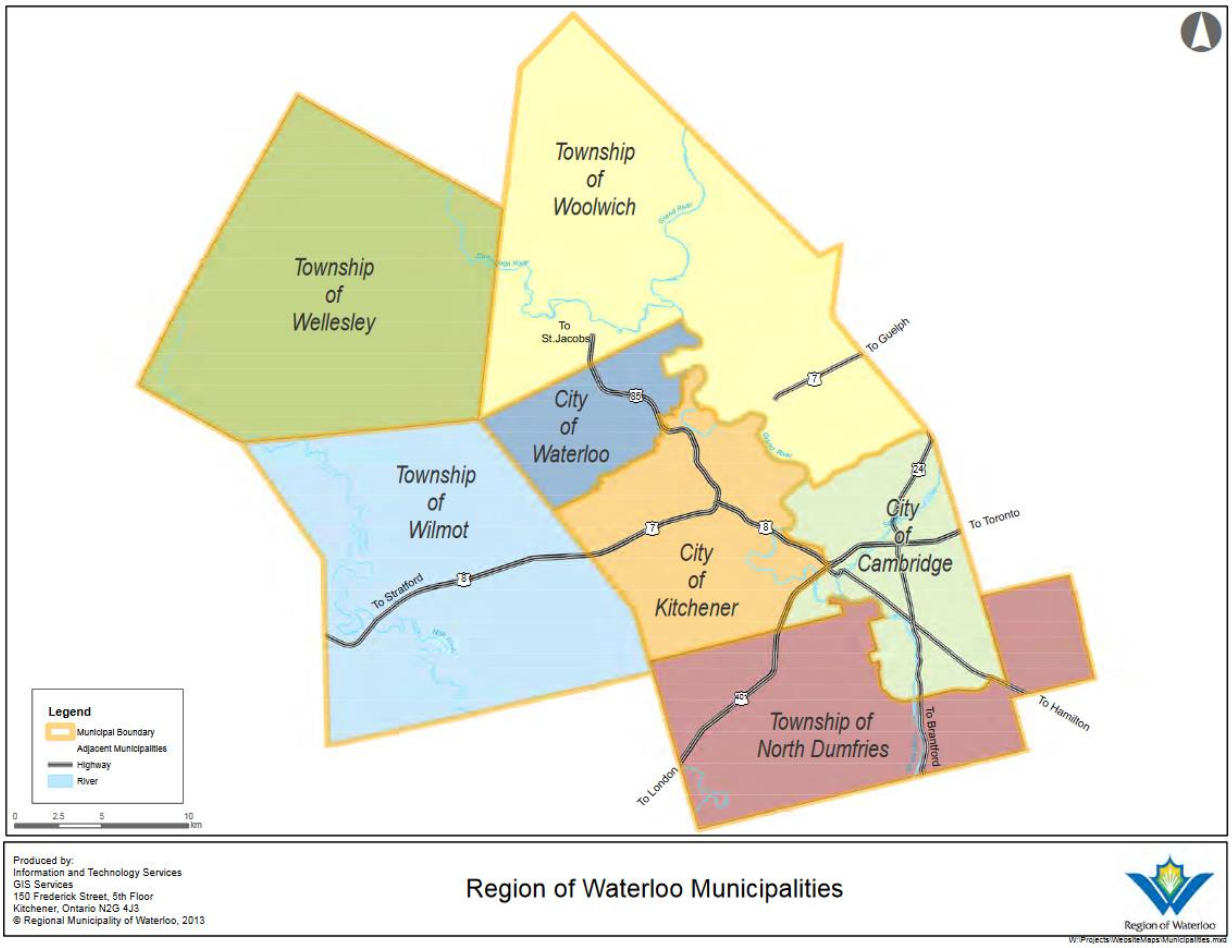

Figure 1. Study area: Kitchener-Waterloo ((Region of Waterloo, 2013a)

The cities of Kitchener and Waterloo are connected by Grand River Transit (GRT), which provides public transit throughout Waterloo Region. A Light Rail Transit (LRT) along the central corridor is also under construction aimed at enhancing the current GRT bus service. The first phase of the rapid transit will operate between the north end of Waterloo and the south end of Kitchener and is estimated to start in early 2018. An Adapted Bus Rapid Transit (aBRT) has also been built between Kitchener and Cambridge at this stage. In the second phase, the LRT will be extended to downtown Cambridge and replace the aBRT.

2.2 Demographics

The Cities of Kitchener and Waterloo cover a total area of 200.91 square kilometres. The City of Kitchener has a land area almost twice the size of Waterloo and a slightly higher population density. According to the 2016 census, Kitchener had a population of 233,222, while Waterloo had a lower population of 104,986. In the five years between 2011 and 2016, the population of Kitchener and Waterloo grew by 6.4% and 6.3%, respectively, higher than the growth rates for both Ontario (4.6%) and Canada (5%) (Statistics Canada, 2017a, b).

Table 1. Descriptive data for Kitchener, Waterloo, Ontario and Canada from the 2016 Census of Canada (Statistics Canada, 2017a, b)

	Kitchener	Waterloo	Ontario	Canada
Population, 2016	233,222	104,986	13,448,494	35,151,728
Population, 2011	219,153	98,780	12,851,821	33,476,688
Population increase from 2011 to 2016 (%)	6.4%	6.3%	4.6%	5%
Population density (persons/km^2)	1705.2	1639.8	14.8	3.9
Land area (km^2)	136.77	64.02	908,699.33	8,965,588.85
Average age	39	39	41	41
Population aged 0 to 14 (%)	17.5%	15.7%	16.4%	16.6%
Population aged 15 to 64 (%)	68.6%	69.9%	66.8%	66.5%
15 to 19 years (%)	6%	7%	6%	6%
20 to 24 years (%)	7%	11%	7%	6%
25 to 29 years (%)	8%	7%	7%	7%
30 to 34 years (%)	8%	6%	6%	7%
35 to 39 years (%)	7%	6%	6%	7%
40 to 44 years (%)	7%	6%	6%	6%
45 to 49 years (%)	7%	7%	7%	7%
50 to 54 years (%)	7%	7%	8%	8%
55 to 59 years (%)	7%	7%	7%	7%
60 to 64 years (%)	6%	5%	6%	7%
Population aged 65 and over (%)	15.7%	16.6%	18.9%	19.1%

The average age in both Kitchener and Waterloo is 39 years, younger than the 41 years for Ontario and Canada (Statistics Canada, 2017a, b). This difference may be due to the large student group residing in the area. In fact, 11% of the population In Waterloo are in the 20-24 age group, which is higher than the distribution in Kitchener (7%) and Ontario (7%). The post-secondary students studying in University of Waterloo and Wilfrid Laurier University in Waterloo may account for the higher percentage of the 20-24 age group. Although most of the population in KW are within working age, there's is still a clear evidence of aging population (Statistics Canada, 2017a, b). From 2011 to

2016, the percentage of population aged 65 and over increased from 12.3% to 15.7% in Kitchener and 12.6% to 16.6% in Waterloo (Statistics Canada, 2017a, b). The higher percentage of younger generation and the aging population may also result in more student and senior renters in KW's rental housing market. Further analysis is presented in ***Chapter 4. Descriptive Statistical Analysis*.**

2.3 Policy Context

2.3.1 Overview of Planning Policies

The local and regional planning documents play an important role in shaping the local community structure and housing market. The Regional Official Plan guides the growth direction for the region in the next 20 years (Region of Waterloo, 2015a, p1). The vision of the Plan is that "*Waterloo Region will be an inclusive, thriving, and sustainable community committed to maintaining harmony between rural and urban areas and fostering opportunities for current and future generations*". The central concepts of this vision focus on sustainability and liveability. While sustainability focuses on a robust development within the natural limits, liveability indicates that the needs of different people need to be accommodated.

The Regional Official Plan sets up ten objectives in order to create vibrant urban and rural places to live in within Waterloo Region. The first objective is to "plan for an appropriate range and mix of housing choices for all income groups" (Region of Waterloo, 2015a, p39). Housing is a basic but essential element of people's daily life. Therefore, providing a range and mix of housing is a requirement of developing a liveable community. As described in Policy 3.A.2, "Area Municipalities will plan to provide an appropriate range of housing in terms of form, tenure, density and affordability to satisfy the various physical, social, economic and personal support needs of current and future residents". Similar plans and objectives of "range and mix of housing" are also found in Kitchener and Waterloo Official Plans (City of Kitchener, 2014; City of Waterloo, 2016). Except for providing various housing choices, the Regional Official Plan also sets up objectives related to social inclusion and integration, including to "plan for an older and more culturally diverse population" and to "promote social inclusion and improve access to human services"(Region of Waterloo, 2015a, p39).

To fulfill the housing needs for all income groups, the Regional Official Plan also has a section for affordable housing. Based on the definitions, there exist two different forms of affordable housing: ownership housing and rental housing. An ownership or rental housing is considered as affordable if the annual accommodation cost of the housing does not exceed 30% of the gross income of a household. For those not able or not motivated to own a house, rental housing provides a more flexible and budget-friendly approach to satisfy their housing need. Based on the Residential Condominium Conversion Policy (Policy 3.A.4) of the Regional Official Plan, a rental affordable housing building could be potentially converted to condominium ownership if "the rental vacancy rate for comparable units has been at or above three per cent for the preceding three years". Except for this, the Official Plan does not have other policies related rental housing.

2.3.2 Housing Tenure

An adequate range of housing tenure represents an important aspect of liveability. The number of owner-occupied households in the Region of Waterloo has been increasing gradually at an average rate of 13% over every five-year period from 1991 to 2011. Yet, during the same period of time, the number of renter-occupied households remains relatively flat, with an average increase rate of 2%. As of 2011, the last year for which the housing tenure data is available, there were 54,120 renter-occupied households and 127,370 owner-occupied households in the Region of Waterloo. The ratio of renter to owner-occupied household in 2011 is 30:70, which is slightly higher than the ratio of 28:72 for Ontario and lower than the ratio of 31:69 for Canada.

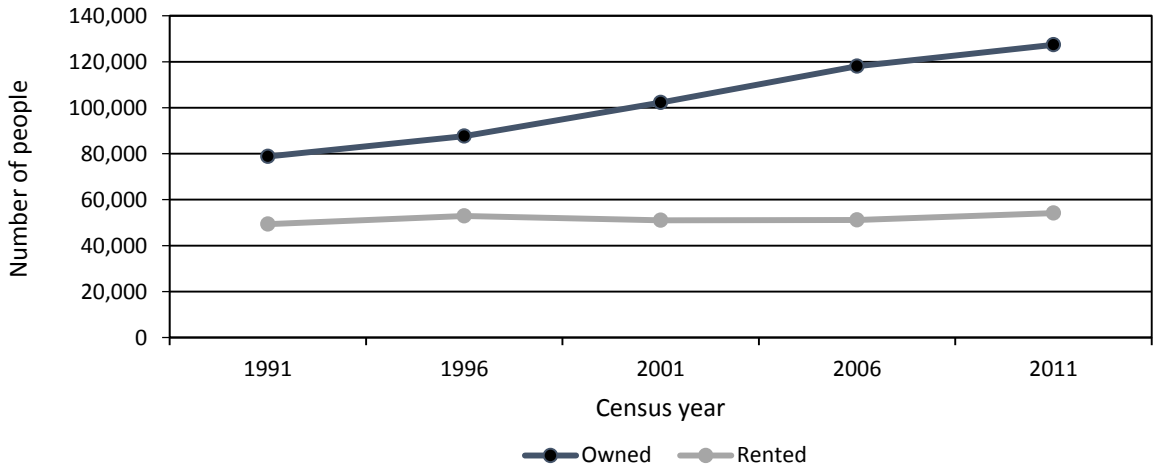

Figure 2. Number of renter and owner household in Waterloo Region (1991-2011)
Source: 1991, 1996, 2001, 2006 and 2011 Statistics Canada data

2.3.3 Affordable Housing

Based on 2011 Census, 26% of the households in Kitchener and 22% of the households in Waterloo spent 30% or more of their household income on shelter costs, both lower than the 27% for Ontario. Meanwhile, the housing system in the Region of Waterloo has still been identified as under pressure through community input, and the priority issues include a lack of affordable housing in terms of availability and housing options (Region of Waterloo, 2013b). Based on the result of public consultation, some low to middle income households are renting places for more they can afford due to the lack of affordable rental units, especially in the core areas. Moreover, the existing affordable housing for low income households is often poorly maintained and lacks adequate accessibility to services and amenities.

Seeing the growing housing needs and barriers throughout the Region, the government has taken various strategies to support affordable housing. According to the Regional Housing Action Plan (2013), Waterloo Region is currently providing five kinds of community housing aiming to help low to moderate income households to find rental housing at a lower cost, including *Waterloo Region Housing, Non-profit Housing, Co-operative Housing, Rent Supplement Program* as well as *Below Average Market Rent Program*. These affordable housing units are either owned or overseen by the Region of Waterloo. On the other hand, the *Affordable Home Ownership Program* provides opportunities for low to moderate income households to enter homeownership.

2.3.4 Complexity of Rental Housing Market

Though the importance of rental housing market has been realized, unclear factors that are affecting the rental prices still exist. These include large numbers of temporary residents - students, typically post-secondary students. Not belonging to the Region's regular population, their high housing demand influences the form of rental housing market and has been identified as one of the pressures increasing rental costs (Region of Waterloo, 2013c). Other rental market issues raised by the community include high overall rent for low to middle income households, lack of affordable rental units, as well as limited vacancies (Region of Waterloo, 2013c).

2.3.4.1 Waterloo Student Housing Surge

As seen from Figure 3, the construction of rental housing targeted at students has been increasing drastically since 2011 in the City of Waterloo (CMHC, 2017). The construction is encouraged by the strong growth of enrolment in the two local universities (University of Waterloo and Wilfrid Laurier University) throughout years from 2001 to 2010. Meanwhile, the growth rate of student housing now exceeds the enrolment increase, which has slowed down since 2011. In fact, enrolment declined slightly in 2014, which could result from the declining student-aged population. Other evidence also supports the student housing surge in Waterloo. According to a study of Waterloo's Town and Gown committee (2015), there was a potential surplus of over 1,000 bedrooms for student housing in Waterloo in 2014.

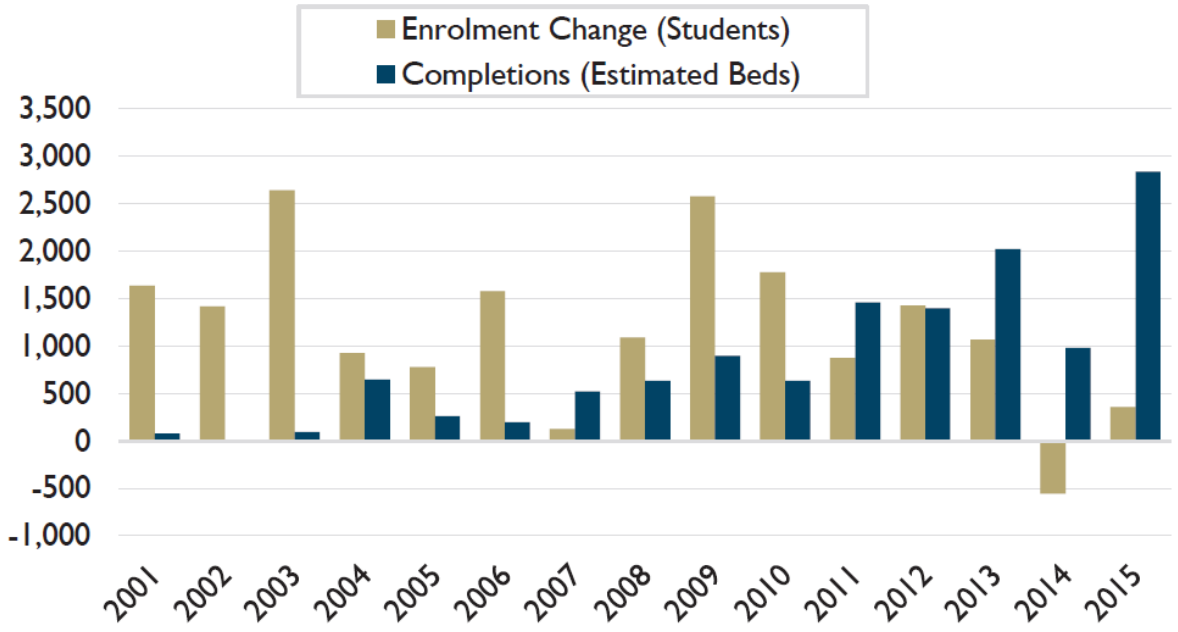

Figure 3. University enrolment change and estimated student beds completions in the City of Waterloo (CMHC, 2017)

Source: CMHC, adapted from Region of Waterloo (University data)

2.3.4.2 Demand and Supply Dynamics

Waterloo's student housing surge has been identified, whereas some other signs indicate that the increase in rental housing demand is gradually matching the increase in supply. Actually, the rental

market has stabilized recently. According to the Rental Market Survey (RMS) conducted by Canadian Mortgage and Housing Corporation (CMHC), the vacancy rate in the Kitchener-Waterloo-Cambridge (KWC) has not changed much, with a 2.2% in 2016 and 2.4% in 2015 (CMHC, 2016). This indicates that the increase in rental supply has matched with an equivalent amount of demand. The increase of demand generally comes from an increasing of immigration, senior renters and international students and, as well as fewer households moving to ownership.

Immigrated households account for a large proportion of the increase in demand. For instance, in the first quarter of 2016, there were already 1,715 Syrian refugees immigrated to the Region of Waterloo (CMHC, 2016). The aging population also increases the total number of senior renters. The population aged 70 and older has grown over 7% from 2014 to 2016 (CMHC, 2016). On the other hand, as home prices increase faster than incomes, many rental households choose to continue renting, and fewer are moving to homeownerships

Although the university enrolment has stabilized, the percentage of international students has been increasing. From 2005 to 2015, the full-time international student enrolment grew by 219% for University of Waterloo and 231% for Wilfrid Laurier University, which are far above the growth rates of other universities in Ontario (CMHC, 2017). Most of the international students require some sort of rental housing accommodation; thus, they form a strong student housing demand even though the total university enrolment changes little.

2.3.4.3 A Mobile Rental Market

Complex as it is, the rental housing market in KWC is also recognized as a mobile market. According to CMHC's the Rental Market Survey (RMS), KWC has a rental turnover rate of 20.5% in 2016, which is higher than any other CMA in Ontario (CMHC, 2016). The turnover of tenants happens when tenants relocate or purchase a home. This could result from a higher percentage of students and younger households renting. The co-operative education system at the local universities which combines academic study terms with work terms has made university students more frequent movers. Moreover, the turnover rate is found to be higher in newer buildings than in older buildings.

Chapter 3. Survey Design and Sampling

Chapter Overview

This chapter describes the survey methodology. The design of the survey is first presented, followed by a description of strategies used to conduct the survey. Next, the sampling methodology of the mailing recruitment approach is explained, including a description of the sample address collection process and stepwise sampling method. Then, the preliminary survey results are presented, comparing results from different survey recruitment approaches. The complete questionnaire is included in **Appendix A**.

3.1 Survey Design

The survey aims to explore renters' location choice behaviour in KW, with questions covering preference for residence and neighbourhood, renting experience, and perceptions on the upcoming Light Rail Transit (LRT). Overall, the renters' survey contains 6 parts and 51 questions as described below:

- Part A: 13 questions on residential characteristics
- Part B: 3 questions on residential location choice
- Part C: 10 questions on renting behaviours

- Part D: 8 questions on LRT and location choice
- Part E1: 8 questions on household characteristics
- Part E 2[1]: 8 questions on travel behaviours
- Additionally, 1 question asking how the respondent heard of this survey

The incentive to complete this survey was a prize draw for a Fitbit Charge 2 fitness tracker (a $199.95 value). A winner was drawn for every 100 responses received. A fitness tracker was chosen as an unbiased incentive, assuming it is of the same attractiveness to different demographic groups.

In order to catch errors and to estimate the time needed to complete the survey, the questionnaire was pre-tested informally by the researchers and several graduate students. The survey ethics package[2] was then reviewed and received full ethics clearance from the University of Waterloo's Office of Research Ethics on April 6, 2016.

3.2 Conducting the Survey

Renters during the period of June 2016 to November 2016 in KW are the targeted participants in the study. Three major approaches were implemented to recruit survey participants:

1) Mail recruitment posters to rental housing addresses obtained from Kijiji.
2) Put recruitment posters in public areas including public libraries and Kitchener Market, as well as post recruitment message in relevant Facebook groups.
3) Contact Neighbourhood Associations in KW and ask them to distribute the recruitment message on Facebook.

[1] Considering the scope of thesis and the time constraint, questions from Part E2 (travel behaviours) are not analyzed.

[2] Except for the Survey Questionnaire, the survey ethics package also includes other 8 documents: Request for Ethics Clearance of a Revision of Modification to an Ongoing Application to Conduct Research with Human Participants, Recruitment Letter/Poster, Information Letter, Consent Form, Follow-up, Feedback Letter, Study Purpose and Methodology, and Methodology Overview.

Kijiji is a classified advertising website. Local ads are posted on it by category and region. In my data collection process, “Kitchener-Waterloo, Ontario” is set as the region, and rental housing addresses from three for-rent categories under “real estate” section are collected, including “apartments, condos”, “house rental” and “room rental, roommates”.

The sample size of the Kijiji approach was determined by the Kijiji data collection and sampling result. The sample sizes of the poster/online posting and KW Neighbourhood Associations approaches were unknown. We sought to identify advertising strategies that will reach a representative sample. Libraries, Neighbourhood Associations, open Facebook groups and Kitchener Market are services used by all population groups, and we expected that a representative sample can be reached through these channels.

Potential participants could complete the survey through web-based questionnaire or by requesting a paper-copy survey. The web-based survey was hosted through FluidSurveys, a service provided by Survey Monkey, a corporation of the United States. Potential participants could access the survey website by scanning the QR code on the posters or by the link provided. If they preferred a paper-copy survey, they could contact the researchers through email or phone call to request a mail-back survey package.

The survey recruitment posters were first sent to Waterloo Public Library – Main Library on June 15, 2016. Then, the librarians helped us distribute the posters to all 8 public libraries in KW, and had them posted on the library information boards. The recruitment poster described the general purpose of the study and informed potential respondents of different ways to participant. In the same month, a Facebook page “Urban Growth and Change” was created for survey recruitment, and recruitment messages were posted on this page and shared in relevant Facebook groups and pages. These include the “Housing” group1 and 31 neighbourhood associations2 in KW. The recruitment message was reposted on Facebook in July to reach more potential respondents.

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[1] “Housing” group is described as a group where people can “research cheap and quality housing in the KW area” (Facebook, 2016). It is an open group for users within the Region of Waterloo.

[2] 40 Facebook pages/groups of different neighbourhood associations in KW were contacted initially, but some didn’t respond. In the end, the survey recruitment massage was posted in 31 pages/groups either as a visitor’s post or as a repost by the administrator of the page/group. The list of neighbourhood associations are obtained from the city’s websites: http://www.waterloo.ca/en/living/neighbourhoodassociations.asp https://www.kitchener.ca/en/livinginkitchener/NeighbourhoodAssociations.asp

After about two and a half months, on October 4, 2017, survey posters were mailed out to 2912 sample addresses through Tstone Mailing[1]. All bulk mails were addressed "TO THE RESIDENCE" due to a lack of contact information. University of Waterloo letter head was used and the mailing address of Dr. Dawn Parker at the University of Waterloo was listed as the return address. Over the next two weeks, 10 potential participants who received the invitation via mail contacted the researcher through phone calls and asked for paper copies of the survey.

While waiting for the responses from the mailing addresses, an outreach event was held at the Kitchener Market on October 22, 2016. Recruitment posters were also sent to 5 senior community centers in KW aiming to recruit more senior respondents, who are perceived as hard to reach theoretically.

Table 2. Data collection and response timeline

Date	Time since original publication (days)	Completed responses since previous date	Total completed responses to date	Description	Number of addresses contacted
15-Jun, 2016	0	--	--	Sent recruitment posters to libraries	--
22-Jun, 2016	7	0	0	Created a Facebook Page and posted recruitment message on Facebook	--
18-Jul, 2016	33	78	78	Reposted recruitment message on Facebook	--
04-Oct, 2016	111	27	105	Mailed recruitment posters	2912
19-Oct, 2016	126	144	249	Mailed paper copies of survey	10
22-Oct, 2016	129	5	254	Outreach at Kitchener Market	--
30-Oct, 2016	137	20	274 (5 paper copies)	Sent posters to senior centers	--
30-Nov, 2016	168	16	291(8 paper copies)	Preliminary analysis begins	--
13-Jan, 2017	212	1	292	Survey closed; analysis begins	--

[1] Tstone Mailing is a mailing service company. They printed our recruitment posters and envelopes, purchased postage from Canada Post, prepared all mail packages and had them delivered to Canada Post.

3.3 Sampling of the Mailing Approach

There is no public rental housing address data available which can serve as the mailing list of the survey. Therefore, such data were manually collected from Kijiji and then sampled to provide rental housing addresses for the mailing approach.

3.3.1 Sample Address Collection

Rental housing addresses were collected daily from Kijiji during the period of July 7- August 9, 2015 (5 weeks). This period was chosen to build a picture of a representative rental housing market. Ads for summer rental housing are mostly posted before this period. They are avoided intentionally because summer rental market is considered more volatile comparing with other seasons. Many of the summer ads are short-term housing, which might no longer be occupied by renters by the time we mail out our surveys. Moreover, some summer houses are subletted by the original tenants, and it is very likely that those "landlords" reduce the rents to attract subtenants. Therefore, the rental housing addresses were collected from July 7, 2015 to August 9, 2015, when most of the Kijiji ads listed during that time are for contracts starting fall 2015 when there are fewer summer posts.

The Kijiji rental housing data collection process followed a similar procedure used by Nick Revington in his master's thesis and subsequent publication[1] (Revington, N., 2015; Revington, N., & Townsend, C., 2016). First, Kijiji data were collected daily using Xpath[2] statements in Google Docs Spreadsheets. This web scraping technique allowed the researcher to collect the most recent ads of the day. Then, the collected data were preprocessed by removing duplicated and unreliable records.

3.3.2 Sampling Method

A total number of 19,544 rental units in KW were collected through Kijiji. It was unrealistic to send survey invitations to every address considering the budget and time constraint of this study.

[1] Nick Revington collected rental housing data for Montreal and Vancouver from Kijiji and Kraiglist in summer 2014.

[2] XPath is a query language for selecting contents from an XML document, such as a webpage.

Therefore, a stratified sampling strategy was implemented to obtain an appropriate and representative sample. Collected Kijiji units were first divided into homogeneous subgroups by three characteristics: city (Kitchener and Waterloo), housing type and unit number in each rental housing address. Then, a simple random sample was taken within each subgroup in proportion to the size of the group identified through census data.

Census data is used as sample frame, since it can provide the most accurate information of the entire rental housing population in KW. Census data from 2006 is used instead of 2011. This is because 2011 census data is more general than data from 2006 in terms of categories of dwelling types. It does not contain individual columns for semi-duplex house, row house, duplex in apartment building less than 5 storeys. Moreover, 2011 census is considered less reliable as NHS in 2011 was completed voluntarily. Housing type and storey data is only available for City of Kitchener. City of Waterloo's open data catalogue does not provide this information. Therefore, it is assumed that the distribution of number of units by housing type in Waterloo is the same as the distribution in Kitchener.

3.3.2.1 Step1. Stratify Kijiji rental housing addresses by number of units

KW address points data obtained from the Geospatial Center, University of Waterloo were preprocessed: multi-unit addresses were separated from single-unit addresses[1], and a list of units is generated for every address that has multiple units. Then, Kijiji rental housing addresses were matched with the preprocessed KW address point data. Kijiji addresses that have multiple units were classified by their number of units. The categories include: 2-9 units, 10-49 units, 50-99 units and 100 and more units.

[1] Two fields from the KW address points table, FullAddress and IsPrimary, are used to classify address points by their number of units. "IsPrimary" indicates the address point is a single unit address. If a point is not primary, it indicates that there exist other unit/units sharing the same address. Therefore, if a collected Kijiji address is not primary, the particular rental housing could be an apartment, multiple or single/semi/duplex or townhouse.

3.3.2.2 Step2. Stratify Kijiji addresses in Kitchener by housing type

Kiiji address points in Kitchener were matched with the Buildings data downloaded from the City of Kitchener's Open Data Catalogue. The storey numbers data and building subcategory data were added to the Kijiji data. In this way, Kitchener's Kijiji addresses were classified by both the 4 classes of unit numbers and 4 housing types: single/semi/duplex, townhouse, apartment<=4 storeys, and apartment >=5 storeys.

3.3.2.3 Step3. Sample for Kitchener using 2006 Census as sample frame

2006 census data for Kitchener is processed to obtain reference ratios of different housing types in Kitchener's rental housing market. Of all the rental units, 13% are in single-detached houses, semi-detached houses or duplex apartments, 13% of those are in townhouses, 40% are in apartment buildings that have fewer than 5 storeys, and 34% are in apartment buildings that have five or more storeys.

In order to reach a representative sample, the same ratios were applied to the collected Kijiji rental housing units. Not many single/semi/duplex units were collected through Kijiji; thus, all 276 such units were used. The same process applied to the other 3 housing types. As a result, 2128 rental units were sampled as mailing addresses in Kitchener, including 276 of 276 "single/semi/duplex" units, 280 of 782 townhouse units, 844 of 1251 "apartment<=5 storeys" units and 728 of 5488 "apartment >=5 storeys" units. In the end, 7.5% of the 28340 rental units in Kitchener have been sampled for the survey.

3.3.2.4 Step4. Sample for Waterloo using 2006 census as sample frame and Kitchener' sample result as a reference

Similar to the sampling process for Kitchener, the 2006 census for Waterloo is used in order to obtain reference ratios of different housing types in the rental housing market in Waterloo. According to 2006 census, there are fewer units for rent in Waterloo compared to Kitchener. The ratio of units in Waterloo to Kitchener is 10435/28340= 36.8%. Since 2128 units are sampled in Kitchener, the sample size in Waterloo is set to be 784 to maintain the same ratio with the sample frame.

As mentioned previously, the distribution of different classes of unit number in Waterloo is assumed the same as the distribution in Kitchener due to data constraints. The ratios in Kitchener are then applied to Waterloo to achieve a reasonable stratification. As a result, the 784 sampled units in Waterloo should consist of 131 of the 465 single-unit addresses, 11 of 104 units from “2-9 unit” addresses, 261 of 1235 units from “10-49 unit” addresses, 180 of 531 units from “50-99 unit” addresses, and 201 out of 1614 units from “100 and more unit” addresses. Therefore, the sample for Waterloo achieves the same ratio of number of sampled units to the number of rental units from the census, which is 7.5%.

3.4 Preliminary Survey Results

Among all 2912 survey posters mailed, mailings from 143 addresses were returned, labelled as “moved/unknown”, “address incomplete”, “no such address” or “unclaimed” by Canada Post. These addresses were then manually checked on Canada Post’s website to validate their existence. It turns out that 83 addresses of the returned mails are correct. Reasons for receiving such mails include moved residences, vacant units, unclaimed mails, rejected mails and non-residential units. Among all, 37 mails were returned because no unit number was listed; 22 mails were returned because of the wrong unit listed. One address was rental housing during the time of the Kijiji data collection, but it has turned into a new development when the survey posters were mailed. In the end, 4.9% of the mailings were returned.

In total, 463 people attempted to participate in the online survey, of which 284 completed the questionnaire. Of the 10 people who contacted us through email/phone call to request a paper copy of the survey package, 8 of them mailed the package back. One respondent withdrew from the online survey at the end. Another response is removed for duplication. Finally, a total number of 290 responses were appropriate for analysis. The average completion time of the online survey was 28 minutes (n=282). However, the individual completion time varied greatly from 6 minutes to 2 days. It is likely that some respondents might have left the survey website open and completed the questionnaire in hours or even days.

In the questionnaire, the respondents were asked to how they heard of this survey to help better understand the efficiency of different recruitment methods. Most participants were recruited through

mailing and online posting (61% and 31%, respectively; n=290). Other respondents indicated that they heard of this survey through the researchers, posters in public libraries, outreach events and Kitchener-Waterloo Neighbourhood Association. Some respondents heard through multiple channels. One respondent indicated that he/she saw poster in library first and received the survey poster by mail. Another respondent also indicated that he/she saw Facebook message first and received the mail.

Over half of the respondents (61%) were recruited through mailing using addresses collected through Kijiji. Popular as the website is, relying on one single online source to collect sample addresses did raise concerns originally. However, the survey result reveals that this strategy does not necessarily lead to a bias towards Kijiji in the collected data. In the questionnaire, respondents were asked how they normally found rental information (see ***Section 4.4.3*** for more details). Among those who received the survey poster by mail, 66% selected Kijiji as a source of rental information (n=176). Moreover, among those who participated through channels other than mailing, 53% still indicate that they normally find rental information on Kijiji (n=114). Therefore, it is reasonable to assume that Kijiji rental housing advertisements cover a fair amount of rental addresses in Kitchener and Waterloo, which also validates the mailing address collection method on Kijiji.

Table 3. Summary of sampling methodology and survey result

Sample period			June – November, 2016	
Administration			Internet and Mail	
Number of questions			51	
Study population			Households renting in KW	
Sample unit			All types of residential addresses including apartments	
Sample frame (mailing approach)			2006 Census data	
Sampling strategy (mailing approach)			Stratified and simple random sampling	
Target sample size (mailing approach)	City	Kitchener	784	26.9%
		Waterloo	2128	73.1%
		KW	2912	100%
Sample size	City	Waterloo	144	49.7%
		Kitchener	144	49.7%
		No address	2	0.7%
	Recruited through	Mailing	176	60.7%
		Facebook	90	31.0%
		Researcher	13	4.5%
		Public libraries	6	2.1%
		Outreach	3	1.0%
		KWNA	2	0.7%
		Other	2	0.7%
	Responded through	Internet	282	97.2%
		Mail	8	2.8%
	Total		290	100%
Non-respondents	Non-reachable addresses (mailing approach)	Correct address	83	57.2%
		Incomplete address	37	25.5%
		Wrong unit number	22	15.2%
		Address not existing any more	1	0.7%
	Disqualified		2	1.4%
	Total		145	100%
Response rate (mailing approach)			6.4%	
Average completion time (Internet)			28 min	

Chapter 4. Descriptive Statistical Analysis

Chapter Overview

This chapter presents descriptive statistical analysis of the survey responses within the scope of the research. The first section summarizes the demographics and location distribution of the survey respondents. Analyses using both the full survey sample and only the mailing responses are presented and compared. The respondents' characteristics are then used to categorize responses to other questions in the rest of this chapter. The next section explores respondents' residential location choice decision considering both the residence and neighbourhood characteristics. The features of their residences are compared to those of their ideal residences. To better understand the renting process, the renting behaviours of survey respondents are explored through different topics, including subletting, lease length, sources of rental information, searching process and "renting vs. buying". Last but not least, respondents' opinions on Central Transit Corridor (CTC) and Light Rail Transit (LRT) are investigated to unveil how they influence renters' location choice decision.

4.1 Survey Respondent Summary

This section analyzes the demographics and location distribution of the survey respondents. Normally, the survey demographics are compared with the census data, which serves as a

benchmark, to reflect the representativeness of the demographics. However, there are two major issues when comparing the demographics with the census data in this thesis.

First, the survey conducted in this thesis focuses on renters only while the census data are aggregated and cover the entire population. Using census data of both renters and home-owners is not very ideal in terms of comparison analysis. In this case, the *2011 National Household Survey (NHS) Public Use Microdata Files (PUMF) on individuals* (Statistics Canada, 2014a) are used to obtain demographics of renters only. The entire Canadian dataset contains 887,012 records collected through the 2011 NHS, representing a 2.7% sample of the Canadian population. PUMF allow users to perform statistical analysis using census data on an individual level, and renters can be distinguished from home-owners in this way. Therefore, PUMF is used for demographics comparison in this thesis.

Using PUMF for comparison also brings up the second challenge: unmatched geographical unit. The geographical scope of this thesis is the cities of Kitchener and Waterloo. Meanwhile, the closest geographical unit in PUMF is the Kitchener-Waterloo-Cambridge census metropolitan area (CMA). The NHS does collect the full address of every individual; yet the geographic identifier of PUMF has been restricted to metropolitan area level to ensure the confidentiality of each response. Thus, using the CMA level PUMF data for comparison is under the assumption that the cities of Kitchener and Waterloo have the same demographics as the City of Cambridge.

There are 133 variables in PUMF. Three variables[1], tenure, age and CMA of current residence, are used to filter out PUMF data to make the two dataset more comparable. Tenure refers to whether the dwelling is owned or rented. PUMF population aged 17 or younger are excluded because the age of survey respondents in this research ranges from 18 to 90. As a result, a subsample of 2246 individual responses is obtained from the PUMF.

[1] Initially, the primary household maintainer variable is also used to filter out PUMF. According to Statistics Canada (2012b), the primary household maintainer is the person responsible for rent, mortgage or other bills for the dwelling. Nevertheless, anyone of a household could participate in our survey, and the survey respondents are not necessarily the primary household maintainers. Therefore, the primary household maintainer variable is not used as a filter for PUMF in the end.

4.1.1 Demographics of Survey Respondents and Their Households

This section presents the demographics of the survey respondents and their households, including household type, age group, employment status, household income, birth place, ethnicity, sex, and education. Although a total number of 290 participated in the survey, not every respondent completed all 51 questions in the questionnaire. Therefore, an “n” value, which represents the number of valid responses for each question, is reported for each analysis. The difference between 290 and “n” value represents the number of respondents who did not answer a particular question.

4.1.1.1 Household Type

To better understand the survey responses from a household perspective, relevant census definitions of “household” have been explored. According to Statistics Canada (2012a), a “census family is a married couple (with or without children), a common-law couple (with or without children) or a loneparent family.” If there is at least one census family in a household, this household is a family household. If the household member(s) does not constitute a census family, this household is a non-family household. Typically, there are two kinds of non-family households: “one person living alone in a private dwelling” and “a group of two or more people who share a private dwelling” (Statistics Canada, 2012a).

The survey asked respondents to describe each household member in terms of their demographic information. Then, the researcher categorized the survey respondents using the six household types defined in the census: couple-family with children at home, couple-family without children at home, lone-parent family, one-person, multi-family and other households (see

Table 4).

Table 4. Household type definition (Statistics Canada, 2012a, footnotes section)

	Household type	Definition
Family households	Couple-family with children at home	Couple households with at least one child aged 24 and under
	Couple-family without children at home	Couple households without children aged 24 and under as well as couple households with all children aged 25 and over
	Lone-parent family	Lone-parent family households regardless of age of children
	Multi-family	Households in which two or more census families (with or without additional persons) occupy the same private dwelling
Non-family households	One-person household	One person living alone in a private dwelling
	Other household	Two or more people who share a private dwelling, but who do not constitute a census family

Most respondent households are non-family households, with one-person households and other households representing 20% and 42%, respectively (n=290). Compared to 2011 PUMF, the "other households" category is over-represented. The primary respondents of the "other households" are mostly students (80%; n=103). Many university students moved to KW to attend school; therefore, they are more likely to rent and live with people outside of their census family. Meanwhile, "couple-family households with children at home" and "lone-parent family" households are under-represented. They may be too busy to complete the lengthy survey. Only one multi-family household responded to the survey, and it is merged into couple-family with children households in the following analysis.

The overrepresentation of "other household" could result from the bias of recruiting survey participants through social media. Even though the Facebook "Housing" group is an open group and targets at all renters in KW, it is reasonable to assume that many of its active members are students from University of Waterloo and Wilfrid Laurier University. In fact, 82% Facebook responses (n=90) belong to "other household", and 75% of Facebook respondents (n=76) are students. Moreover, 60% of student responses (n=96) are collected through Facebook recruitment.

In order to alleviate the overrepresentation of students and reduce the potential impact of biased recruitment, responses collected only through the mailing strategy are compared to PUMF in terms of household types under the assumption that mailing is a more representative method and collects more reliable data. ***Figure 4*** shows that the overall household type distribution of the mailing

responses is more similar to that of the PUMF. Therefore, in the following analysis, in addition to the full survey sample, the mailing responses are also analyzed separately.

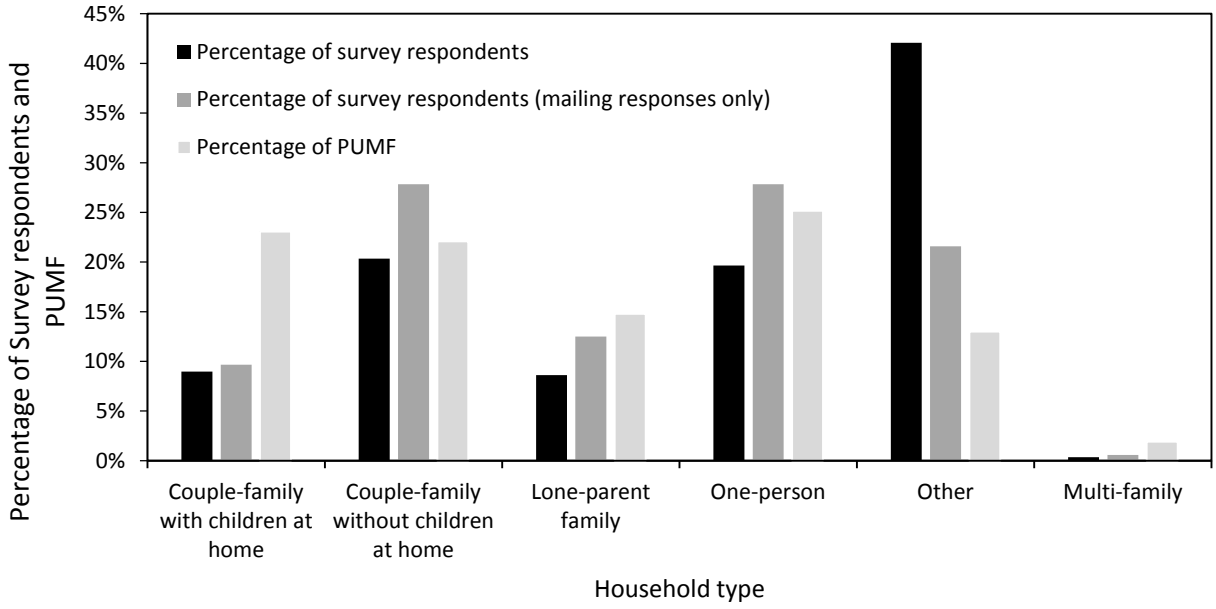

Figure 4. Household type of all survey respondents (n=290), mailing responses only (n=176) and 2011 PUMF, organized by census household categories

4.1.1.2 Age Group

Figure 5 shows the proportional distribution of people by age groups, comparing all survey respondents, mailing responses only and 2011 PUMF. Overall, senior respondents are well represented. Respondents aged under 35 are overrepresented, while respondents in 35-59 are underrepresented. It is likely that younger generations and seniors have more time to participate in the survey and are thus more likely to respond. Overall, the age group distribution of mailing responses shows a better representation of PUMF than the full sample. The 20-24 age group in the full sample (33%; n=242) is highly overrepresented.

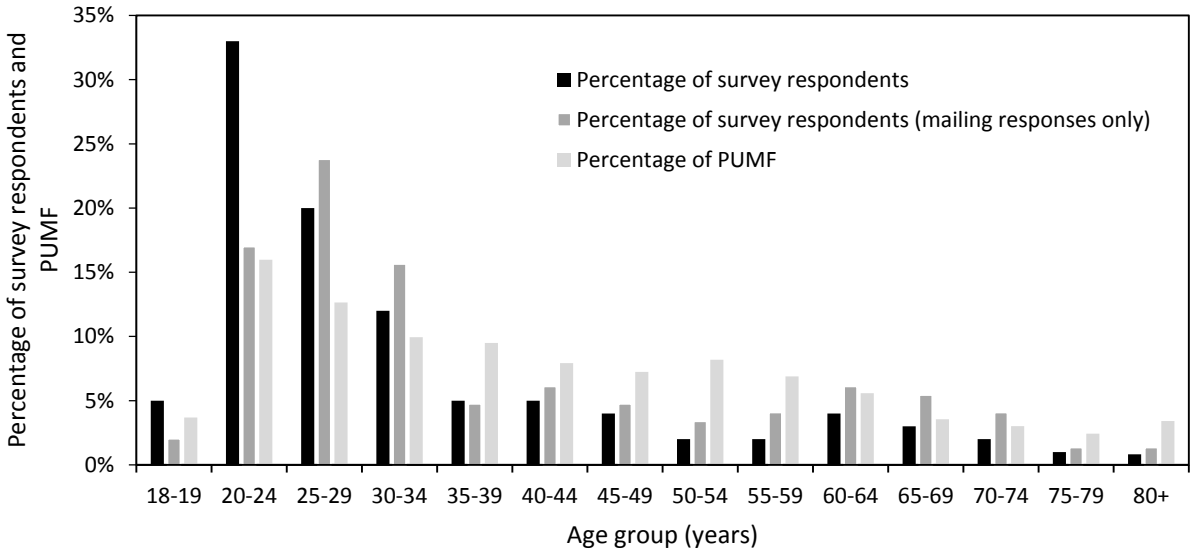

Figure 5. Percentage of people in each age group of all survey respondents (n=242), mailing responses only (n=147) and 2011 PUMF

Figure 6 and ***Figure 7*** show the age distribution of respondents renting in Kitchener vs. Waterloo. In the full sample, the average age of respondents in Kitchener (38) is much older than the average in Waterloo (28). Moreover, 65 out of 116 (52%) respondents in Waterloo are 20-24 years old, which significantly influences the proportion of 20-24 age group in the full sample. The difference between Kitchener and Waterloo using mailing responses (***Figure 7***) is not as great as using the full sample (***Figure 6***). Moreover, the averages age in Kitchener and Waterloo using mailing responses are also a lot closer (39 and 38, respectively).

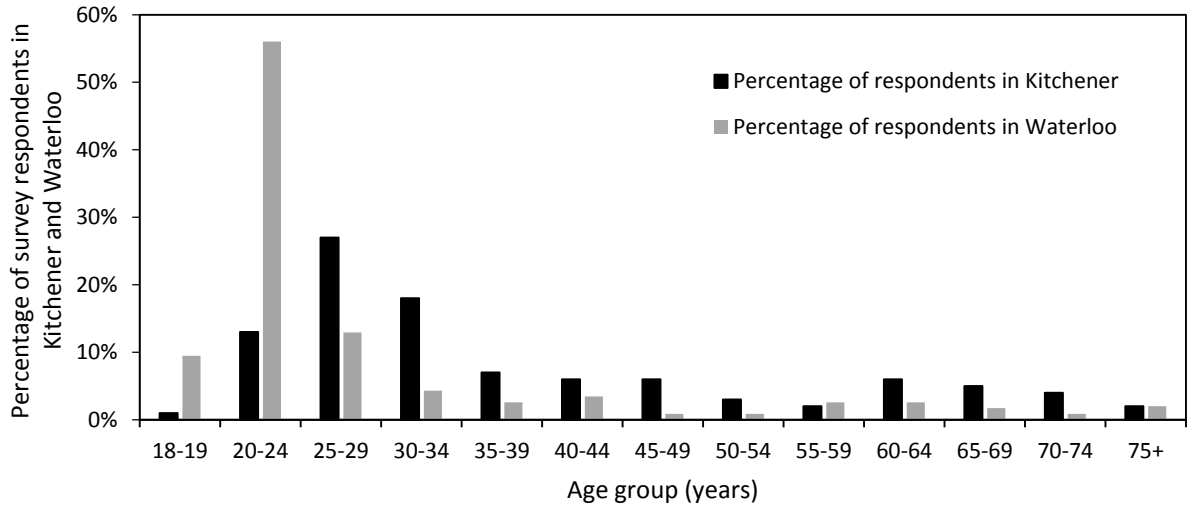

Figure 6. Percentage of respondents in each age group in Kitchener (n=125) and Waterloo (n=116)

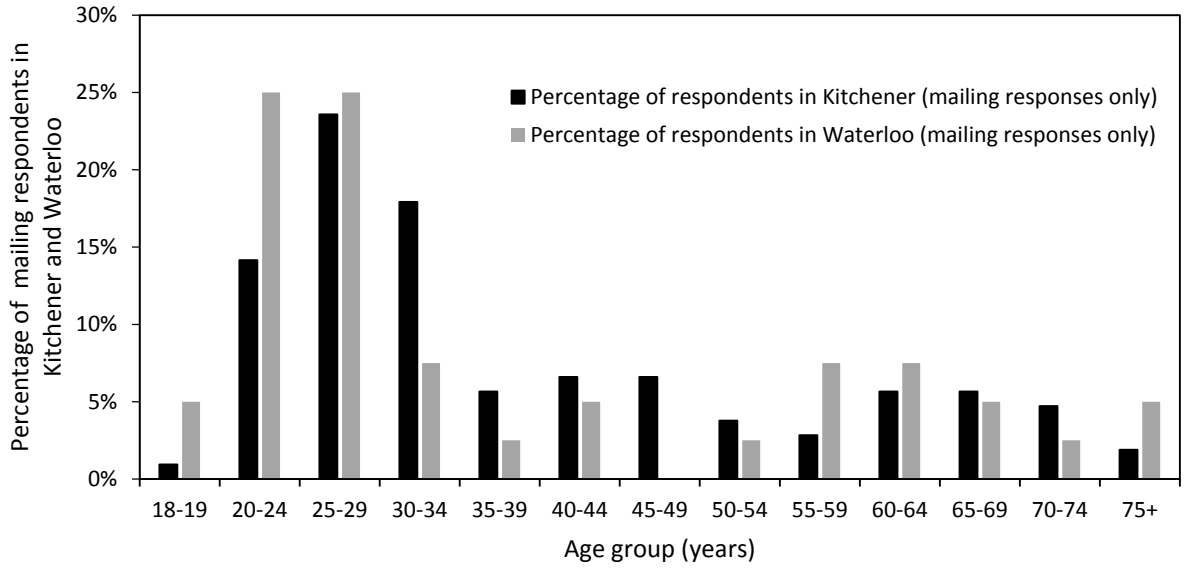

Figure 7. Percentage of respondents in each age group in Kitchener (n=106) and Waterloo (n=40) (mailing responses only)

4.1.1.3 Employment Status

In terms of employment status, most respondent households are employed households and student households (51% and 38%; n=251). If a student respondent is renting with an employed partner, their household is defined as an employed household instead of a student household in this thesis, given that the household has employed income. Twenty respondents stated their employment status as retired (n=249), of which 16 are 65 years or older. Only 6 unemployed households responded to the survey, which are somewhat underrepresented compared to the proportion in PUMF. Mailing responses have a much lower proportion of student households (20%; n=154) in comparison to the full sample, which is expected because most respondents recruited through Facebook are students, and they are not included.

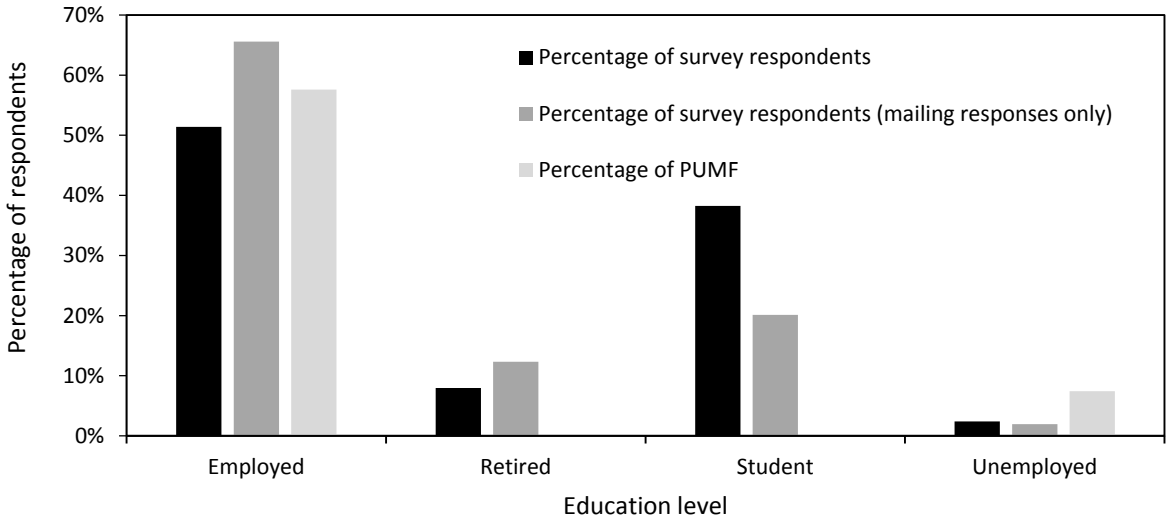

Figure 8. Employment status of all survey respondents (n=251), mailing responses only (n=154) and 2011 PUMF

Note: The 2011 NHS only used three general categories of employment statuses: employed, unemployed and not in the labour force (Statistics Canada, 2014b). Therefore, the proportions of retired and student households could not be compared. Household Income

Household income before tax is analyzed for a subsample instead of the total responses. Student households[1] are excluded in this analysis, including students living by themselves, students renting with a student partner[2] and students renting with people outside of their census family. The 2010 median household income is $63,709 in Kitchener and $77,626 in Waterloo (Statistics Canada, 2013a and 2013b). For one-person households, the median income is a lot lower: $32,999 in Kitchener and $38,685 in Waterloo. Sixty-three percent of the survey respondents have a household income between $30,000 and $99,999 (n=175), which roughly corresponds with the 2011 census, especially considering the high proportion of one-person households in the survey sample (20% in full sample and 28% in mailing responses only). Only 13% of the survey respondents have a household income over $100,000 in year 2015. The household income distribution of survey respondents is similar to the distribution of 2011 PUMF. The group with an income lower than $29,999 is the most underrepresented, which could be the result of excluding student households.

[1] There were multiple issues in the data when student renters reported their household income. Some students answered with their original family's income, who are not actually living with them in Kitchener-Waterloo. Also, student respondents may have little knowledge of their roommates' income, those of which are outside of their census family. As a result, the household income they entered is not very reliable. Considering the inconsistency of the household income data from the student respondents, they are excluded in the analysis of household income.

[2] If a student respondent is renting with a partner who is also a student, this response is not included in the household income analysis even though they still form a census family.

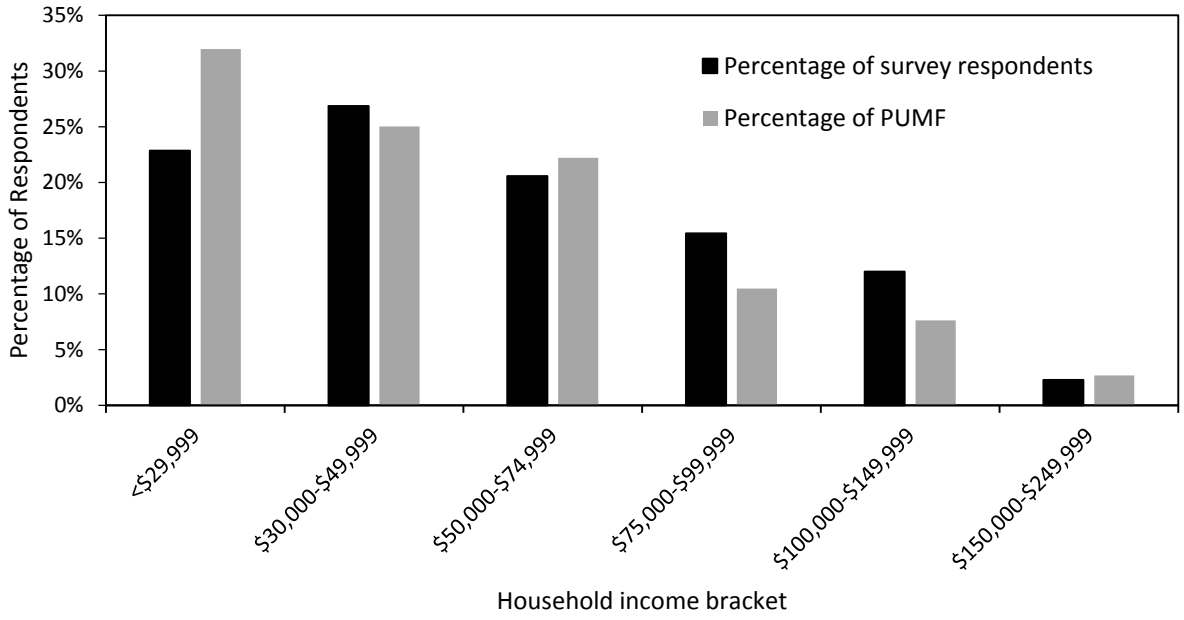

Figure 9. Household income of survey respondents excluding student households (n=175) and 2011 PUMF

4.1.1.4 Place of Birth

According to the PUMF, 72% of sampled renters in KWC are born in Canada (Statistics Canada, 2014a). Similarly, most of the KW survey participants were born in Canada (72%; n=290), of which 88% originated in Ontario (n=200). China, India and United States are the three most common birth places outside of Canada, with 44% of those non-Canadian-born participants born in these three countries (23%, 12% and 9%, respectively; n=78). In comparison, in the analysis of mailing responses, India, United States and China together only account for 33% of the 45 non-Canadian-born respondents, but they are still the top three birth places. Meanwhile, the birth place distribution of survey respondents (using both full sample and mailing responses) doesn't exactly correspond with the distribution in PUMF; places such as West Central Asia and Middle East and Other Southern Europe are underrepresented in the survey. This could be due to the fact that PUMF data covers not only the study area (cities of Kitchener and Waterloo), but also the City of Cambridge. Sixty-three percent of non-Canadian-born participants are from countries where English is not the official language, suggesting that some respondents may have been using English as a second language (n=78).

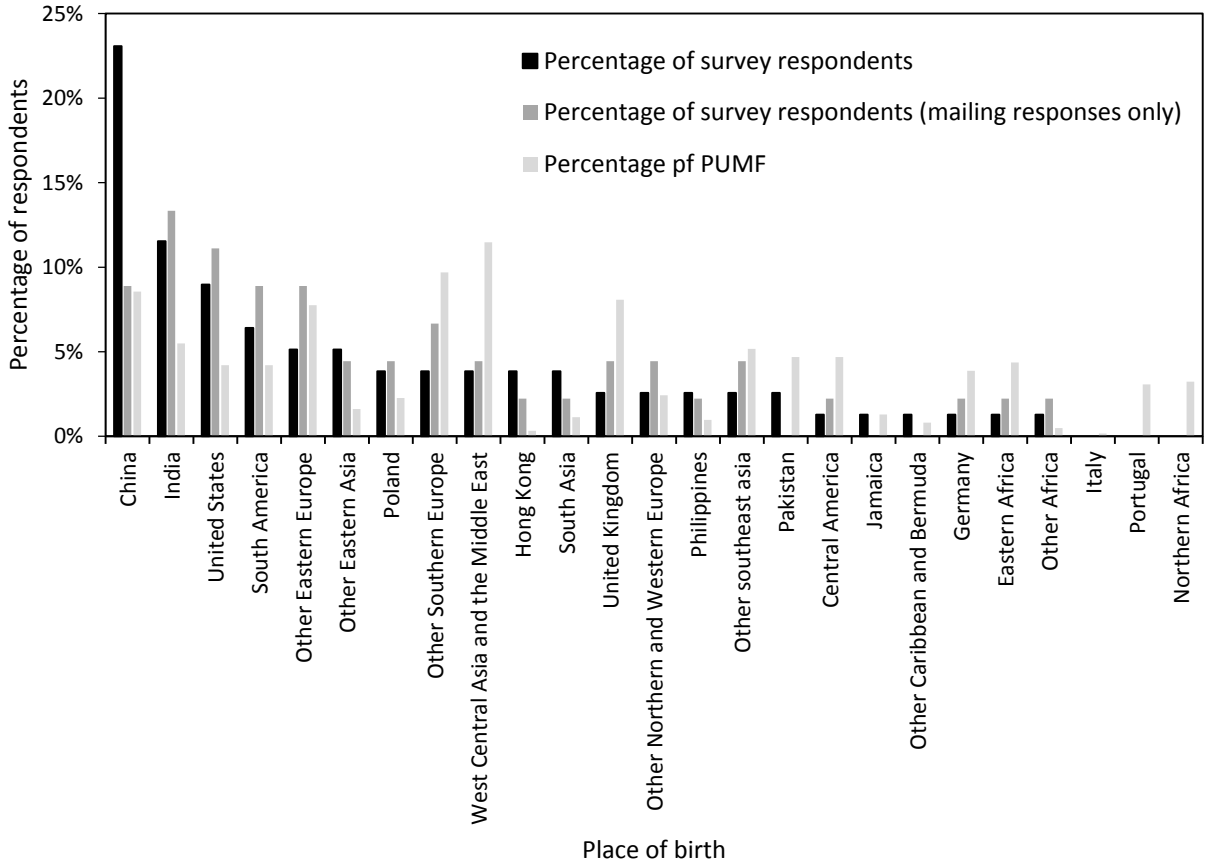

Figure 10. Birth places for respondents born outside of Canada, comparing full sample (n=290; 210 born within Canada, 80 born outside of Canada) with mailing responses only (n=176; 131 born within Canada, 45 born outside of Canada)

Note: respondents answered their places of birth with country names. Meanwhile in census, some the places of birth are reported by country names and some are by areas of interest, such as South America. For the purpose of comparison analysis, the collected country names are matched with the categories from census. For more details, see Appendix A of the PUMF Documentation and User guide (Statistics Canada, 2014b).

4.1.1.5 Year of Arrival in Canada

Respondents born outside of Canada arrived in Canada between 1960 and 2016. Thirty-four percent of them arrived since 2011 (n=77), indicating that approximately 1/3 the survey participants have lived in Canada for 5 years or less. Most of these non-Canadian-born participants are currently employed or students (54% and 38%, respectively; n=65). Student respondents are generally newer to Canada, with an average arrival year of 2008 (n=25). Meanwhile, the arrival year of employed respondents varies a lot, from 1962 to 2016, and their average arrival year is 2001 (n=35).

Compared to the full survey sample, fewer mailing respondents arrived in Canada between 2011 and 2016. The exclusion of Facebook respondents filtered out some student respondents who are newer to Canada.

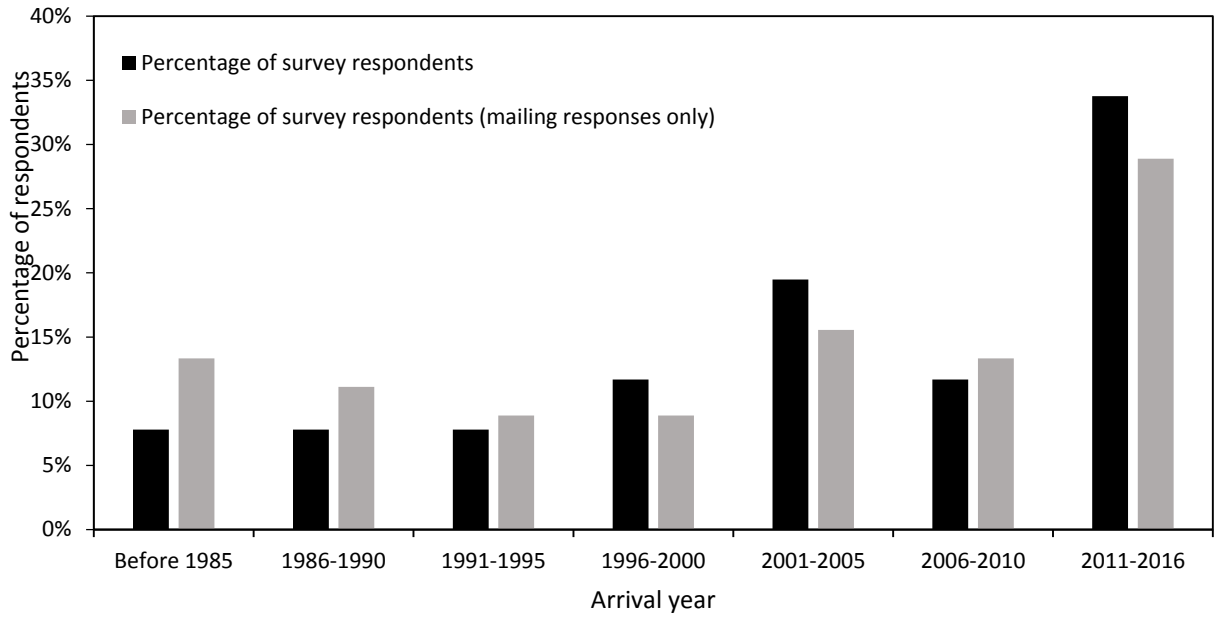

Figure 11. Year of arrival in Canada for respondents born outside of Canada, comparing full sample (n=77) and mailing responses only (n=45)

Table 5. Arrival year of respondents born outside of Canada, organized by respondent and household characteristics

Respondent and household characteristic	n	Before 1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2016	Mean
Total	77	8%	8%	8%	12%	19%	12%	34%	2002
	Household type								
Couple with children	11	0%	18%	0%	9%	9%	27%	36%	2005
Couple without children	8	13%	0%	0%	13%	13%	25%	38%	2005
Lone-parent family	6	0%	0%	17%	17%	33%	17%	17%	2003
One-person	12	33%	33%	8%	8%	8%	0%	8%	1985
Other	40	3%	0%	10%	13%	25%	8%	43%	2006
	Age group								
18-24	26	0%	0%	12%	12%	31%	4%	42%	2006
25-34	18	0%	17%	6%	17%	17%	11%	33%	2003
35-54	11	18%	9%	9%	18%	9%	9%	27%	1998
55+	5	60%	20%	0%	0%	0%	20%	0%	1979
	Employment status								
Employed	35	6%	14%	11%	14%	17%	11%	26%	2001
Retired	3	67%	0%	0%	0%	0%	33%	0%	1981
Student	25	0%	0%	0%	12%	32%	4%	52%	2008
Unemployed	2	0%	0%	50%	0%	0%	50%	0%	2001
	Household income bracket								
Less than $29,999	12	17%	8%	17%	17%	17%	8%	17%	2007
$30,000-$49,999	6	0%	17%	17%	17%	33%	0%	17%	1996
$50,000-$74,999	9	0%	33%	11%	22%	11%	22%	0%	2000
$75,000-$99,999	3	100%	0%	0%	0%	0%	0%	0%	1997
$100,000-$249,999	12	17%	8%	17%	17%	17%	8%	17%	1968

4.1.1.6 Ethnicity

According to 2011 PUMF, 81% of the sampled renters in KWC described themselves as white (Statistics Canada, 2014a). Similarly, of all 290 survey participants, most people describe themselves as white (64%; n=290). 19% are self-identified as Chinese, which is overrepresented compared to the proportion in PUMF. Most of the Chinese respondents are students (72%; n=42). Other ethnicities include South Asian, Southeast Asian, Latin American, Korean, Aboriginal, Black, Arab, West Asian, Japanese and Pilipino, covering all the groups listed in the 2011 National Household Survey questionnaire (Statistics Canada, 2012d). Compared to the full survey sample, the ethnicity distribution of the mailing responses is closer to the distribution of PUMF. The exclusion of social media respondents results in a good representation of the "real" renters' composition in terms of ethnicity.

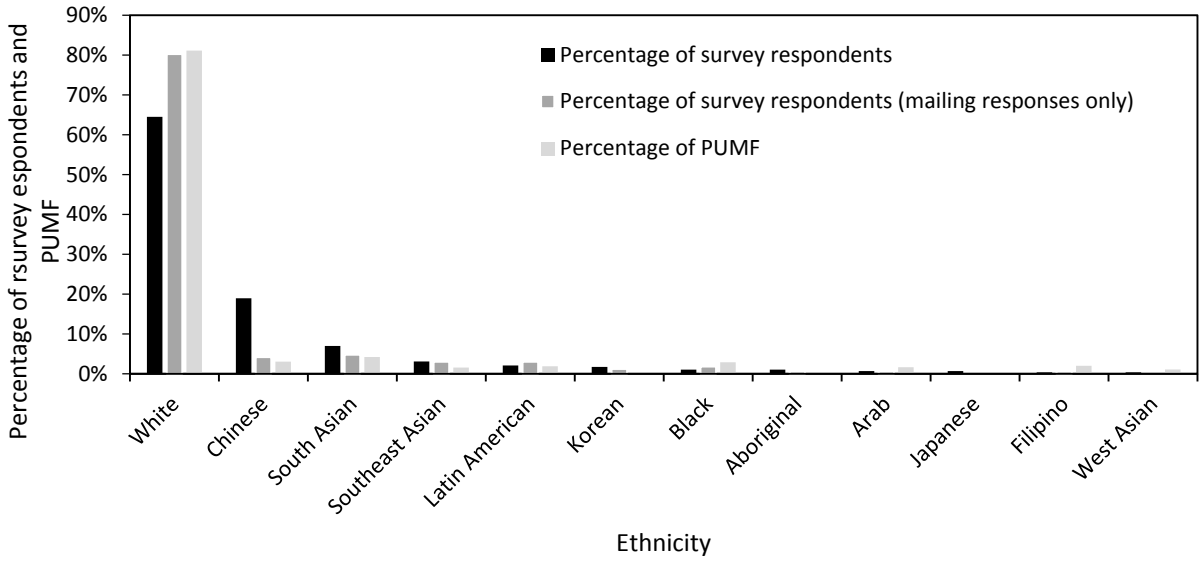

Figure 12. Ethnicity of survey respondents (n=290), mailing responses only (n=167) and 2011 PUMF

4.1.1.7 Sex

Among the 248 respondents who indicated their gender, only 38% are male while 62% are female. In mailing responses, 41% are male and 59% are female (n=152). However, according to 2011 census, the male/female ratio in Kitchener and Waterloo is 49:51. It is possible that females are more likely to respond to the survey recruitment. On the other hand, as mentioned in ***Section 3.1***, the incentive of this survey, a prize draw for a Fitbit Charge 2 fitness tracker, might also have contributed to this unbalanced sex ratio of survey respondents. Although Fitbit was chosen as an unbiased incentive, it is still likely that Fitbit is more appealing to females than males.

4.1.1.8 Education

Compared to 2011 PUMF, respondents with an education level of lower than high school are underrepresented while respondents with graduate level education are overrepresented. Only one respondent has received an education level of lower than high school. Potential participants with an education level lower than high school are less likely to complete the questionnaire due to lower literacy. Most participants have received post-secondary level education or higher, with “post-secondary” and “graduate” representing 38% and 32%, respectively (n=247). Forty-nine out of the 73 respondents with high school level education are self-identified as students (67%; n=73); they might be currently pursuing their bachelor’s degree. Comparing to the education level of the full sample, mailing responses have a lower percentage of respondents with high school level education (19%; n=150), which could result from the fact that many student respondents recruited through social media are excluded.

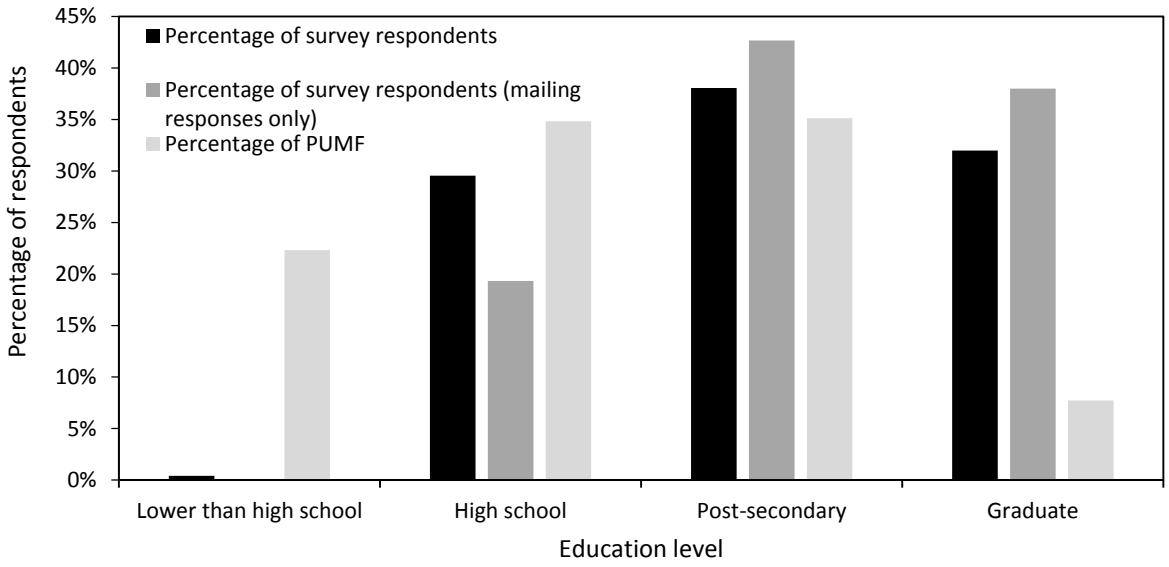

Figure 13. Education level of all survey respondents (n=247), mailing responses only (n=150) and 2011 PUMF

4.2 Location Distribution of Respondents

To better understand the locational distribution of survey respondents, their answered addresses are plotted on a map. The majority of respondents (99%; n=290) who provided their full addresses are geocoded into a shapefile document using ArcGIS technology. Three respondents did not report their full address. Thus, they could not be geocoded and are not included in this location analysis.

The result shows that there are an equal number of survey respondents renting in Kitchener and Waterloo (144 and 144; n=288). As PUMF does not contain city-level information, we use number of rental units in Kitchener and Waterloo from 2011 NHS as the benchmark. According to 2011 NHS, there were a lot fewer units for rent in Waterloo compared to Kitchener. The ratio of rental units in Waterloo to Kitchener was 9,895/30,245= 32.7% (Statistics Canada 2013a and 2013b). Several potential reasons may have led to this result. First, the data quality of the 2011 NHS is generally considered less reliable as it was completed voluntarily, which may have led to an unreliable result. Second, the 2011 NHS provides outdated data; there has been an intense development of high-rise apartment buildings in Waterloo in recent years, which is not reflected in 2011 NHS. Last but not least, recruiting survey participants through social media turns out to be a biased recruitment strategy. Many respondents recruited through Facebook are students living in Waterloo.

As explained in previous sections, mailing responses are analyzed in comparison with the full sample. There are 123 mailing respondents from Kitchener and 51 from Waterloo, with a Waterloo/Kitchener respondent ratio of 41.5%, which more closely corresponds with the census. Meanwhile, renters in Waterloo are still somewhat overrepresented. The average age of renters in Waterloo is younger than that in Kitchener. Compared to the middle age group, younger people have more free time and are more likely to respond to survey invitations. On the other hand, younger generations might also be more interested in winning a Fitbit.

For analytical purposes, the Region of Waterloo (2015a) divided KW into 22 relatively homogeneous neighbourhoods called “planning neighbourhood”. The following maps show the number of respondents by planning neighbourhood in KW using both full sample and mailing responses only. The survey respondents come from 21 of the 22 “planning neighbourhoods”. “Columbia/Lakeshore Neighbourhood” has 72 respondents (25%; n=287), followed by “Downtown Kitchener and Area Neighbourhood” (12%) and “Central Waterloo Neighbourhood” (11%). Meanwhile, no respondents live in “Hidden Valley/Pioneer Tower Neighbourhood” (southeast corner of the map), which is an estate home neighbourhood with large areas of open space. Comparing the full sample map to the mailing responses map, the location distributions of respondents are similar but not identical. The most notable difference is the shift of density center. Among all 174 mailing respondents, 16% live in “Downtown Kitchener and Area Neighbourhood” and only 9% live in “Columbia/Lakeshore Neighbourhood”. A main reason is the concentration of student renters in the “Columbia/Lakeshore Neighbourhood”, who are overrepresented in the full sample.

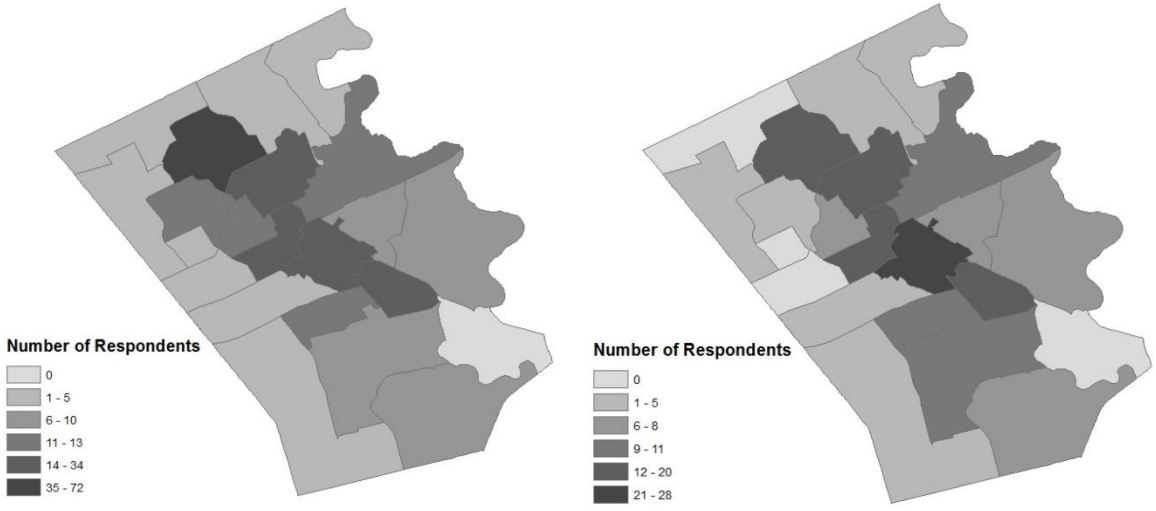

Figure 14. Number of respondents by “planning neighbourhood”, comparing full sample (n=287) with mailing responses only (n=174)

4.3 Residential Location Choice

The following section explores respondents' motivations for moving and outlines the residential and neighbourhood characteristics that influenced respondents as they chose to rent in their current residence.

4.3.1 Motivations of Choosing Current Home

Respondents were asked "What reasons have motivated you to move to and live in your current residence?" Affordability is the most important consideration, with 37% indicating it as a motivation (n=289). Other notable motivations include better accessibility to facilities (shopping and services), better accessibility to transit, better neighbourhood environmental quality, getting a new job, downsizing and upsizing.

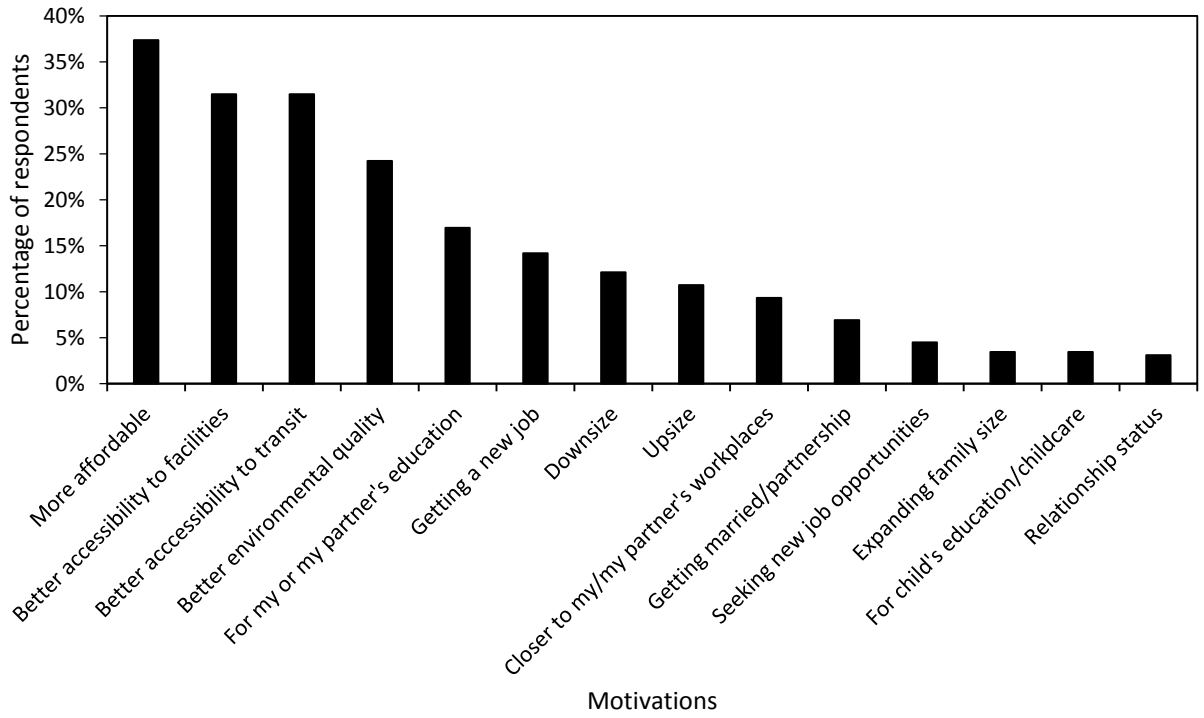

Figure 15. Motivations to move to and live in their current residence (n=289)

To further analyze the motivations of moving, answers to this question are organized by different respondent and household characteristics. Prominent findings are presented by motivations.

- **Accessibility to facilities (shopping and services)**: 55% of retired households and 48% of high-income households ($100,000-$249,000) indicate that they have been motivated by better accessibility to facilities.
- **Accessibility to transit**: respondents in the 18-24 age group, student households, and households with an income lower than $29,999 are more likely to be motivated by better accessibility to transit (37%, 40% and 38%, respectively).
- **For my or my partner's education**: many respondents in the 18-24 age group and student households are also motivated by the education needs of themselves or their partners (31% and 38%).
- **Getting a new job**: new jobs motivated 29% of the couples with children, 27% of respondents in the 25-34 age group, and 25% of the employed households to move and live in their current residence.

4.3.2 Residential Characteristics

The following section explores the importance of different residential characteristics in respondents' decision to move to their current home. The current features are then compared to those of their ideal residences, including housing type, built year of residence, housing size, yard size, and number of bedrooms. The descriptive analysis and comparisons are organized by various respondent and household characteristics.

4.3.2.1 Importance of Residential Characteristics

Survey respondents were asked to rate the importance of each residential characteristic in their renting decision. Most of the residential characteristics are perceived as important/very important by over 50% of participants. Rental price appears to be the most significant among all factors and it is "very important" to 70% of respondents (n=289). Perceptions on the importance of "availability of parking" and "private bathroom" are more polarized than other characteristics. Such distributions are expected, as owners of a vehicle may find it very important to have access to parking, while respondents who don't drive may find it unnecessary and not as important.

To make different residential factors more comparable, the mean value of each characteristic is calculated based on a scale of 1 (not at all important) to 5 (very important) to represent the perceived importance level. Then, the importance of factors is compared within each respondent and household group. Rental price remains the most important residential characteristic in most groups. Meanwhile, for senior respondents (55+) and high income households ($100,000-$249,999), parking appears to the most important factor, followed by “ease of maintenance” and “rental price”. Central air is perceived most important by retired households, followed by “availability of parking”.

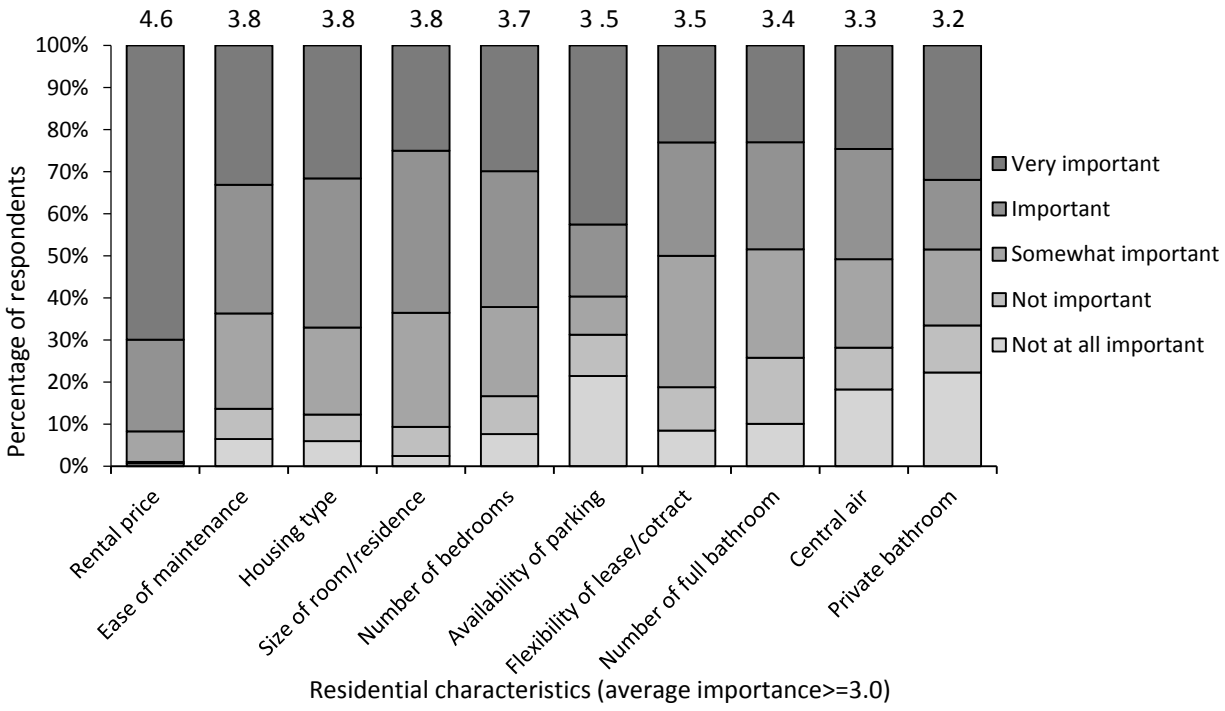

Figure 16. Importance of various residential characteristics in respondents’ decisions to move to their current residence (various sample sizes)

Note: Mean value of each characteristic is displayed on top of each column. They are calculated based on a scale of 1 (not at all important) to 5 (very important).

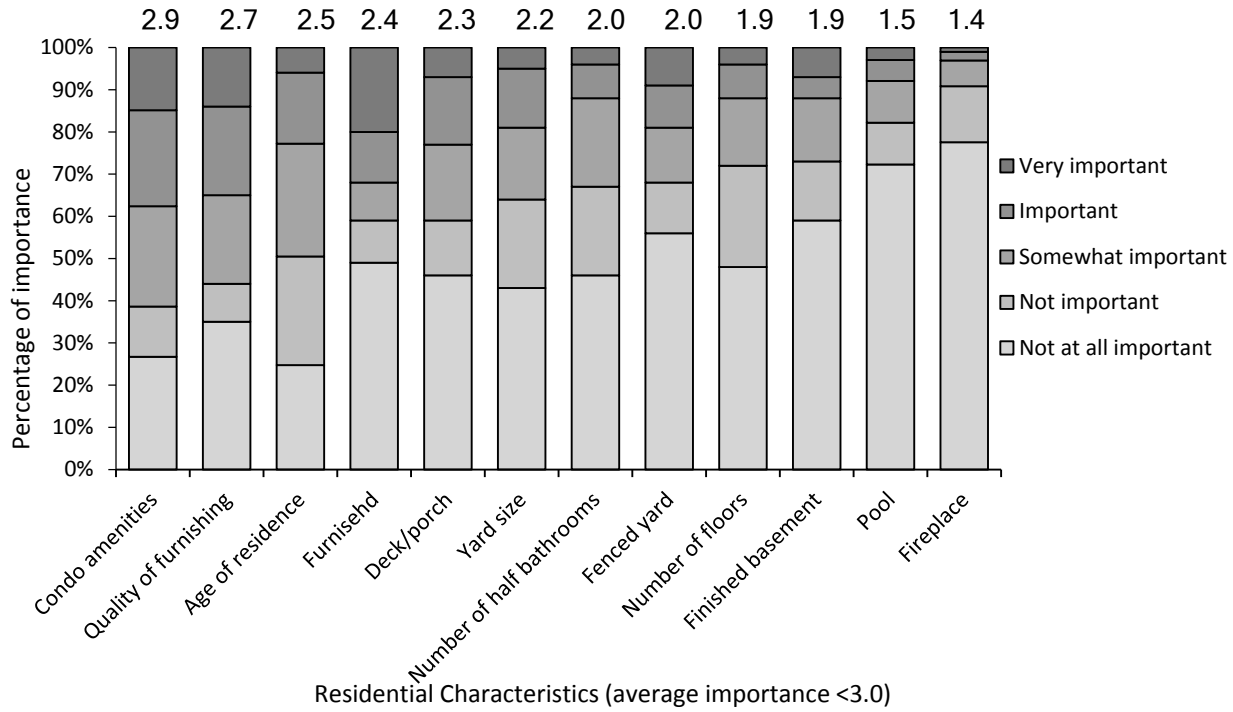

Figure 17. Importance of various residential characteristics in respondents' decisions to move to their current residence (various sample sizes)

4.3.2.2 Housing Type

The structural types of rental housing are compared between the survey responses and the 2006 census. As explained previously in the sampling methodology (see ***Section 3.3.2***), the 2011 census does not contain detailed columns for semi-detached house, row house, duplex and low-rise apartment. Therefore, 2006 census is used instead for this comparison. Apartments in a building of 4 storeys or lower represent the greatest proportion of rental housing in both Kitchener (40%; Statistics Canada, 2006) and Waterloo (39%; Statistics Canada, 2006). However, in Waterloo, the greatest proportion represented in survey responses are apartments in a building of 5 storeys or higher (49%; n=144). Such high proportion could result from the intense development of high-rise apartment buildings in Waterloo since 2006. The over-sampled student group also contribute to the potential over-representation of high-rise apartment buildings. In mailing responses, the percentage of high-rise apartments in Waterloo (41%; n=51) is lower than that in the full sample, but is still over represented in comparison to the census (25%). Overall, mailing responses show a better representation of housing type distributions in both Kitchener and Waterloo, with low-rise and high-rise representing 38% and 34% of the responses, respectively (n=174).

Table 6. Housing types of all survey respondents (n=288), mailing responses only (n=174) and 2006 census, organized by census categories

Structural type of dwelling	Kitchener						Waterloo						Kitchener & Waterloo					
	Full sample		Mailing responses only		Census		Full sample		Mailing responses only		Census		Full sample		Mailing responses only		Census	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Total	144	100%	123	100%	28,340	100%	144	100%	51	1	10,440	100%	288	100%	174	100%	38,780	100%
Single-detached house	20	14%	13	11%	1,440	5%	15	10%	4	8%	705	7%	35	12%	17	10%	2,145	6%
Semi-detached house	5	3%	5	4%	885	3%	5	3%	0	0%	520	5%	10	3%	5	3%	1,405	4%
Row house	13	9%	11	9%	3,730	13%	15	10%	9	18%	2,060	20%	28	10%	20	11%	5,790	15%
Apartment, building <=4 storeys	53	37%	50	41%	11,240	40%	32	22%	16	31%	4,065	39%	85	29%	66	38%	15,305	39%
Apartment, building >=5 storeys	43	30%	39	32%	9,695	34%	71	49%	21	41%	2,650	25%	114	40%	60	34%	12,345	32%
Apartment, duplex	10	7%	5	4%	1,265	4%	6	4%	1	2%	425	4%	16	6%	6	3%	1,690	4%

4.3.2.2.1 Current and Ideal Housing Types by Respondent and Household Characteristics

Currently, 22% of surveyed couples with children (n=27) live in single-detached houses, which is higher than that of any other household types. Most respondents in the 18-24 and 55+ age groups live in apartment buildings (75% and 94%, respectively). Similarly, 18 out of 20 retired respondents currently live in apartment buildings. From a household income perspective, the higher the income is, the higher the percentage of surveyed respondents living in high-rise apartments is. This is expected because the rental price of apartment in a building of 5 storeys or higher is generally higher (see 4.3.2.7 Rent).

In terms of ideal housing types, couples with children have the greatest desire towards renting a house in comparison to any other household type. Single-detached houses, row houses and semi-detached houses are ideal to 63%, 19% and 11% to such respondents, respectively. Respondents in the 25-34 and 35-54 age groups also indicate great preference for single-detached houses (45% and 49%, respectively). Meanwhile, retired respondents, respondents aged 55 or older, and student respondents generally prefer apartments (75%, 68% and 59% respectively) to houses (25%, 32% and 41%, respectively).

Table 7. Current housing types of survey respondents, organized by respondent and household characteristics

Respondent and household characteristic	n	Total	Single-detached house	Semi-detached house	Row house	Apartment, building <=4 storeys	Apartment, building >=5 storeys	Apartment, duplex
Total	290	100%	12%	3%	10%	29%	40%	6%
	Household type							
Couple with children	27	100%	22%	4%	19%	30%	26%	0%
Couple without children	59	100%	12%	2%	5%	39%	34%	8%
Lone-parent family	25	100%	8%	8%	16%	36%	32%	0%
One-person	57	100%	7%	2%	7%	32%	47%	5%
Other	122	100%	13%	4%	11%	22%	43%	7%
	Age group							
18-24	93	100%	9%	4%	9%	22%	53%	4%
25-34	78	100%	17%	1%	13%	37%	24%	8%
35-54	37	100%	16%	5%	16%	22%	35%	5%
55+	34	100%	0%	3%	3%	29%	65%	0%
	Employment status							
Employed	129	100%	12%	4%	12%	32%	34%	6%
Retired	20	100%	0%	5%	5%	25%	65%	0%
Student	96	100%	11%	3%	10%	25%	46%	4%
Unemployed	6	100%	17%	0	0	17%	50%	17%
	Household income bracket							
Less than $29,999	40	100%	5%	0%	15%	38%	38%	5%
$30,000-$49,999	47	100%	26%	0%	4%	45%	23%	2%
$50,000-$74,999	36	100%	8%	3%	6%	36%	33%	14%
$75,000-$99,999	27	100%	19%	4%	19%	19%	37%	4%
$100,000-$249,999	25	100%	4%	8%	16%	20%	44%	8%

Table 8. Ideal housing types of survey respondents, organized by respondent and household characteristics

Respondent and household characteristic	n	Total	Single-detached house	Semi-detached house	Row house	Apartment, building <=4 storeys	Apartment, building >=5 storeys	Apartment, duplex
Total	286	100%	35%	5%	13%	20%	27%	0%
	Household type							
Couple with children	27	100%	63%	11%	19%	4%	4%	0%
Couple without children	58	100%	43%	5%	14%	21%	17%	0%
Lone-parent family	25	100%	28%	4%	36%	12%	20%	0%
One-person	57	100%	30%	2%	11%	28%	30%	0%
Other	119	100%	29%	4%	8%	21%	37%	1%
	Age group							
18-24	92	100%	25%	7%	10%	21%	37%	1%
25-34	78	100%	45%	1%	21%	17%	17%	0%
35-54	37	100%	49%	11%	14%	8%	19%	0%
55+	34	100%	21%	3%	9%	29%	38%	0%
	Employment status							
Employed	129	100%	46%	5%	16%	16%	18%	0%
Retired	20	100%	20%	5%	0%	35%	40%	0%
Student	95	100%	23%	6%	12%	18%	40%	1%
Unemployed	6	100%	33%	0	17%	33%	17%	0
	Household income bracket							
Less than $29,999	40	100%	35%	5%	22%	22%	15%	0%
$30,000-$49,999	46	100%	37%	0%	15%	33%	15%	0%
$50,000-$74,999	36	100%	53%	3%	8%	11%	25%	0%
$75,000-$99,999	26	100%	38%	8%	12%	15%	27%	0%
$100,000-$249,999	25	100%	48%	4%	12%	20%	16%	0%

4.3.2.2.2 Comparison: Current Housing Type vs. Ideal Housing Type

The most preferred housing type is apartment (47%，n=286), with high-rise apartment and low-rise apartment ideal to 27% and 20% of the survey respondents, respectively. This is in line with the fact that apartments in a building of 4 storeys or lower take up the greatest proportion of the rental housing in both Kitchener and Waterloo. The second most ideal housing type of survey respondents is single-detached house (35%).

Table 9. Comparison of current and ideal housing types (n=290)

Current housing type	Count and % of total responses	Ideal matches Current	Ideal matches most popular other than current
Single-detached house	n=35 (12%)	71% still prefer current	24% prefer apartment
Semi-detached house	n=10 (3%)	40% still prefer current	40% prefer single
Row house	n=28 (10%)	38% still prefer row current	41% prefer single
Apartment, building <=4 storeys	n=85 (29%)	36% still prefer current	35% prefer single
Apartment, building >=5 storeys	n=114 (40%)	56% still prefer current	19% prefer single
Duplex, apartment	n=16 (6%)	No one prefer duplex	63% prefer single

Renters' ideal housing types are compared to that of their current rental housing. Surprisingly, many respondents prefer a different type of rental housing than their current housing type (37%). In fact, among all 6 respondent groups categorized by their current housing types, single-detached houses appear to be the most ideal housing type for 5 groups of respondents. On the other hand, respondents currently renting in single-detached houses and high-rise apartments seem to be more satisfied with their current housing type in comparison to other groups of respondents. Seventy-one percent of the single-detached house respondents and 56% of the high-rise respondents choose their current housing type as their ideal types.

Unlike the popularity of single-detached houses in the rental housing market, only one respondent chooses "Duplex, apartment" as an ideal housing type. Even for respondents currently in a duplex**,** 10 out of 16 prefer single-detached houses, 4 prefer to rent in a low-rise apartment building, and none of the respondents still want to live in a duplex. According to an anonymous realtor, many

duplexes are re-developed from houses, and they are usually not as nice as other types of rental houses because often the less desirable unit, such as a basement or loft of a duplex, is rented out.

4.3.2.3 Built Year of Residence

The age of residence is perceived as unimportant by more than half of the respondents (26% “not important” and 25% “not at all important”; n=287). Moreover, renters generally do not know much about the age of their residences; only 106 respondents know the built year of their rental housing (37%; n=290). The reported built years range from 1890 to 2016. Forty-four percentage of the residences have been built since 2000 (n=106), many of which are apartments in a building of 5 storeys of higher (64%; n=47). Yet, 28% of the residences are 36 years or older (built before 1970), of which 10 are low-rise apartments and 8 are single-detached houses. In terms of average built year, row house (2000) and high-rise apartment (1997) are generally newer than single-detached house (1946), duplex apartment (1957), semi-detached (1974) house and low-rise apartment (1979).

Table 10. Built year of residence by housing types (n=106)

	n	Total	Before 1970	1970-1979	1980-1989	1990-1999	2000-2009	2010-2016	Mean
Single-detached house	10	100%	80%	10%	0%	10%	0%	0%	1946
Semi-detached house	1	100%	0%	100%	0%	0%	0%	0%	1974
Row house	8	100%	13%	0%	0%	13%	50%	25%	2000
Apartment, building <=4 storeys	31	100%	32%	16%	26%	0%	3%	23%	1979
Apartment, building >= 5 storeys	48	100%	13%	13%	4%	8%	23%	38%	1997
Duplex, apartment	8	100%	63%	0%	0%	0%	25%	13%	1957

Many respondents don’t have a preferred built year for their ideal homes (45%; n=287). Among those who indicate a preference, the newer the residence is, the higher percentage of respondents would prefer it. The newest option, “2010-2016”, is the most preferred built year range (75%; n=157). However, some respondents still prefer an older residence to a newer one. One respondent

indicated that “a loft in a post-industrial site” would be ideal. Two other respondents who preferred older residences mentioned “unique” and “character”.

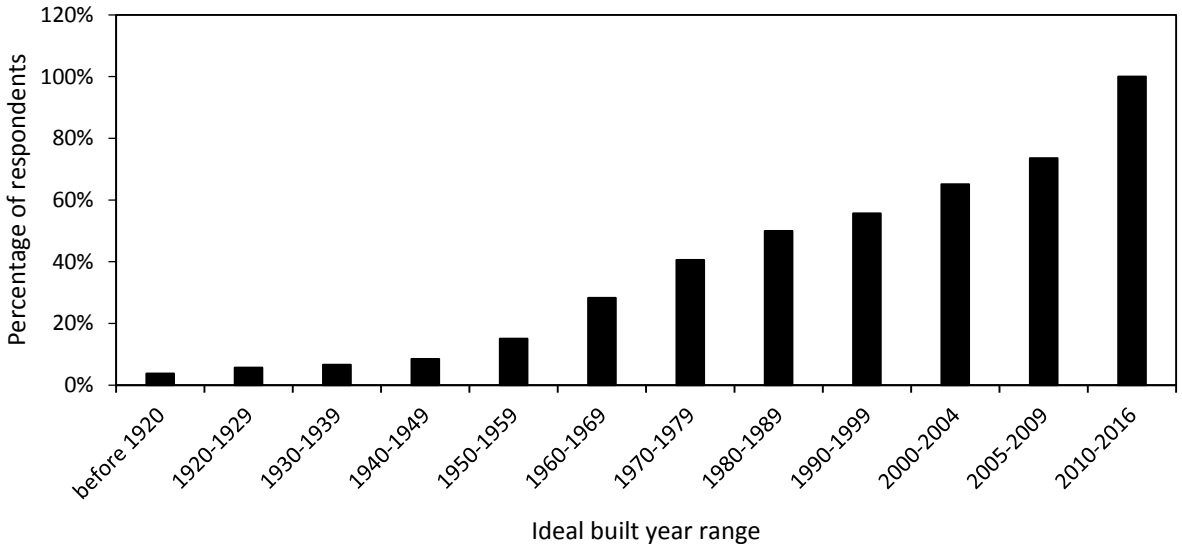

Figure 18. Built year range of ideal homes (n=287)

4.3.2.4 Housing Size

A housing size of 1000-1499 square feet (sqft) is ideal to the largest group of the respondents (47%; n=272)[1]. Twenty-three prefer a smaller residence of less than 1000 sqft, and 19% prefer a larger size of 2000-2499 sq. ft. A housing size of 2500 sqft or larger is only ideal to 6 respondents.

The ideal housing sizes for couples with children is generally larger than that of other groups, which also corresponds with their greater desire for single-detached houses. Fourteen out of 26 couples with children prefer a residence of 1500 sqft or larger. Meanwhile, 31% of the one-person households prefer a smaller residence of less than 1000 sqft (n=54). Generally, the preferences for residences of less than 1499 sqft increase as the age group of respondents gets older. For respondents aged 55 and older, “1000-1499 sqft” and “less than 1000 sqft” are ideal for 69% and

[1] The ideal housing size and yard size chosen by the survey respondents may not reflect the “actual” size they have in mind, but their answers could not be validated. Emma DeFields (2013) compared the measured yard sizes with the estimated yard sizes reported by her surveyed home owners in her master’s thesis, and only 23% respondents estimated the sizes correctly.

19%, respectively (n=32). As to household income, different income levels do not seem to influence households' preferences of housing size as much. Except that, households with an income less than $49,999 do appear to be more attracted to smaller size housing (less than 1000 sqft) than other groups.

4.3.2.5 Yard Size

When asked about the yard size of their ideal home, 39% choose patio, deck or balcony (n=271), followed by "small yard (area of 0-4 single car garages)" and "medium yard (area of 5-9 single car garages)" (26% and 17%, respectively). Not many respondents prefer "large yard (area of 10-16 single car garages)" or "very large yard (area of 17+ single car garages)" (6% and 2%). Ten percent indicate that they don't want any outdoor space.

- By **household type**: Medium yards and small yards are ideal to most of the couples with children (35% and 31%; n=26). Couples without children and lone-parent families are mostly attracted to medium yards, small yards and patio, deck or balcony. Meanwhile, one-person households generally prefer a smaller yard size, with patio, deck or balcony ideal to 52% (n=56).
- By **age group**: "No outdoor space" is ideal to 18% of the respondents in the 18-24 age group (n=87), which is higher than the percentage in any other category. Respondents in 55+ generally prefer patio, deck or balcony and small yard (53% and 28%; n=32). Medium or larger yard sizes are only ideal to 9% of this group.
- By **employment status**: Employed households are mostly attracted to small yard (35%), medium yard (28%) and patio, deck or balcony (26%; n=123). Student households are generally attracted to patio, deck or balcony (52%) and small yard (22%; n=91). Similarly, 12 of 17 retired households find patio, deck or balcony ideal.

Table 11. Ideal housing size of survey respondents, organized by respondent and household characteristics

Respondent and household characteristic	n	< 1000 sqft	1000-1499 sqft	1500-1999 sqft	2000-2499 sqft	> 2500 sqft
Total	272	23%	47%	19%	9%	2%
	Household type					
Couple with children	26	12%	35%	31%	23%	0%
Couple without children	55	25%	56%	9%	9%	0%
Lone-parent family	23	17%	57%	22%	0%	4%
One-person	54	31%	56%	11%	2%	0%
Other	114	22%	39%	24%	11%	5%
	Age group					
18-24	86	28%	40%	22%	8%	2%
25-34	76	25%	46%	17%	9%	3%
35-54	37	16%	59%	19%	5%	0%
55+	32	19%	69%	9%	3%	0%
	Employment status					
Employed	123	20%	50%	20%	9%	1%
Retired	19	11%	74%	11%	5%	0%
Student	91	30%	37%	19%	10%	4%
Unemployed	6	17%	83%	0%	0%	0%
	Household income bracket					
Less than $29,999	37	27%	49%	19%	5%	0%
$30,000-$49,999	42	29%	48%	14%	7%	2%
$50,000-$74,999	35	17%	66%	6%	9%	3%
$75,000-$99,999	25	12%	48%	28%	12%	0%
$100,000-$249,999	24	12%	62%	17%	8%	0%

Table 12. Ideal yard size of survey respondents, organized by respondent and household characteristics

Respondent and household characteristic	n	No outdoor space	Patio, deck or balcony	Small yard	Medium yard	Large yard	Very large yard
Total	271	10%	39%	26%	17%	6%	2%
	Household type						
Couple with children	26	4%	15%	31%	35%	15%	0%
Couple without children	51	2%	31%	27%	25%	10%	4%
Lone-parent family	23	0%	30%	35%	17%	9%	9%
One-person	56	5%	52%	30%	9%	4%	0%
Other	115	19%	43%	21%	14%	2%	1%
	Age group						
18-24	87	18%	45%	23%	10%	2%	1%
25-34	76	1%	33%	34%	22%	9%	0%
35-54	34	3%	26%	35%	29%	3%	3%
55+	32	9%	53%	28%	0%	9%	0%
	Employment status						
Employed	123	4%	26%	35%	24%	8%	3%
Retired	17	6%	71%	12%	0%	12%	0%
Student	91	15%	52%	22%	9%	1%	1%
Unemployed	6	17%	17%	50%	17%	0%	0%
	Household income bracket						
Less than $29,999	40	5%	32%	38%	18%	8%	0%
$30,000-$49,999	43	2%	37%	28%	23%	7%	2%
$50,000-$74,999	35	3%	31%	29%	29%	9%	0%
$75,000-$99,999	25	12%	24%	32%	16%	16%	0%
$100,000-$249,999	22	9%	36%	14%	27%	5%	9%

4.3.2.6 Number of Bedrooms

The respondents were asked about the number of bedrooms in their current rental housing. The number of bedrooms ranges from 1 to 7. 2-bedroom residence is the most common type (35%; n=290), followed by 5-bedroom (21%), 1-bedroom (17%), and 3-bedroom (17%). Single-detached, semi-detached, duplex and row houses generally have more bedrooms than apartments. In high-rise apartment buildings (>=5 storeys), 3-bedroom and 5-bedroom units are most common (38% and 34%, respectively; n=85).

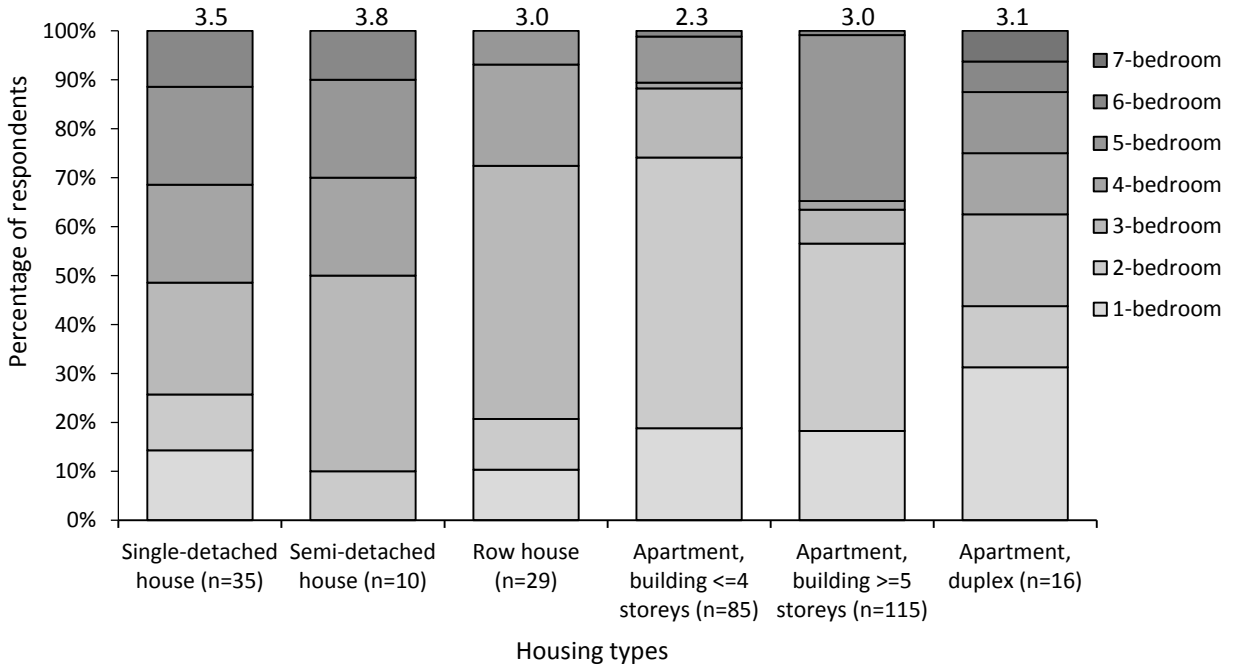

Figure 19. Percentage of various bedroom numbers in different types of housing (various sample size)

While 2-bedroom residence is the most common type among many respondent and household groups, 46% of the students are living in 5-bedroom residences. Moreover, most of the 5-bedroom residences are occupied by students (77%; n=60). Therefore, the over representation of student households might have also lead to an overrepresentation of 5- bedroom residences in the full sample.

In terms of ideal homes, 2-bedroom and 3-bedroom residences are popular among survey respondents; they are ideal to 39% and 31% (n=286), respectively. Couples with children and lone-

parent families both have stronger preferences for 3-bedroom residences (50% and 56%, respectively) than 2-bedroom residences.

Even though 24% of the participants are currently living in a residence of 5 or more bedrooms, only 4% indicate that their ideal number of bedroom is more than 4 (n=286). In fact, 46 out of 60 (77%) 5-bedroom residences are currently rented by student households. It is likely that there exist many 5-bedroom residences that have been developed targeting at the student rental housing market. However, respondents generally prefer a residence of rooms less than 4, and 5-bedroom residence is only ideal to 3%.

Table 13. Current number of bedrooms, organized by respondent and household characteristics

Respondent and household characteristic	n	1-bedroom	2-bedroom	3-bedroom	4-bedroom	5-bedroom	6-bedroom	7-bedroom
Total	290	17%	35%	17%	7%	21%	3%	0%
	Household type							
Couple with children	27	4%	48%	44%	4%	0%	0%	0%
Couple without children	59	31%	53%	14%	0%	3%	0%	0%
Lone-parent family	25	0%	60%	36%	4%	0%	0%	0%
One-person	57	51%	46%	4%	0%	0%	0%	0%
Other	122	2%	13%	16%	15%	48%	7%	1%
	Age group							
18-24	93	10%	16%	13%	10%	46%	4%	1%
25-34	78	29%	45%	14%	6%	4%	1%	0%
35-54	37	22%	38%	41%	0%	0%	0%	0%
55+	34	15%	74%	12%	0%	0%	0%	0%
	Employment status							
Employed	129	26%	47%	22%	4%	2%	1%	0%
Retired	20	10%	75%	15%	0%	0%	0%	0%
Student	96	9%	12%	14%	9%	48%	6%	1%
Unemployed	6	33%	17%	33%	0%	17%	0%	0%
	Household income bracket							
Less than $29,999	40	25%	45%	22%	5%	2%	0%	0%
$30,000-$49,999	47	15%	53%	19%	4%	4%	4%	0%
$50,000-$74,999	36	36%	44%	17%	0%	3%	0%	0%
$75,000-$99,999	27	19%	41%	33%	4%	4%	0%	0%
$100,000-$249,999	25	20%	52%	12%	8%	8%	0%	0%

Table 14. Ideal number of bedrooms, organized by respondent and household characteristics

Respondent and household characteristic	n	1-bedroom	2-bedroom	3-bedroom	4-bedroom	5-bedroom	6-bedroom
Total	286	9%	39%	31%	17%	3%	1%
	Household type						
Couple with children	26	0%	12%	50%	38%	0%	0%
Couple without children	58	5%	50%	36%	9%	0%	0%
Lone-parent family	25	0%	40%	56%	0%	4%	0%
One-person	57	21%	58%	18%	4%	0%	0%
Other	120	8%	30%	27%	27%	7%	2%
	Age group						
18-24	92	12%	33%	24%	24%	8%	0%
25-34	78	8%	47%	32%	12%	1%	0%
35-54	36	6%	39%	44%	11%	0%	0%
55+	34	9%	68%	21%	3%	0%	0%
	Employment status						
Employed	128	6%	45%	34%	15%	1%	0%
Retired	20	5%	65%	25%	5%	0%	0%
Student	95	12%	34%	25%	20%	8%	1%
Unemployed	6	33%	17%	33%	17%	0%	0%
	Household income bracket						
Less than $29,999	46	9%	46%	35%	9%	0%	2%
$30,000-$49,999	36	3%	47%	39%	11%	0%	0%
$50,000-$74,999	26	4%	38%	35%	23%	0%	0%
$75,000-$99,999	25	4%	52%	28%	16%	0%	0%
$100,000-$249,999	46	9%	46%	35%	9%	0%	2%

4.3.2.7 Rent

All 290 respondents reported their current monthly rents. The highest reported rent is $2200 while the lowest is $183[1]. Considering the great variation in rents, different renting types are taken into consideration. Survey participants were asked if they were renting a house, an apartment/condo, a room or a basement in the questionnaire. Most respondents are either renting an apartment/condo or a house (51% and 10%, respectively; n=290). 102 of them are renting a room (35%) and 11 are renting a basement apartment (4%). The average, minimum and max rents are then presented by these three renting types.

Table 15. Rent by housing type and renting type (n=290)

Structural type of dwelling	Rent per month ($)								
	House/Apartment (n=177)			Room (n=102)			Basement apartment (n=11)		
	Average	Min	Max	Average	Min	Max	Average	Min	Max
Total (n=290)	1120	183	2200	551	325	760	737	450	1230
Single-detached house (n=35)	1309	890	2200	466	330	575	866	475	1230
Semi-detached house (n=16)	1345	1224	1500	517	490	550	--	--	--
Row house (n=29)	1230	812	1890	477	325	560	618	450	807
Apartment, building <=4 storeys (n=85)	964	183	1500	518	375	675	--	--	--
Apartment, building >=5 storeys (n=115)	1179	500	1800	620	375	760	--	--	--
Apartment, duplex (n=10)	1037	550	2000	485	325	595	752	518	985

According to 2011 census, the average monthly shelter cost for rented dwellings is $854 in Kitchener and $946 in Waterloo in 2010 (Statistics Canada, 2013a and 2013b). The average price of renting a house/apartment is $1120 (n=177) and the average room rent is $551 (n=102), which very roughly correspond with the 2011 census. The price of renting a room fluctuates relatively less than renting a

[1] This rent is extremely low compared to any other responses. The respondent left a comment indicating that it is a subsidized housing. Except for this response, the second lowest rental price for apartment (<=4 storeys) is $705 per month. Therefore, this record is marked as an outlier, and is not used in the hedonic model.

house/apartment or a basement apartment, which is predicted. Further analysis on rents from a modeling perspective is presented in ***Chapter 5 (Review of Hedonic Modelling)***.

4.3.2.7.1 Current Rent, Ideal Rent and Affordability

The survey questionnaire also asked the respondents about their ideal rental price given their budget. It turns out that their current rents and ideal rents have a strong positive correlation of 0.74, even if there exist outliers such as ideal rents of $0 as seen from the scatterplot. Generally, the higher the current rent is, the higher the ideal rent will be. The highest reported ideal rent is $10,000 and it is excluded from the plot and following analysis in this section.

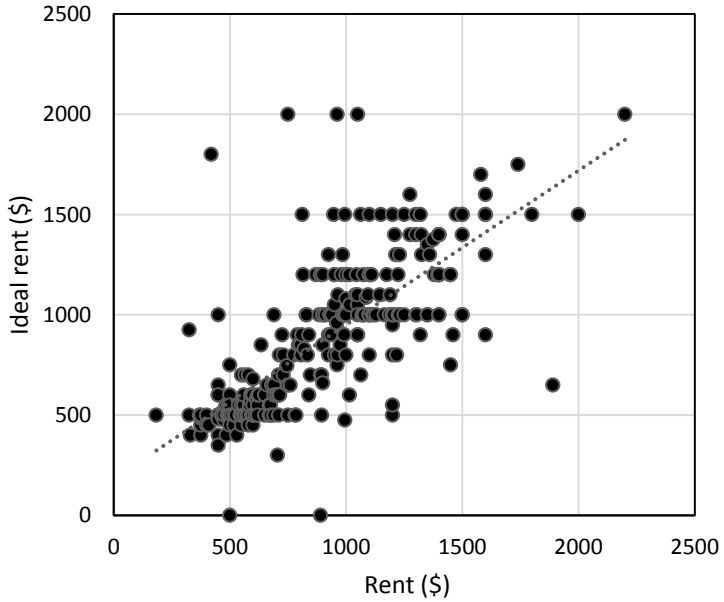

Figure 20. Scatter plot of current rent vs. ideal rent (n=284)

Many respondents note that affordability is important in their residential location choice, yet many of them are still willing to pay higher rents for their ideal homes. On one hand, 70% of respondents believe that "rental price" is very important in their renting decision (the most important residential characteristics); 37% indicate "more affordable" as a reason to select their current residence. On the other hand, 106 out of 284 respondents (37%) are willing to pay more than 1.5%[1] of their current

[1] According to the rent increase guideline in Ontario (2017), 1.5% is the maximum rent increase allowed for landlords without the approval of the Landlord and Tenant Board. Here, 1.5% is used as an increase threshold when comparing survey respondents' ideal and current rent. For example, if a participant's current rent is $996 and his ideal rent is $1,000, the respondent is not paying more than 1.5% of their current rent, and this case is defined as "not willing to pay more".

rent given their budget. Moreover, respondents who have been motivated by affordability do not necessarily prefer a rent lower than their current price. In fact, 53 of the respondents who note affordability as a moving motivation are still willing to pay higher rent for their ideal homes (n=107).

4.3.2.7.2 Who is Willing to Pay a Higher Rent?

To better understand the respondents who are willing to pay more for their ideal homes, the current rent and ideal rent are analyzed and compared by respondents' demographics. Room renters are separated from respondents renting a house/apartment, and they are presented in ***Table 17***.

In general, older respondents are currently paying higher rents and are willing to pay higher rents than younger respondents. Employed and retired households have higher current and ideal rents than student and unemployed households. Generally, the higher the household income is, the higher the current and ideal rents are. Nevertheless, the differences of household income do not seem to impact either rent or ideal rent much, which might be caused by the unreliability of the self-reported household income data and the fact that student households are excluded. As to whether the respondent is willing to pay a higher rent, the difference among various respondent and household groups does not seem to be significant. A higher household income doesn't result in a higher percentage of respondents who are willing to pay more than their current rents.

Table 16. Price of renting a house/apartment, organized by respondent and household characteristics

Household income brackets	n	Current rent ($)			Ideal rent ($)			Ideal rent higher than current	
		Average	Min	Max	Average	Min	Max	#	%
Total	171	1122	183	2200	1077	0	2000	64	37%
	Household type								
Couple with children	27	1170	890	1500	1172	800	1600	10	37%
Couple without children	54	1134	500	2000	1068	0	2000	19	35%
Lone-parent family	23	1076	183	1600	1040	500	2000	8	35%
One-person	49	1035	705	1600	1025	300	1600	22	45%
Other	18	1310	925	2200	1151	550	2000	5	28%
	Age group								
18-24	19	1004	500	1450	888	475	2000	6	32%
25-34	65	1075	183	1890	1058	0	2000	27	42%
35-54	36	1190	781	2000	1096	500	1500	12	33%
55+	30	1190	705	1800	1165	300	2000	13	43%
	Employment status								
Employed	113	1126	550	2000	1092	475	2000	43	38%
Retired	19	1210	730	1740	1182	700	1750	10	53%
Student	17	962	183	1600	865	0	1500	6	35%
Unemployed	4	1009	705	1450	800	300	1200	1	25%
	Household income bracket								
Less than $29,999	32	1048	183	1500	977	300	1500	9	28%
$30,000-$49,999	37	1121	730	2200	1051	500	2000	13	35%
$50,000-$74,999	32	1084	550	1740	1163	500	2000	17	53%
$75,000-$99,999	24	1173	750	1400	1183	550	1600	11	46%
$100,000-$249,999	22	1296	828	2000	1207	660	1700	6	27%

Table 17. Price of renting a room, organized by respondent and household characteristics

Household income brackets	n	Current rent ($)			Ideal rent ($)			Ideal rent higher than current	
		Average	Min	Max	Average	Min	Max	#	%
Total	102	551	325	760	557	0	1800	37	36%
	Household type								
Couple without children	2	523	450	595	575	500	650	1	50%
Other	100	552	325	760	557	0	1800	36	36%
	Age group								
18-24	69	567	325	760	563	350	1000	24	35%
25-34	9	449	325	675	678	400	1800	6	67%
	Employment status								
Employed	8	491	325	690	653	450	1000	7	88%
Student	74	563	330	760	559	0	1800	23	31%
Unemployed	2	518	325	710	500	500	500	1	50%
	Household income bracket								
Less than $29,999	5	462	325	710	625	500	925	4	80%
$30,000-$49,999	5	500	400	690	635	475	1000	4	80%
$50,000-$74,999	1	610	610	610	500	500	500	0	0%
$75,000-$99,999	3	483	375	575	467	400	500	1	33%
$100,000-$249,999	3	527	490	560	483	400	550	1	33%

Note 1: This table is very student oriented. There are very limited data for the analysis of household income.

Note 2: Most of the room renters are students. Thus, the majority of them have a household type of “other” (a household of two or more people who are not in a census family sharing a private dwelling) and they are all in the younger age groups.

Note 3: As mentioned previously, student households are excluded in the analysis of household income. Therefore, only 17 respondents are analyzed by household income bracket.

4.3.2.7.3 Why are Some Respondents Willing to Pay a Higher Rent?

To better understand why so many survey respondents are willing to pay more for their ideal homes, the ideal yard size, housing size and bedroom number[1] are analyzed comparing two groups: respondents who are willing to pay higher rents for their ideal homes ("higher rent group") and the rest[2].

Generally, the "higher rent group" has higher preferences for relatively larger yard and living area (see ***Figure 21***). Patio, deck or balcony is ideal to 44% of those who are not willing to pay more (n=168), but only 30% of the "higher rent group" (n=99). Meanwhile, 35% of the "higher rent group" prefer a small yard, which is only ideal to 21% of the rest of the respondents. As to housing size (***Figure 22***), residences larger than 2000 sqft are ideal to 33% of the "higher rent group" (n=101) and 27% of the rest (n=169). Residences smaller than 1000 sqft are ideal to 18% of the "higher rent group" and 27% of the rest. Therefore, it is likely that some respondents are willing to pay higher rents for a residence for a larger yard and living area. Meanwhile, the ideal number of bedrooms doesn't vary much between respondents who are willing to pay more and the rest of participants (see ***Figure 23***).

[1] The analysis of ideal yard size and ideal housing size could not be broken down by housing types. In real life, apartments are generally smaller with patio or balcony, while houses are generally larger with backyards. However, the results of the survey indicate that respondents didn't answer these ideal related questions in terms of one particular residence. For instance, 21 respondents indicate their ideal housing is an apartment with a yard of different sizes, which is unrealistic. Therefore, theses ideal related questions are analyzed independently to reflect a general preference of respondents.

[2] Thanks to an anonymous realtor for suggesting this line of inquiry.

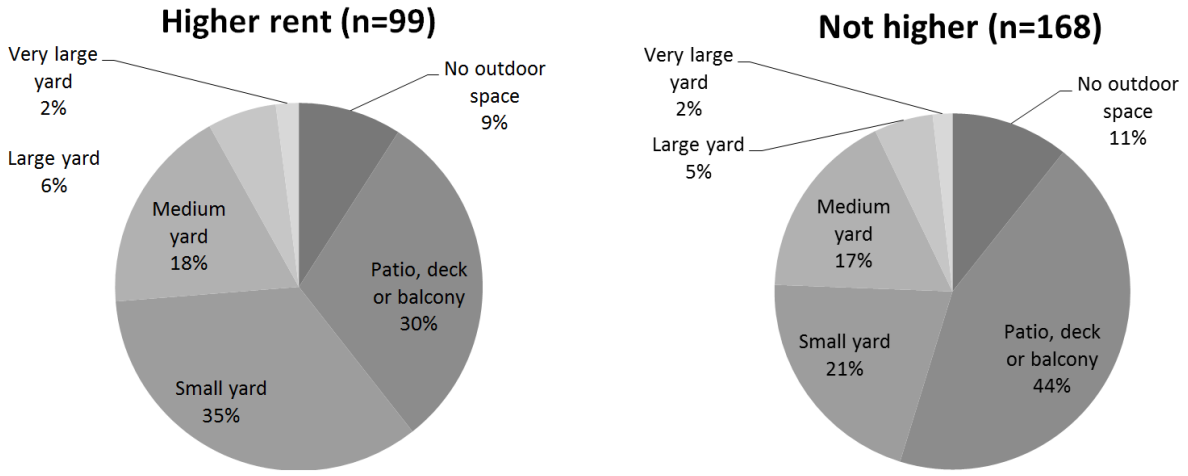

Figure 21. Ideal yard size, comparing respondents who are willing to pay higher rent with the rest

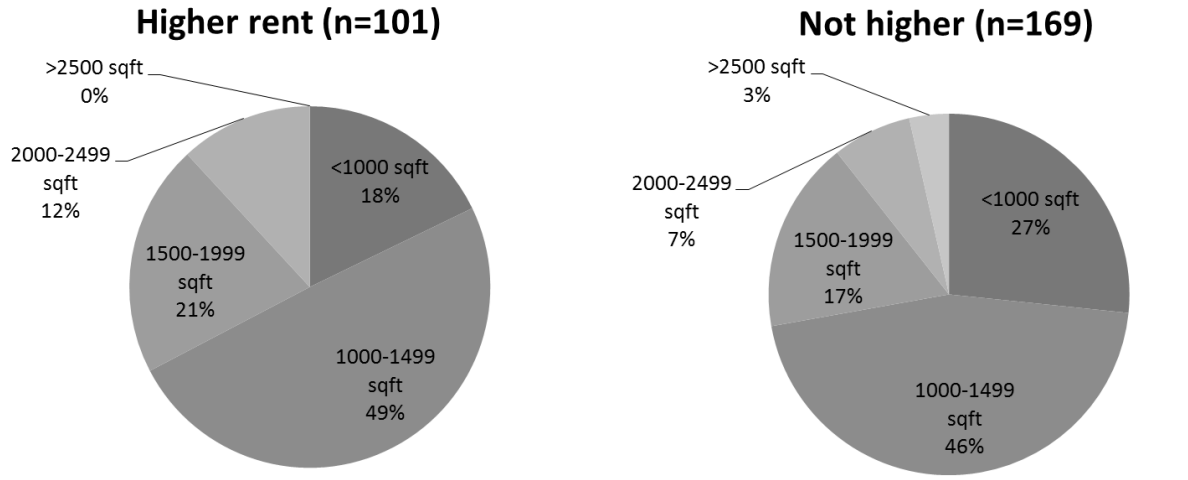

Figure 22. Ideal housing size, comparing respondents who are willing to pay higher rent with the rest

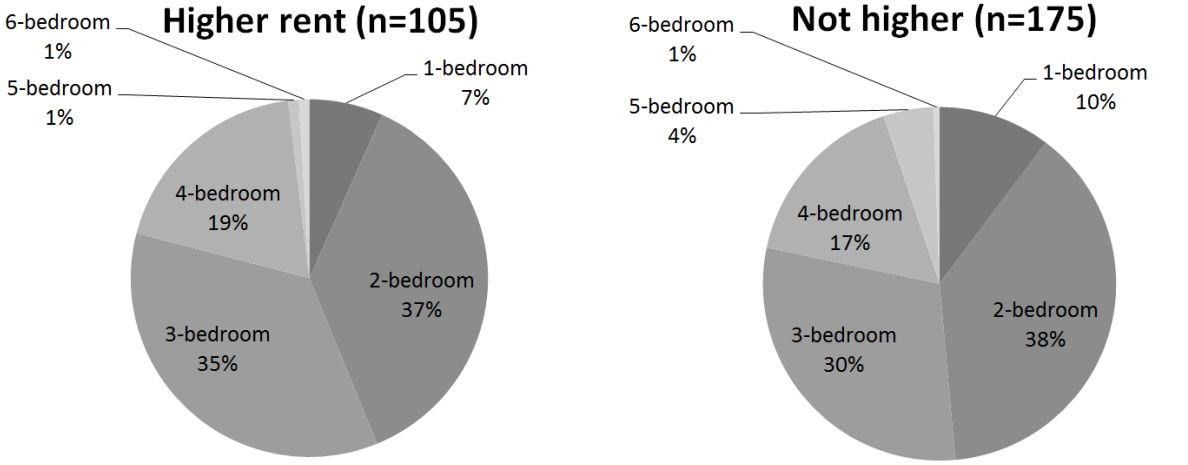

Figure 23. Ideal number of bedrooms, comparing respondents who are willing to pay more with the rest

4.3.3 Neighbourhood Characteristics

In the survey, a “neighbourhood” is defined as an area within a 10-minute walk to the respondent’s residence. Renter’s neighbourhood characteristics are classified into three aspects: built environment, socio-demographic and accessibility. Respondents were asked to rate the importance of each characteristic in their decision to move to their current residence.

4.3.3.1 Built Environment Characteristic

Many respondents note that the ease of walking is a very important built environment characteristic in their renting decision (51%; n=290). Traffic noise, land use mix and ease of cycling are marked as important/very important by more than half of the respondents, while density of housing is generally not perceived as important as other characteristics.

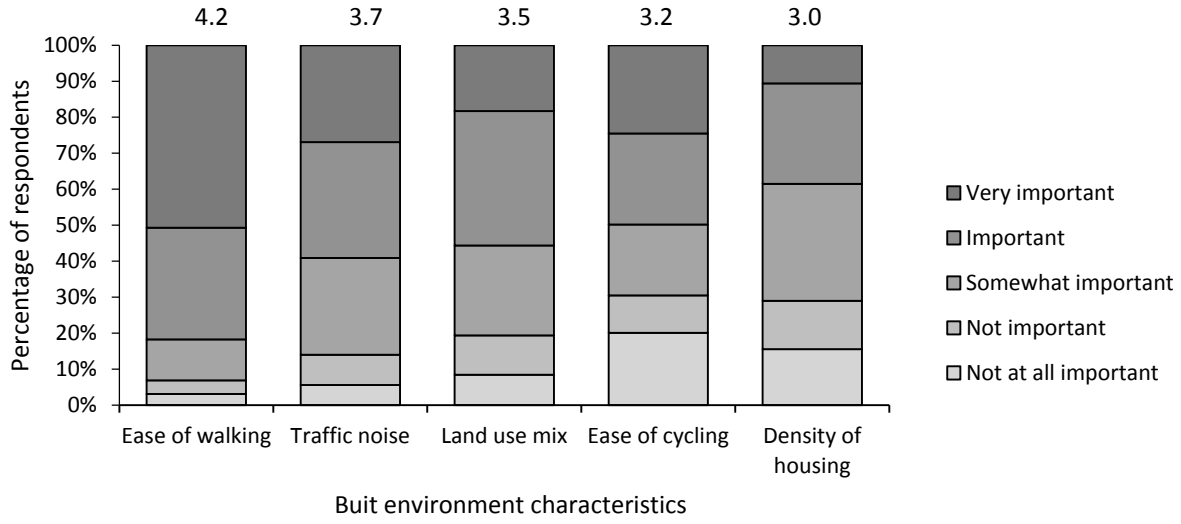

Figure 24. Importance of various built environment characteristics in respondents’ decisions to move to their current neighbourhood (various sample sizes)

Ease of walking is generally perceived as very important across different respondent and household groups. In particular, it is very important to 65% of the students, 61% of the respondents in 18-24 and 55% of the retired households. Forty-seven percent of the retired households also think traffic noise is very important.

4.3.3.2 Socio-demographic Characteristic

When asked about the importance of each socio-demographic characteristic in their renting decision, safety level/crime rate is marked as very important (68%; n=285) to more respondents than any other characteristic, followed by school quality (35%; n=257). Meanwhile, respondents seem to be quite tolerant to the diversity of their neighborhood households. The similarity of ethnicity to themselves is generally marked as unimportant, and over 30% of the respondents indicate that the similarity of education level, age, household income and household size to themselves are "not important" or "not at all important".

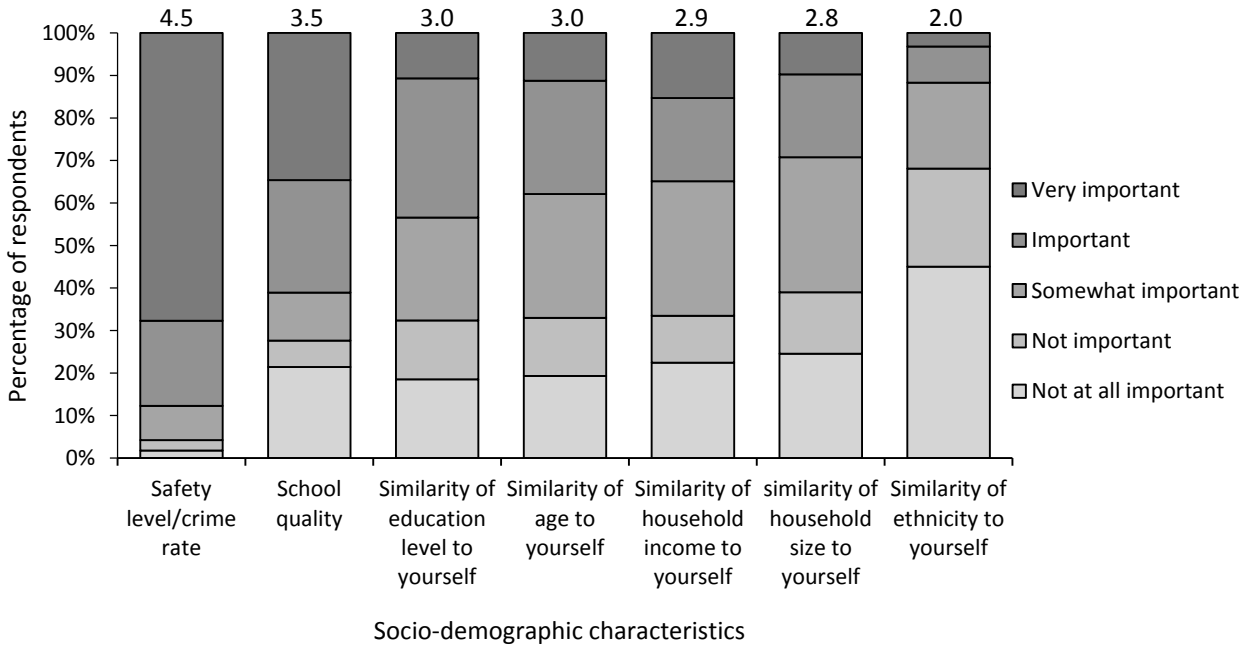

Figure 25. Importance of various socio-demographic characteristics in respondents' decisions to move to their current neighbourhood (various sample sizes)

Importance of School Quality

Respondents' perceptions on the importance of school quality are more polarized than other socio-demographic characteristics. To better understand this, the responses to the importance of school quality are organized by different respondent and household characteristics:

- By **household types**: Couple-families with children at home and lone-parent households think school quality is “very important” or “important” in their decision making (96% and 83%, respectively). School quality is prioritized in their location choice decision when considering children’s education. Couple-families without children and one-person households generally think school quality is not important/not at all important (42% and 54%, respectively).
- By **age groups**: Many respondents in the 35-54 age group find school quality very important in their decision making (59%; n=32). Respondents aged 55 or older generally find school quality not important/not at all important (61%; n=23).
- By **employment status**: 72% of student households think school quality is more than “somewhat important”. Apparently, many of them have been attracted to KW for the quality of the local universities. Some employed households also think school quality is more than “somewhat important” (32% choose “very important” and 23% choose “important”; n=117). Seven out of 14 retired households generally think school quality is not important/not at all important.

Table 18. Perceived importance of school quality, organized by respondent and household characteristics

Respondent and household characteristic	n	1(not at all important)	2 (Not important)	3 (somewhat important)	4(important)	5(very important)	Mean
Total	257	21%	6%	11%	26%	35%	3.5
	Household type						
Couple with children	26	4%	0%	0%	12%	85%	4.7
Couple without children	53	34%	8%	9%	32%	17%	2.9
Lone-parent family	23	13%	4%	0%	30%	52%	4.0
One-person	39	44%	10%	23%	13%	10%	2.4
Other	116	14%	6%	13%	31%	36%	3.7
	Age group						
18-24	89	10%	9%	11%	34%	36%	3.8
25-34	69	36%	4%	12%	20%	28%	3.0
35-54	32	12%	3%	3%	22%	59%	4.1
55+	23	52%	9%	17%	13%	9%	2.2
	Employment status						
Employed	117	30%	5%	9%	23%	32%	3.2
Retired	14	43%	7%	29%	14%	7%	2.4
Student	88	10%	7%	10%	36%	36%	3.8
Unemployed	4	0%	0%	0%	50%	50%	4.5
	Household income bracket						
Less than $29,999	31	23%	13%	19%	16%	29%	3.2
$30,000-$49,999	43	23%	7%	16%	23%	30%	3.3
$50,000-$74,999	32	22%	9%	9%	25%	34%	3.4
$75,000-$99,999	24	25%	0%	4%	29%	42%	3.6
$100,000-$249,999	22	55%	0%	14%	9%	23%	2.5

Note: mean value of perceived importance of school quality is displayed at the last column by each respondent and household characteristic. They are calculated based on a scale of 1(not at all important) to 5(very important).

4.3.3.3 Accessibility Characteristic

Every accessibility characteristic listed in the questionnaire has an average importance value higher than 3.0. Compared to the built environment and socio-demographics of their current housing, responding renters seem to care more about the accessibility characteristics. Most of the accessibility characteristics are “very important” or “important” to 50% or more of the respondents except for “distance to family/friends” and “distance to highway exits”. Answers to “accessibility to school” and “accessibility to bus stops” are more polarized than other factors.

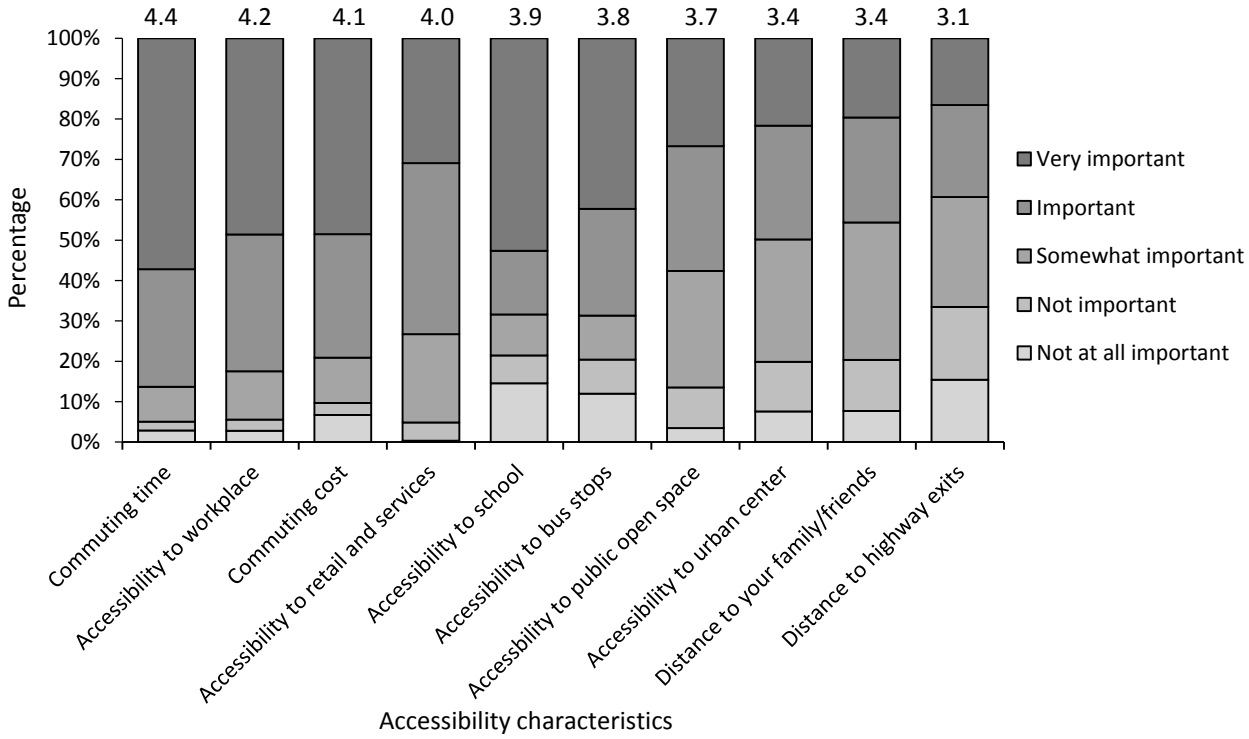

Figure 26. Importance of various accessibility characteristics in respondents’ decisions to move to their current neighbourhood (various sample sizes)

Accessibility to school is very important to 77% of students and 69% of couples with children. Meanwhile, it is not important at all to 75% of retired households and 56% of respondents aged 55 and older. As to accessibility to bus stops, 91% of respondents in 18-24 age group and 87% of students find it more than “somewhat important”. Yet, households with higher income generally think

that accessibility to transit is less important. In fact, accessibility to transit is “very important” and “important” to only 4% and 29% of households with an income of $100,000-$249,999 (n=24).

Overall, student respondents find accessibility to bus stops and school very important, but respondents who do not go to school and do not use public transit very often such as seniors regard these characteristics as unimportant. In the survey questionnaire, respondents were asked “how many days per week do you use public transit”. The result indicates that, the older the respondents are, the lower the frequency of using public transit is (see

Table 19). The majority of 55+ respondents (82%) and retired households (88%) rarely or never used public transit.

Table 19. Frequency of using public transit, organized by respondent and household characteristics

Respondent and household characteristic	n	Rarely or never	1-2 days	3-4 days	Every weekday (5 days)	Every day (7 days)
Total	282	43%	15%	13%	16%	14%
	Household type					
Couple with children	27	63%	11%	4%	11%	11%
Couple without children	58	57%	9%	12%	16%	7%
Lone-parent family	24	67%	8%	4%	12%	8%
One-person	51	76%	4%	6%	6%	8%
Other	122	12%	24%	21%	21%	21%
	Age group					
18-24	93	15%	17%	20%	25%	23%
25-34	78	53%	15%	12%	12%	9%
35-54	36	67%	14%	3%	8%	8%
55+	28	82%	0%	7%	4%	7%
	Employment status					
Employed	127	61%	11%	6%	9%	12%
Retired	16	88%	0%	12%	0%	0%
Student	96	11%	19%	23%	26%	21%
Unemployed	5	40%	40%	0%	20%	0%
	Household income bracket					
Less than $29,999	39	36%	13%	10%	23%	18%
$30,000-$49,999	44	73%	11%	5%	5%	7%
$50,000-$74,999	35	71%	11%	6%	9%	3%
$75,000-$99,999	26	58%	15%	4%	15%	8%
$100,000-$249,999	25	76%	4%	8%	4%	8%

Compared to other groups, retired households are less concerned about many accessibility characteristics. Accessibility to school, accessibility to work, commuting time and commuting cost are not important/not at all important to 75%, 45%, 33% and 33%, respectively. On the other hand, accessibility to retail and services, accessibility to open space, accessibility to urban center and distance to family/friends are important/very important to 80%, 85%, 85% and 69% of t group, respectively. Older respondents are generally more concerned about their accessibility to open space than younger generations.

4.4 Renting Behaviours

The following section explores the renting behaviours of respondents. Topics discussed here include lease length, subletting, sources of rental information, searching process and “Renting vs. Buying”.

4.4.1 Length of Lease/Contract

Most respondents have a rental lease of 12 month or shorter (91%; n=289). 12-month is the most common lease length (52%) followed by month to month contract (24%). Five respondents note that their contracts are now month to month after an original longer lease period. Some respondents also indicate that they have received discount after a long-time lease/contract (17%; n=247).

4.4.2 Subletting

Ten percent of the survey participants were living in a sublet residence during the survey period (n=289). Most of them have a 4-month or even shorter rental lease (75%; n=28), which is a lot shorter than the 12-month lease that many non-sublet renters sign (55%; n=261). According to their household information, students account for most these subtenants (83%). This corresponds with the fact that students are more frequent movers, especially for those enrolled in the co-operative education program.

Some responding subtenants also reported the original monthly rent that their subletters pay to the landlords. Compared to the monthly rents the subtenants pay, 10 out of 21 subtenants are paying

less than the original rental prices. Therefore, the subletters may have adjusted the rent in order to attract more potential subtenants.

4.4.3 Sources of Rental Information

The respondents were asked how they normally found rental information. Both online and off-line sources have been used by survey respondents to find rental information. Sixty-one percent of respondents indicate that they normally use Kijiji, a popular classified advertising service, to look for rental housing online (n=288). Except for Kijiji, other online resources including social media, housing company's websites, Google search and Craiglist are used by 22% of the surveyed renters. 31% note that the University of Waterloo's off campus housing website provides them rental information, which corresponds with the fact that 38% of the survey respondents are student households (n=251).

Word of mouth is the most important off-line source of rental information; 40% of the participants find information through their friends, families or someone else they know. Also, 18% seek help from housing agents. Other sources include for rent signs, newspapers and street advertisements/posters. Four people left comments saying that they use their observation such as noticing a construction site of rental housing.

Seniors are generally less likely to use online sources than younger generations, which is expected. Only 29% of respondents aged 55 and older (n=34) normally use Kijiji to find rental information and none of them use social media or housing company's websites. Instead, senior respondents rely more on off-line sources, including newspaper (35%; n=34), for rent signs (35%) and someone they know (35%).

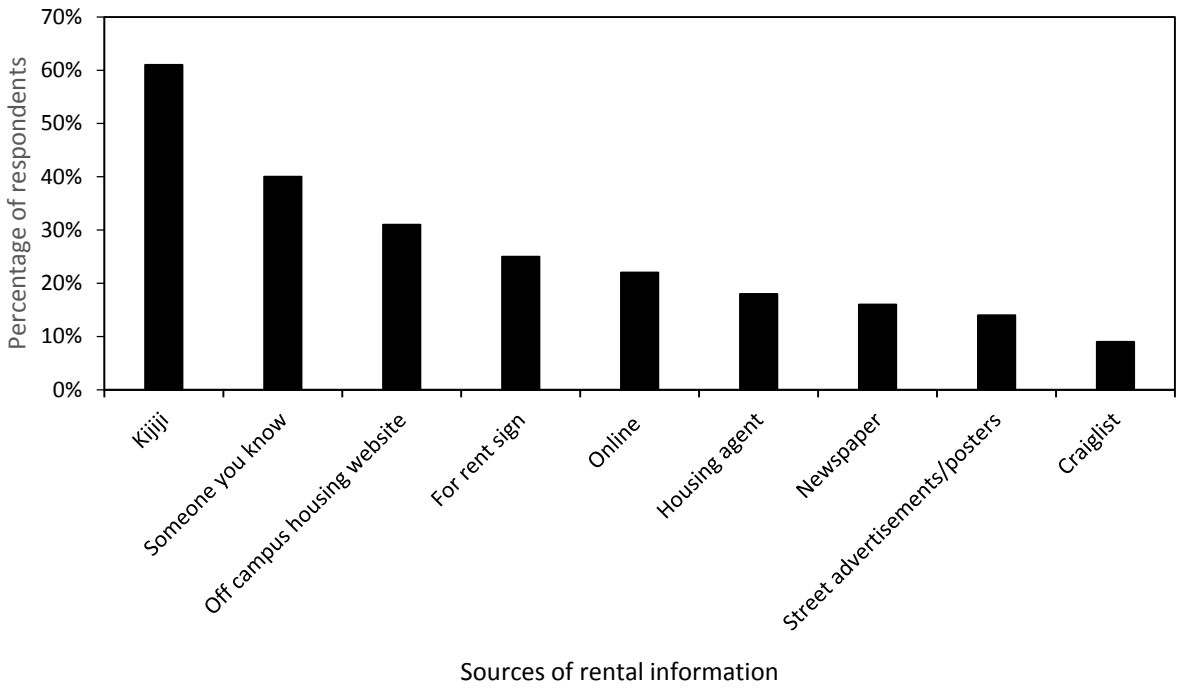

Figure 27. Sources of rental information (n=290)

4.4.4 Searching for Current Residence

Participants answered questions regarding their search process for their current rental housing. The length of their searching varies a lot, from less than 1 week to 150 weeks. The most common search period is two weeks (24%; n=287). Almost all respondents indicate that they found their living place within 2 months (91%). The average searching period is about 6 weeks.

On average, each respondent visited about 3 places before choosing their current residence (n=287). Most participants visited 5 places or less before making their decision (85%). The number of places visited varies from 0 to 30. Surprisingly, 38 out of 287 respondents (13%) didn't visit any place before renting their current place, which means that they made choices based on photos and descriptions of the housing or even less information. On the other hand, people who didn't see their places in person signed relatively shorter contracts compared to the entire sample. There might be fewer options available in the market for those short-term renters.

4.4.5 Comparison: Renting vs. Buying

The survey asked respondents why they chose renting instead of buying. Affordability, convenience and responsibility are the three biggest concerns. Fifty-one percent note that they cannot afford a mortgage/down payment; and 23% prefer to live with no debt. About half indicate that renting meets their short-term housing needs (51%; n=289) and makes it easier when they move (41%). Also, the convenience of the renting process versus buying process attracts people to rent (30%). Moreover, the responsibilities of owning a home (e.g. repairs and maintenance) make people less likely to buy (47%). Among all respondents, 11% are downsizing to rent.

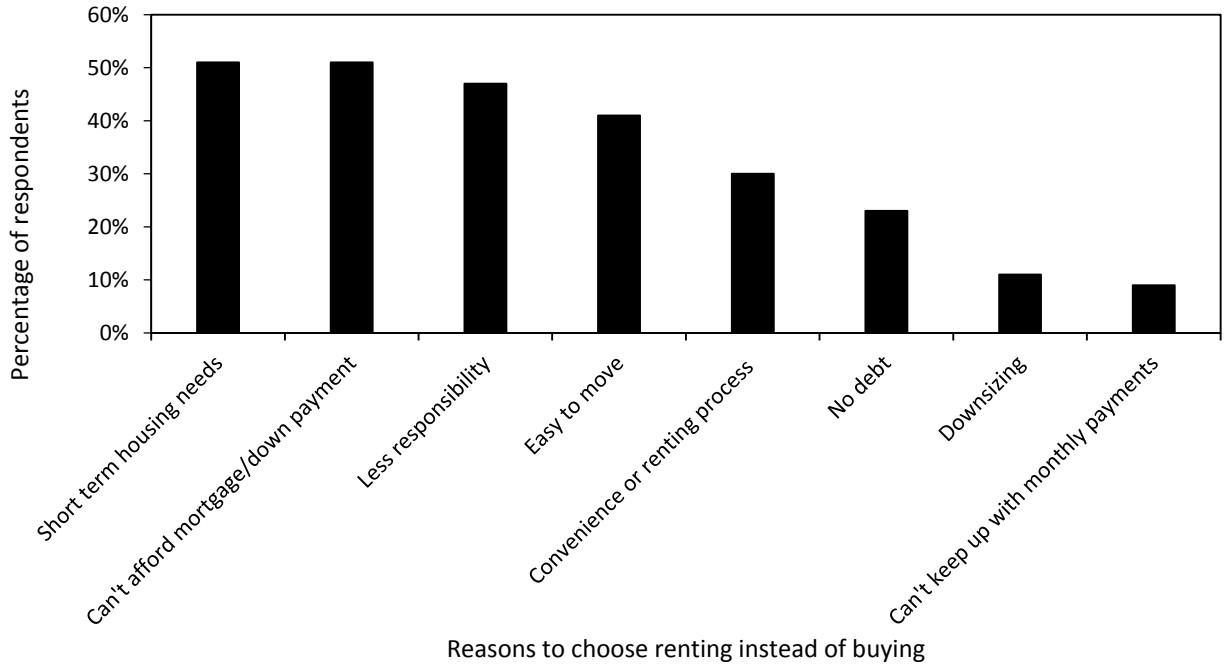

Figure 28. Reasons to choose renting instead of buying (n=289)

Renters aren't always renting. Some renters used to be home owners. Twenty-four percent of the respondents note that they have owned a home before (n=288). But many of them choose renting for less responsibility (58%; n=69) and downsizing (42%; n=69).

Furthermore, renters will not be renting forever, and many of them are planning to buy a home in the future. Twenty-eight of the 69 respondents who have owned a home before still plan to buy a home in the future. Overall, 75% of respondents are planning to become home owners (n=286) in 0-20 years (n=200). Student households have the highest tendency towards buying a home in the future

(93%; n=95), meanwhile only 2 out of 20 retired household have the plan. Sixty percent of those who have the plan estimate to buy in 5 years or sooner. Their average purchase time is around 6 years.

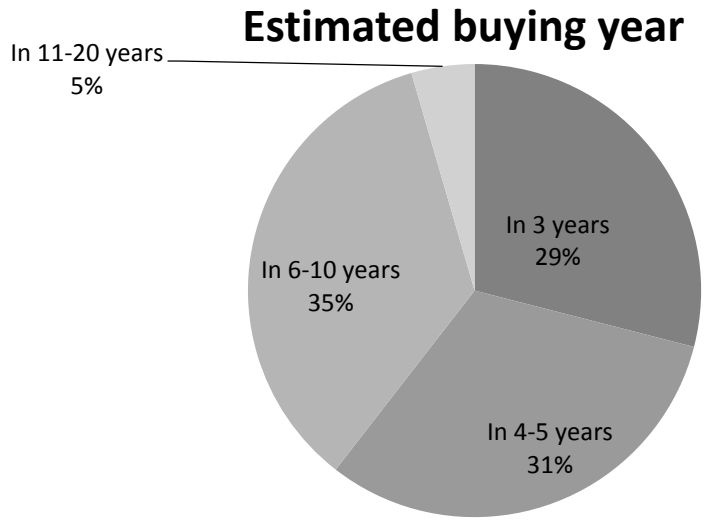

Figure 29. Estimated buying year for respondents who are planning to buy a home in the future (n=200)

4.5 Light Rail Transit and Location Choice

The following section presents respondents' opinions on Central Transit Corridor (CTC) and Light Rail Transit (LRT) and explores how they influence renters' location choice decision.

4.5.1 Central Transit Corridor and Location Choice

The Central Transit Corridor (CTC) is defined as the area within around 800 meters or roughly a 10-minute walk distance from the future LRT stops in the Region of Waterloo. It is a theoretical and conceptual boundary used in this research. A web-based lookup tool[1] has been created to help survey participants to check whether their home is inside the CTC area. The respondents were asked to answer the question using this tool.

[1] Dr. Xiongbing Jin helped me create this tool: http://research.wici.ca/survey/ctc.html.

To validate the answers to this question, the conceptual CTC boundary was used in ArcMap to check whether the address point lies within the CTC area polygon. After comparing the result with the survey responses, it turns out that 33 out of 288 respondents gave the wrong answer in terms of whether they lived inside CTC (11%). Some respondents either did not accurately know whether they were in the CTC, or did not use the provided tool to check. Answers to this question are manually corrected for analysis.

Table 20. Percentage of respondents in and outside CTC (n=288)

	Kitchener		Waterloo		Kitchener & Waterloo	
	#	%	#	%	#	%
In CTC	59	41%	96	67%	155	54%
Outside CTC	85	59%	48	33%	133	47%
Total	144	100%	144	6%	288	100%

There are slightly more respondents renting inside the CTC area (54%; n=288) than those renting outside. Sixty-seven percent of the participants in Waterloo live inside the CTC area (n=144), whereas in Kitchener there are less people living close to the future LRT stops (41%; n=144).

Respondents renting outside the CTC area were asked 2 follow-up questions[1] regarding their opinions on renting in CTC: "have you considered residences inside the CTC area during your search process?" and "did any of the factors below influence your decision not to rent inside the CTC area?" Only 21% mark that they have considered residences inside the CTC area during their search process (n=99). The biggest factor that influenced their decision not to rent inside the CTC is "not economical (higher rental price within CTC area)" (51%; n=73). The noise level and on-going LRT construction also made them less willing to rent inside the CTC area (44% and 40%, respectively). Some respondents also left comments saying that LRT was not in the immediate future when they looked for rental housing, therefore LRT construction was not a concern when they made the decision (12%).

[1] The completion rates of the two questions following the CTC question (Q27) are very low (73% for Q28 and 54% for Q29, n=135). This could be the result of the conditional setting of the online survey: only when respondents indicate that they live outside of the CTC will the conditional questions appear. Moreover, 11% of the respondents didn't correctly answer whether they lived inside the CTC, which may have led to low completion rates of the following two questions.

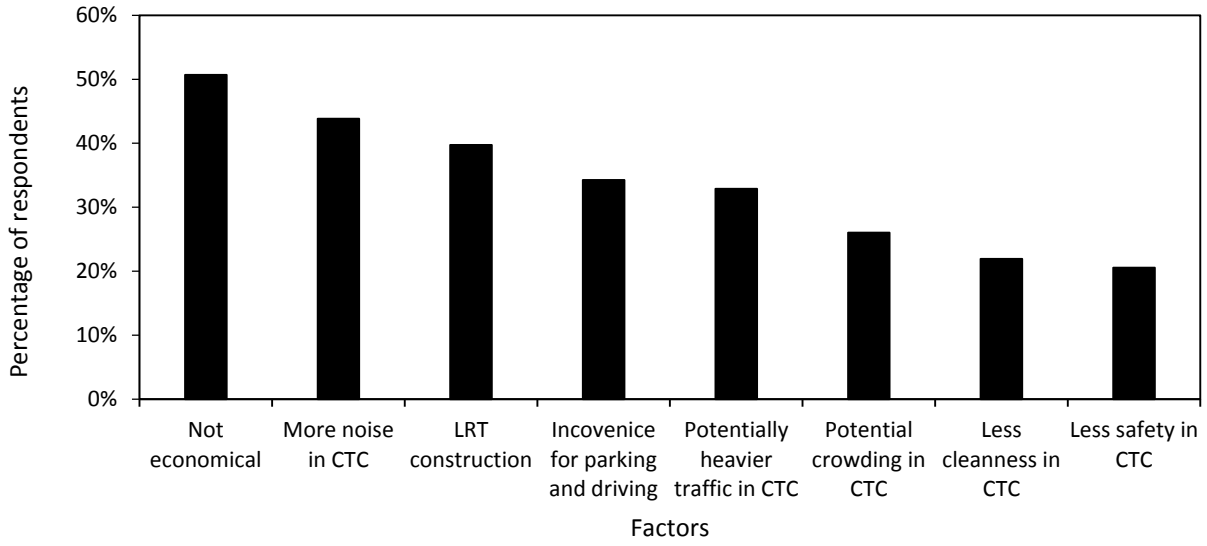

Figure 30. Factors influencing respondents not to rent inside the CTC area (n=73; 155 renting within CTC, 135 renting outside CTC)

4.5.2 General Attitude towards LRT and Important LRT features

The participants were asked about their attitudes towards the LRT system in KW. Their opinions vary a lot, yet the respondents are generally positive towards this project, with "positive" and "very positive" taking 29% and 19%, respectively (n=288). Respondents holding neutral attitudes take up 31% of the whole, whereas 22% are negative or very negative towards the LRT system.

Respondents renting inside the CTC area are compared to those living outside in terms of their general attitudes towards LRT. It turns out that renters living inside the CTC are slightly more positive towards the LRT system in KW.

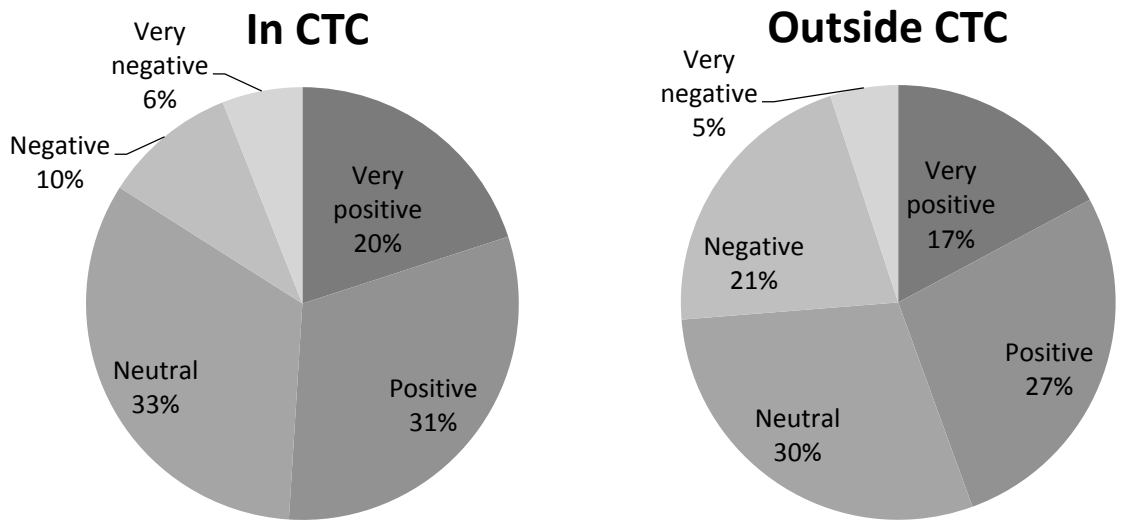

Figure 31. General attitudes towards LRT comparing in CTC (n=153) with outside CTC (n=135)

Participants were also asked to select all features of the future LRT services that might be important to them. All features listed in the survey are perceived as important by 20% or more participants (n=278). Among all, service frequency (80%), transit fare (76%), hours of operation (73%), on time performance (72%), convenience for bus connections and transfers (64%), convenience for walking to the LRT stations (63%) and availability of scheduling information (59%) are all checked off as important by over half of the respondents.

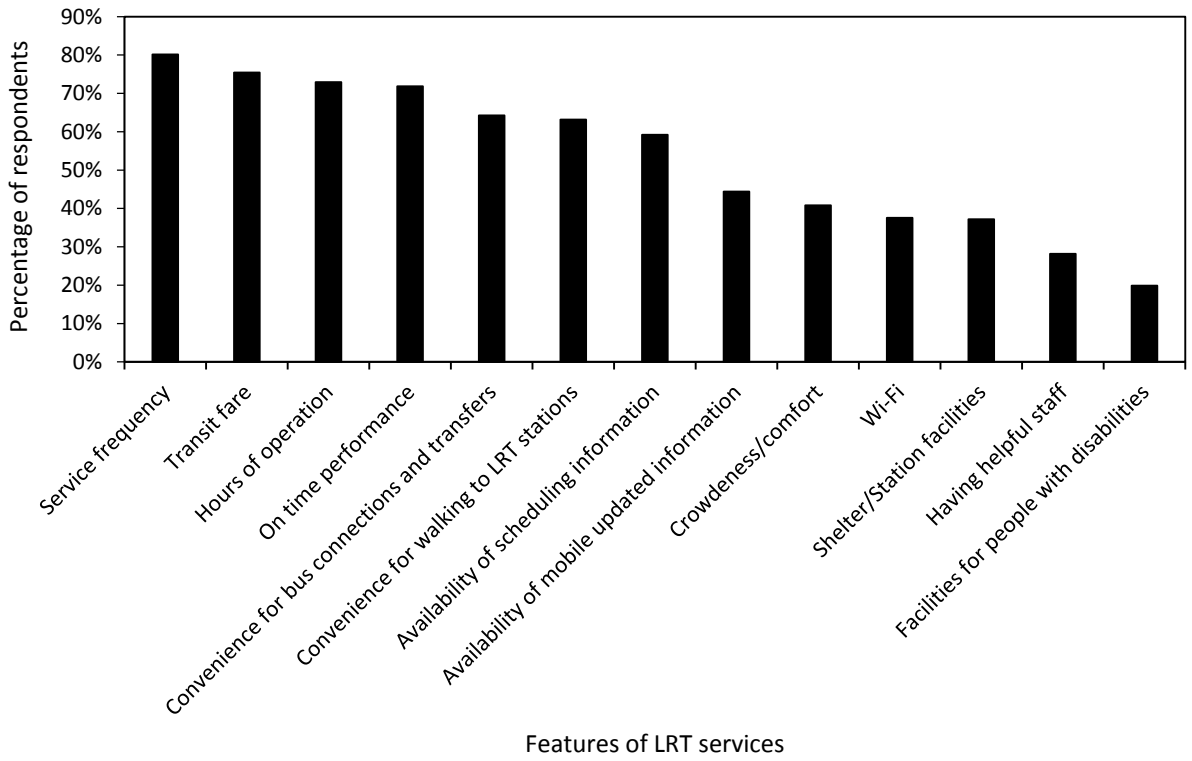

Figure 32. Features of the future LRT services that are improtant to survey respondents (n=278)

4.5.3 LRT and Location Choice

To better understand the relationship between LRT and renters' location choice, respondents were asked "To what extent will the LRT will influence your future location choice decision?" People holding neutral attitudes form the biggest group (35%; n=289). Some respondents believe that LRT is important in their future location choice decision, with "Important" and "Very important" representing 22% and 10%, respectively. Meanwhile, 22% find LRT not important at all in terms of the location choice of their future housing and 13% choose "Somewhat important".

The survey also listed some features of LRT, and participants were asked to select all applicable items that make them more likely to rent inside the CTC area in the future. The fact that LRT is faster and more on-time than buses is attractive to many people (62% and 59%, respectively; n=268). Moreover, being able to avoid traffic congestion and save driving cost through using LRT also makes some people more likely to rent inside the CTC area (52% and 50%). Meanwhile, some people didn't find any of the listed LRT features to make CTC more attractive. In fact, one respondent indicates that they are moving out of the area partially because of LRT.

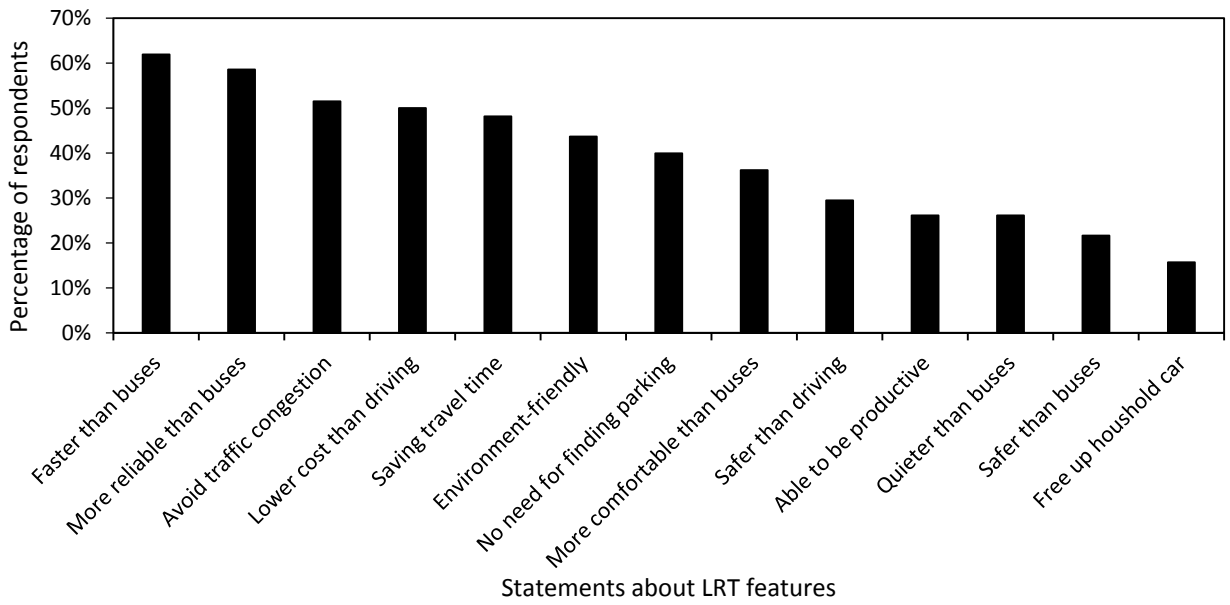

Figure 33. LRT features that make respondents more likely to rent inside the CTC area (n=268)

4.5.4 LRT and Trip Purposes

Respondents were asked to select all trip purposes they might use to LRT system for. The trip list comes from a previous research study conducted by Kevin Yeung (2015). Many respondents indicate that they might use the LRT system for social activities and school/work activities (65% and 58%; n=288). Shopping (grocery and other shopping) and recreational activities could also be some people's trip purposes using LRT (47%, 46% and 46%, respectively). Meanwhile, using LRT for chaperone activities (e.g. accompanying others to their own activities) seems less likely (10% of respondents). Fifty out of 288 (19%) note that they will not use LRT for any trip purposes, which corresponds to the 22% who find LRT not at all important in their future location choice decisions.

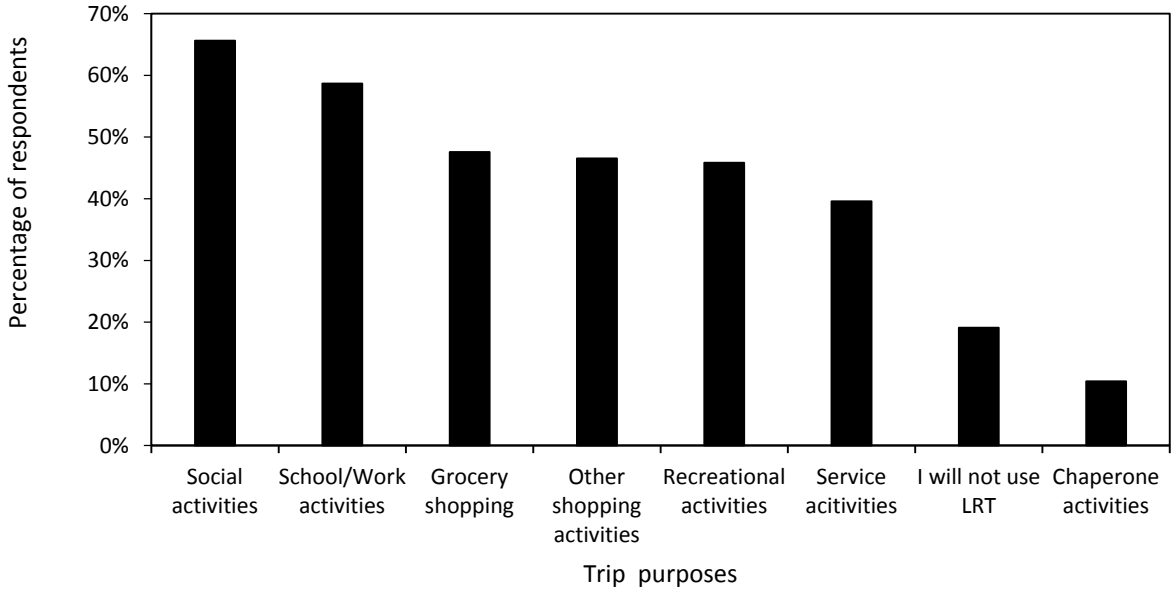

Figure 34. Trip purposes of using LRT (n=288)

Chapter 5. Review of Hedonic Modelling

Chapter Overview

Although the descriptive statistical analysis of the survey responses is very revealing, the results do not control for influences of other variables - they reveal simple correlations. A regression model is designed to help identify the independent influence of each characteristic explicitly - it reveals partial correlations. Regression is a statistical method for measuring the relationship between one dependent variable and one or more explanatory variables. Instead of determining the causation between variables, a regression answers correlation, for example, the direction of correlation (positive or negative), and the strength of the relationship (level of significance).

Hedonic regression, a popular model used to estimate prices in economics, is reviewed in this chapter. First, a brief history of hedonic regression development is presented. Issues related to model specification are discussed, covering topics including general form, functional form, variable selection, under-specification, over-specification and model performance. Finally, the potential spatial effects in models are discussed, focusing on spatial autocorrelation and spatial heterogeneity.

5.1 General Form of Hedonic Model

A house consists of different characteristics, and some of these characteristics may influence its value (Sirmans, Macpherson, & Zietz, 2005). Valuating a house is difficult since each house has a unique set of important characteristics and certain characteristics may be valued differently at different locations. A typical method of house valuation is building a hedonic pricing model. The rational of hedonic model is to regard the value of a house as a bundle of characteristics, such as size and location, and then divide the house price into different components by different characteristics. Therefore, the marginal contribution of each individual characteristic can be estimated through modelling.

The general form of hedonic model is a regression between price and its corresponding characteristics (Taylor, 2008). From a statistical point of view, it is also a traditional ordinary least square (OLS) estimation. The general hedonic model takes the form:

$$P = \alpha + \beta_1 * x_1 + \beta_2 * x_2 + \cdots + \beta_n * x_n + \varepsilon$$

Equation 1. General hedonic model

where P is the price, α is the constant, β_i is the coefficient for the ith characteristics, x_i, and ε is the error item in the regression. The parameter β_n can be interpreted as the willingness to pay (WTP) for a unit of characteristic x_n. However, it is necessary to understand that β_n is more like an estimation of the "average" WTP rather than the "actual" WTP. In reality, certain characteristics may be valued differently by different consumers, but hedonic models assume homogeneous preferences where different consumers have the same WTP. Hence, the estimated coefficient β_n should be regarded as an estimated average WTP of different consumers instead the real WTP.

5.2 The Development of Hedonic Regression

It is widely accepted that the first attempt to develop a hedonic price analysis is in a study of Andrew Court (1939). Realizing the inefficiency of using a single variable to represent the demand of automobiles, Court created a hedonic price index using three variables (dry weight, wheelbase and horsepower) in a semi-log form model.

Utility is an economics concept that measures a consumer's preferences over as a set of goods. In 1966, Kelvin Lancaster introduced "utility" to hedonic pricing theory. According to Lancaster, consumers value and demand a product by its useful features. His approach of evaluating the utility-based characteristics of goods built the microeconomic foundation for contemporary hedonic models. Sherwin Rosen (1974) progressed Lancaster's theoretical framework, and focused more on the determination of prices by considering both the structure of supply and budgets constraints. Different from Lancaster's model, Rosen's model is non-linear. Together, they contribute to the emergence of the hedonic pricing method, which has become popular particularly in the field of real estate (Lochl, 2010).

5.3 Model Specification

The specification of hedonic models generally includes two aspects: the specification of the model's functional form and the selection of both dependent and independent variables.

5.3.1 Functional Form

The functional form of a hedonic model is not strictly specified within the hedonic theory. Various functional forms have been implemented and compared, yet no consensus has been reached on the most appropriate functional form. Simple as the linear model is, more complex transformation has been used aiming at increasing the goodness of fit and flexibility of the model (Cheshire & Sheppard, 1995). Level-level and log-level forms are the two most commonly used when estimating hedonic models. In a level-level regression, both dependent and independent variables remain untransformed, while in a non-linear log-level regression, the logged dependent variable is regressed on unlogged independent variables. According to Follain and Malpezzi (1980), a log-level specification has some advantages over the linear specification. The log-level form minimizes the heteroscedasticity, a major concern in regression models. When heteroscedasticity exists, the variance of a variable is not consistent across observations and the variance of model errors is non-stationary. For distance variables specifically, a log transformation generally works better since the non-linear declining effects with distance are captured. Moreover, a coefficient can be easily interpreted as the percentage change of price for one-unit change in a characteristic as estimation. A natural logarithm is expanded from the simple linear method, and it takes the form (Malpezzi, 2003):

$$ln(P) = \alpha + \beta_1 * x_1 + \beta_2 * x_2 + \cdots + \beta_n * x_n + \varepsilon$$

Equation 2. Semi-natural log hedonic model

where the price is in natural logs and the independent variables remain unlogged.

5.3.2 Selection of Dependent Variable

In a residential hedonic pricing regression, the ideal dependent variable is often the latest selling price of a property, presenting the proximate value to the real value of the house. Comparing to using the assessed value of a property, using the observed value is considered as a better choice for dependent variable because it reduces potential bias (Sirmans, Macpherson, & Zietz, 2005). However, in real world research, assessed values are commonly used due to their better availability.

5.3.3 Selection of Independent Variable

When building a hedonic model, an important aim is to explain the endogenous variable as much as possible. Thus, choosing the most explanatory independent variables is the very first and crucial step in building a model. The importance of modeling different housing characteristics was raised early by Lancaster (1966) and Rosen (1974), but they did not specify what exactly these characteristics are.

Different from specifying the dependent variable, the number of independent explanatory variables that could be included is almost limitless. However, including too many characteristics in the model will reduce the significance of each estimator, and make it difficult to identify the real important variables. Researchers may be interested in a particular category of variables; however, including other variables that are relevant in the regression model is still necessary.

A widely referenced paper of Sirmans, Macpherson and Zietz (2005) reviewed 125 studies using hedonic models during the last decade and summarized the variables that are consistently significant. Though these studies focus on housing prices with no consideration of housing rents, their general conclusions are still useful and can shed light on the variable choice of rental price model. According to Davis, Lehner and Martin (2008), the ratio of rental price to housing price of a

property is relatively stable, with a fluctuation within some ranges. This also justifies applying the knowledge learned from hedonic housing price models to hedonic rental price models.

According to Sirmans, Macpherson and Zietz (2005), structural variables are found to be most commonly used in hedonic models. Many are consistently significant throughout different studies, including age of residence, square footage, garage spaces, lot size, number of bedrooms and number of bathrooms. There is a wide range of neighbourhood and environment variables used in hedonic studies. They are generally less frequently applied and appear not as significant or consistent as structural characteristics. Most of the variables are estimated with positive influences on housing prices, while age of residence, crime and vacancy generally have negative impacts.

It is worth noting that the significance level of a variable and the sign of its corresponding coefficient may vary among studies (Sirmans, Macpherson, & Zietz, 2005). For instance, age of residence, the most common variable concerned in the 125 hedonic pricing models, is typically expected to be an important variable with a negative impact on housing prices. Nevertheless, 8 in 81 studies find the age of residence not significant, and 7 out of 78 have a positive estimator for it. In fact, the attractiveness of a specific characteristic may vary across regions. For example, a swimming pool may be of greater value in warmer region like southwest and southeast of the United States (Sirmans, Macpherson, & Zietz, 2005).

5.3.4 Under-specification and Over-specification

When choosing explanatory variables, there exists a trade-off between bias and variance (Fotheringham, Charlton, & Brunsdon, 1998). The under-specification of variables may increase the bias of coefficient estimations; meanwhile including too many variables could increase the chance of multicollinearity and the standard error of estimates.

Omitted variable bias occurs when an important explanatory variable is excluded from the model. In this case, the model is underspecified and the estimators of other independent variables become biased due to the omission of a relevant variable in the model. Nevertheless, the omitted variable bias can be difficult to capture especially when there are already multiple variables in the model. A strong knowledge of the study area and local conditions as well as a thorough understanding of

relevant variables used in hedonic regressions through literature review are needed In order to avoid omitted variable bias when building a model.

Multicollinearity arises when two or more explanatory variables are highly correlated. When this issue occurs, the model becomes over-specified and lacks sufficient information to estimate the influence of each correlated variable (Anselin, 2005) Pair-wise correlations of independent variables can be used to identify potential multicollinearity. The standard threshold of correlation is suggested to be ± 0.70 according to Clark and Hosking (1986); meanwhile low thresholds are also used in some models (Atkinson-Palombo, 2010). The multicollinearity condition number developed by Belsley, Kuh and Welsh (1980) diagnoses the overall multicollinearity of the model. Normally, an indicator of 30 or larger suggests multicollinearity issue among the independent variables (Clark & Hosking, 1986).

5.3.5 Model Performance

In terms of model performance, traditional indicators measures of fit include R^2 and adjusted R^2, where the higher the value is, the better the model fits the data. Beyond this, log likelihood, Akaike information criterion (AIC) and Schwarz criterion also measure model's goodness-of-fit. These three statistics are applicable to both spatial and non-spatial models while R^2 could be only be used in the non-spatial ordinary least square (OLS) estimations and is inapplicable for measuring spatial regressions (Anselin & Bera, 1998). A higher log likelihood value and a lower AIC indicate better fit. It should be noted that these three indicators are only comparable among models using the same variable set, such as comparing an OLS and a maximum likelihood (MLL) lag estimation using the same variables. Comparing log likelihood, AIC and Schwarz criterion between models with different variables is meaningless.

5.4 Existing Hedonic Rental Price Models

Although many studies have used hedonic price models to estimate property values, few studies have been done on rental prices. A hedonic rental price model was conducted for Zurich, the largest canton in Switzerland, using individual level variables developed from open data (Fuhrer, 2012). Its methodology combined both hedonic pricing model and Geographically Weighted Regression

(GWR), which is further explained in ***Section 5.5.2***. Both level-level and log-level functional forms were used, and the results revealed that floor area, age (1991-2011; dummy variable) and percentage of people holding a university degree are the most important variables in both models. Also, environment variables turned out to be less significant than structural, neighbourhood and accessibility variables. Another hedonic rental price model for apartments was built for the Ikeja area of Lagos state, Nigeria, a predominant residential area previously (Babawale, Koleoso, & Otegbulu, 2012). The primary data of this study is obtained through a structured survey questionnaire. The model specification used log-level function, and results of this research showed that number of bedrooms, condition of the property, availability of pipe-borne water, average bedroom size and number of bath/toilets are the major descriptors of the rental prices for apartments.

5.5 Spatial Effects and Spatial Regression

Location has been identified as an essential characteristic for determining housing prices (Lochl, 2010). Therefore, it is important to control for location in hedonic models in order to explain the spatial related price differentials and to derive accurate estimations (Bitter, Mulligan, & Dall'erba, 2007). There are generally two common ways of incorporating location information: use distance variables such as distance to central business district, or introduce dummy variables for specific neighbourhoods. Meanwhile, some researchers have found that including distance and dummy variables might not be able to account for all spatial effects (Wilhelmsson, 2002; Clark S. , 2007). Anselin (1988) has identified two types of spatial effects: spatial autocorrelation and spatial heterogeneity. They have been recognized as the major challenges in spatial modelling. While spatial autocorrelation is a locational/adjacent effect, spatial heterogeneity represents the segmentation of market (Páez, Long, & Farber, 2008).

5.5.1 Spatial Autocorrelation

Spatial autocorrelation or spatial dependence is defined by Anselin (1988) as “the existence of a functional relationship between what happens at one point in space and what happens elsewhere” This phenomenon can be explained by the Tobler’s first law of geography that "Everything is related to everything else, but near things are more related than distant things" (Tobler, 1970). Simply speaking, there exists spatial autocorrelation when larger values tend to be located closer to large values geographically and small values tend to be located closer with small values. In this case, the

traditional OLS is no longer applicable because distances between observations will influence a variable's variation in space, meaning that the OLS assumption of independent and identically distributed model errors is violated (Fortin & Dale, 2009).

Spatial autocorrelation can be corrected in two ways based on the traditional OLS models: as a spatially lagged dependent variable or as a spatial error term. Different from the general hedonic model which uses OLS estimation, spatial lag and spatial error models use maximum likelihood estimation. the spatial lag model accounts for the impacts of nearby observations by including a spatially lagged dependent variable (Anselin, 2005). The spatial error model accounts for spatial dependence in the error term due to omitted random factors that are spatially correlated (Anselin, 2005).

5.5.2 Spatial Heterogeneity

Spatial heterogeneity or spatial non-stationarity represents another important aspect of spatial effects. It may present when there is a lack of uniformity in terms of spatial effects (Lochl, 2010). In regression models, when the relationship between the dependent and independent variables are not consistent in the whole study area spatial, heterogeneity arises. This often results in a strong relationship for one variable in one region, but very insignificant in another region. For example, a swimming pool may have a greater value in warmer regions than in other places, whereas a garage may have a greater value in colder areas (Sirmans, Macpherson, & Zietz, 2005). This kind of spatial non-stationarity could not be captured in global models such as spatial lag and spatial error models since the data generating process in global models is expected to be homogeneous over space.

A local Geographically Weighted Regression (GWR) model provides a solution when spatial heterogeneity problems occur (Fotheringham, Charlton, & Brunsdon, 1998). Different from a global model which estimates one result using all observations, GWR generates a set of estimated coefficients for each individual observation, hence indicating the nonstationary distribution of the whole study area (Bivand, Pebesma, & Gomez-Rubio, 2008). However, GWR generally requires a large number of observations, for instance, county level voting data in 2016 US election. Considering the survey sample size of this thesis, GWR is not feasible.

5.5.3 Diagnostics of Spatial Regression

The most commonly used diagnostic in model misspecification is Moran's I. It was first applied to regression residuals by Cliff and Ord (1972). The Moran's I index measures the spatial pattern of the data: clustering, dispersion or randomness. The values of Moran's I range from -1 to +1, with a positive value indicating positive spatial autocorrelation (similarity of neighbouring values) and a negative value indicating negative spatial autocorrelation (dissimilarity of neighbouring values). While the Moran's I value indicates the spatial pattern, the generated z-score and p-value indicate whether the null hypothesis of random distribution could be rejected.

Although Moran's I is powerful in identifying spatial autocorrelation, it does not suggest which alternative model (spatial lag or spatial error model) is a better fit. In this case, Lagrange Multiplier (LM) test statistics could be implemented. LM lag and Robust LM Lag indicate the suitability of using spatial lag model, while LM Error and Robust LM Error test for spatial error model as an alternative (Anselin, 2005). The spatial regression model selection decision rule is summarized in ***Figure 35***. The steps can be implemented using GeoDa, a free and open source software for spatial data analysis (Luc Anselin Team, 2017a). If both Robust LM-error and LM-case appear to be significant ($p<0.05$), the one with smaller p-value could suggest a more appropriate spatial model. Alternatively, GeoDaSpace could be used in this case to account for the effects of both spatial lag and spatial error (Luc Anselin Team, 2017b).

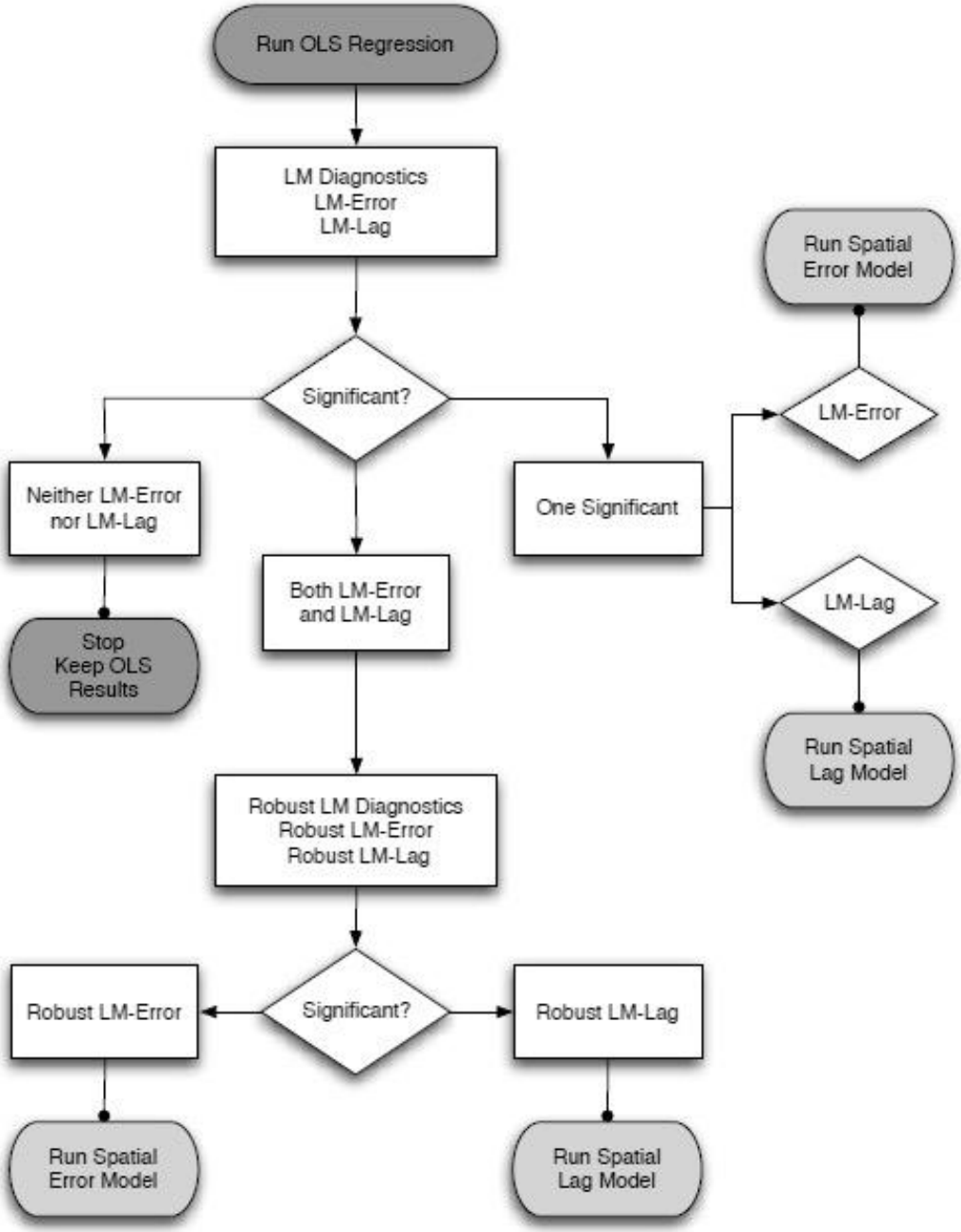

Figure 35. Spatial regression decision process (Anselin, 2005)

Chapter 6. Pre-regression Analysis

Chapter Overview

As presented in the descriptive statistical analysis chapter, the demographics of survey respondents are analyzed using two datasets: the full sample and mailing responses only (a subset of the full sample). Their comparison results indicate that using responses collected through the mailing strategy alleviates the over sampling of student households in the full sample, and shows a more unbiased representation as comparison to the census data. Therefore, only data collected through mailing is used in the hedonic modelling analysis, although the number of observations is only 143.

This chapter pre-processes and analyzes the dependent and candidate independent variables in preparation of the final model specification. The candidate explanatory variables are explored in six categories in correspondence with the survey questionnaire design. Each variable is explained with an equation indicating how it is measured. A summary statistics table is also provided. At the end of this chapter, the results of Moran's I diagnostic are presented, suggesting a weak spatial clustering among the data.

6.1 Dependent Variable

Considering the great variation of rents between room rentals and the rest, using respondents' reported rents directly as dependent variable is not advised. Instead, the rents reported by room renters are adjusted by multiplying rent of the room by the number of bedrooms.

$$Adjusted\ Rent_i = \begin{cases} Reported\ Rent_i \times Number\ of\ Bedrooms_i, & room\ renter \\ Reported\ Rent_i, & otherwise \end{cases}$$

Equation 3. Adjusted rent

6.2 Candidate Independent Variable

In an empirical study like this thesis, qualitative data obtained from the survey needs to be incorporated along with quantitative data into regression models. The measurement of quantitative data is very straight forward: the magnitude of a continuous variable can convey useful information, such as *number of bedrooms* and *age of residence*. Meanwhile, for qualitative information, such *household types*, dummy variables are used. In the simplest case, a dummy variable is developed to distinguish between two categories, for example, whether the observation is within CTC boundary. When multiple categories exist, a set of dummy variables need to be defined in the model. It is worth noting that the number of dummy variables should always be one less than the number of categories. Including same number of dummy variables as the number of categories will result in dummy variable trap of perfect collinearity (Wooldridge, 2012). As to the estimation of dummy variables, the estimated coefficients can be interpreted relative to the base category (the left out category which is not included as a dummy variable).

In this section, candidate independent variables are presented in six general categories: household variables, structural variables, built environment variables, sociodemographic variables, accessibility variables, and behavioral variables.

6.2.1 Household Variables

Typically, demographic variables used in hedonic models are at a spatially aggregated scale, for instance, the percentage of households with children at home at Census Tract (CT) level. Although this kind of data might not reflect the actual demographic information of a specific observation, most hedonic models still choose to use this neighbourhood-level aggregated data due to limited data availability. In this study, household variables are at an individual level using data obtained from the renters' survey. Thus, this study can directly examine the impacts of individual demographic variables on rental prices.

6.2.1.1 Household Type

According to the statistical analysis of survey data, the price of renting a house or an apartment varies among different household types. The average monthly rent of a "other household"[1] ($1310) is a lot higher than that a one-person household ($1035). To further investigate how different household types may influence rent differently, explanatory variables are developed for different household types and are tested in hedonic models for this thesis.

Household types are specified as dummy variables using survey data. Couples with children and lone-parent family are combined as one dummy variable "household with children". In the end, three dummy variables are considered: whether a household has children, whether it is a one-person household and whether it is an "other household". Couple without children is omitted and set to be the base category.

$$Children_i = \begin{cases} 1, & couple\ with\ children\ or\ lone-parent\ family \\ 0, & otherwise \end{cases}$$

$$One-person_i = \begin{cases} 1, & one-person\ housheold \\ 0, & otherwise \end{cases}$$

$$Other_i = \begin{cases} 1, & other\ housheold \\ 0, & otherwise \end{cases}$$

[1] "Other household" is a household of two or more people who share a private dwelling, but who do not constitute a census family. See ***Section 4.1.1.1*** for the definition of different household types.

$$Couple\ without\ children_i = \begin{cases} 1, & couple\ without\ children \\ 0, & otherwise \end{cases} (base\ category)$$

Equation 4. Household type

6.2.1.2 Employment Status

As to employment status, three dummy variables are developed using survey data: student household, retired household and unemployed household. Employed household is omitted and chosen to be the base group.

$$Student_i = \begin{cases} 1, & student\ housheold \\ 0, & otherwise \end{cases}$$

$$Retired_i = \begin{cases} 1, & retired\ housheold \\ 0, & otherwise \end{cases}$$

$$Unemployed_i = \begin{cases} 1, & unemployed\ household \\ 0, & otherwise \end{cases}$$

$$Employed_i = \begin{cases} 1, & employed\ housheold \\ 0, & otherwise \end{cases} (base\ category)$$

Equation 5. Employment status

6.2.1.3 Household Income

Income data collected from the survey are by income brackets. Therefore, to turn the categorical data into continuous form, the average of the upper bound and lower bound is assigned to each household as estimation. As explained previously, student households are excluded in the analysis of household income. However, for the purpose of modelling, the household income of students is assigned to "less than $29,999" in order to fill in missing data in a reasonable way.

$$Income_i = \frac{upper\ bound + lower\ bound}{2}$$

Equation 6. Household income

6.2.1.4 Age group

The age groups of observations are initially specified as dummy variables. Nevertheless, some age group variables are strongly correlated with other demographic variables, for example, age group 55+ and retired household. Thus, age groups are not used in the hedonic models.

6.2.2 Structural Variables

Structural variables are one of the most common variables applied in hedonic models. In this thesis, structural variables investigated include number of bedrooms, number of bathrooms, housing type and age of residence.

In some studies, the relationships between property values and some structural variables (number of bedrooms, number of bathrooms and age of residence) are hypothesized to be non-linear. Meanwhile, in this study, after plotting the three structural variables against the rental prices, their pair-wise relationships show some linearity. Therefore, number of bedrooms, number of bathrooms and age of residence are treated as continuous variables in the thesis, assuming that their relationships with the rental price are linear. This means that, keeping other variables fixed, the rent difference between a 2-bedroom and a 3-bedroom residence are assumed to be the same as the rent difference between a 3-bedroom and 4-bedroom residence.

6.2.2.1 Number of Bedrooms

Number of bedrooms is specified as bedroom number using survey data.

6.2.2.2 Number of Bathrooms

Number of bathrooms is calculated using the sum of number of full bathrooms and the number of half bathrooms divided by two. The number of half bathrooms is not used directly considering that a half bathrooms does not generate as much utility as a full bathroom. Therefore, the number of half bathrooms is divided by two as estimation to match with full bathrooms.

$$Bathrooms_i = full\ bathrooms + \frac{half\ bathrooms}{2}$$

Equation 7. Number of bathrooms

6.2.2.3 Housing Type

Housing types are specified as two dummy variables using survey data: whether the housing type is a high-rise apartment (>=5 storeys) and whether it is a low-rise apartment (<=4 storeys). Due to the small sample size of other housing types (single house, semi-detached house, townhouse and duplex apartment; 39[1] in total), they are omitted and set as the base group. The omitted housing types are named as "house" for the convenience of description in the following sections.

$$High-rise_i = \begin{cases} 1, & high-rise\ apartment \\ 0, & otherwise \end{cases}$$
$$Low-rise_i = \begin{cases} 1, & low-rise\ apartment \\ 0, & otherwise \end{cases}$$
$$House_i = \begin{cases} 1, & house \\ 0, & otherwise \end{cases} (base\ category)$$

Equation 8. Housing type

6.2.2.4 Age of Residence

Age of residence is calculated using the year of the survey (2016) minus the year the residence was built. As mentioned previously, not many respondents know the built year of their rental housing. Therefore, the property built year data from the Region of Waterloo (2015) is used to fill in data where there is no response and to validate reported built year. When the survey data does not match with the Region's data, the Region's data is used, assuming that the Region's data is more reliable. It should be noted that the Region's data could not be used solely because it does not include information for some newer buildings.

$$Age\ of\ Residence_i = 2016 - YearBuilt_i$$

[1] There are 6 duplex apartments of the 143 observations. Attempts were made to incorporate duplexes as a separate housing type category. However, it did not make a significant difference to the model results. In the end, duplexes are treated together with other housing types as the base group.

Equation 9. Age of residence

6.2.2.5 Living Area and Yard Size

Living area and yard size are important independent variables in many hedonic housing price models, but they are not used for models in this thesis. The living areas reported by survey respondents are extremely inconsistent and unreliable, varying from 10 sqft to 16,146 sq. ft. Moreover, using the building footprint data from the Region could only extract the living area of single houses; footprints for semi, duplex, townhouse and apartment are merged with nearby units, and could not be extracted. Yard size is not applicable to apartment renters, which account for 73% of the observations (n=143). Therefore, considering the complexity of the structural characteristics of rental housing, living area and yard size are not considered in the modelling.

6.2.3 Built Environment Variable - Walkability

A walkability Index, created in the Region of Waterloo's NEWPATH project (2009), is used as the only built environment variable in the hedonic models based on a data sharing agreement with the Region. The Walkability Index consists of 4 components, including connectivity, residential density, retail density and land use mix, which cover some of the very important built environment characteristics from the renters' survey (ease of walking, land use mix, and density of housing).

The Walkability Index is measured at a scale of PLUM zones[1]. Connectivity is measured by the intersection density within each zone. Residential density is the density of residential units in each area. Retail Density is the ratio of retail floor area in each buffer. Land Use Mix measures the evenness of the distribution of different land uses.

$$Walkability_i = Connectivity + Residential\ Density + Retail\ Density + Land\ Use\ Mix$$

Equation 10. Walkability index (Region of Waterloo, 2009)

[1] The Regions' Population and Land Used Model (PLUM) divide the Region into 2145 zones (Region of Waterloo, 2008b). These PLUM zones are more granular than CT and they respect the boundaries of CT. (Region of Waterloo, 2008b)

6.2.4 Sociodemographic Variables

Most data for sociodemographic variables are either supplied by Robert Babin (2016) or developed using his methods. Sociodemographic variables investigated include school quality, education rate, and perception of safety.

6.2.4.1 School Quality

The school quality variable is developed using the similar method developed by Robert Babin (2016) with the most recent school ratings from the Fraser Institute (2016). The ratings of public elementary schools are matched with the school catchments (Waterloo Region District School Board, 2015) in ArcGIS to represent the school quality of the corresponding school catchments. Considering the overlapping of catchments between public elementary school and public high schools, only the ratings of elementary schools are used. There also exists overlap between some junior and senior elementary schools. The junior elementary catchments are used in this cases becase they are generally smaller and could provide more precise school ratings.

6.2.4.2 Education Rate

The education rate variable is supplied by Robert Babin (2016). It is measured by the proportion of population with postsecondary education level or higher using Census Tract (CT) level data from Statistics Canada (2011b). The percentage values are very small and thus are magnified by multiplying them by 100. Thus, the education rate variable can be interpreted as the number of population with postsecondary education per 100 people. It should be noted that two CTs contain no postsecondary populations, which conflicts with some survey data. The fact that only 2011 census education data is available might have led to this result.

$$Education\ Rate_i = \frac{Population\ with\ postsecondary_i}{Population_i} \times 100$$

Equation 11. Education rate

6.2.4.3 Perception of Safety

The perception of safety value is also developed using the method developed by Robert Babin (2016), updated with the most recent police phone calls occurrence data from the Waterloo Regional Police Service (2015). There is a wide range of police calls, many of which did not report on safety issues. The Region of Waterloo's CTC monitoring project (2015b) explores different types of police calls and defines the categories that are related to potential public perception of safety. Using the same subset of police calls, the perception of safety of variable is measured as the number of safety related calls per 100 people using Dissemination Area (DA) level data from Statistics Canada (2011c).

$$Perception\ of\ Safety_i = \frac{Police\ Calls_i}{Population_i} \times 100$$

Equation 12. Perception of safety

6.2.5 Accessibility Variables

Most of the data for accessibility variables are supplied by Robert Babin (2016) and Jason Neudorf (2014). In their work, four equations are used to measure accessibility: spatial separation model, cumulative opportunities model, gravity-based model and adjacency calculation. Accessibility to open space is measured using all four models. Accessibility to transit is investigated using spatial separation model. Accessibility to employment uses cumulated opportunity model. Adjacency to regional road is calculated using the adjacency equation. In addition to these accessibility variables, two dummy variables are also developed using survey data: whether the observation is within CTC boundary and whether the observation is in Kitchener.

6.2.5.1 Measurements of Accessibility

In the spatial separation model, the accessibility of a property *i* is measured as the minimum distance from *i* to any opportunity *j*, multiplied by negative one. Therefore, a higher value represents a better access.

$$Accessibility_i = \min(distance_{ij}) * -1$$

Equation 13. Measurement of accessibility, spatial separation model

In the cumulative opportunities model, the accessibility of a property is the sum of opportunities within a distance which is less than the threshold distance.

$$Accessibility_i = \sum_{i=1}^{n} (Opportunity_j \mid distance_{ij} < threshold)$$

Equation 14. Measurement of accessibility, cumulative opportunities model

The gravity-based model is more complex than the previous two models; it accounts for both opportunity and distance. α and δ are decay parameters for the attractiveness and distance. For accessibility to open space, the attractiveness is measured by the size of open space.

$$Accessibility_i = \sum_{i=1}^{n} (Attractiveness_j^{\alpha} \times distance_{ij}^{-\delta})$$

Equation 15. Measurement of accessibility, gravity-based model

Adjacency is measured as a dummy variable. If the observation shares edge with the targeted accessibility amenity, the observation gets an adjacency value of one.

$$Adjacency_i = \begin{cases} 1, & sharing\ edges \\ 0, & otherwise \end{cases}$$

Equation 16. Measurement of accessibility, adjacency

6.2.5.2 Open Space Access

Accessibility to open space is estimated using all four models. In the cumulative opportunities model, there are two ways to measure the opportunity: the sum of open space areas and the number of open spaces within the threshold, as well as different threshold distances (e.g. 250m, 500m, 750m and 1000m). Throughout testing different sets of measurements, Babin (2016) found that using a 1000m threshold performs the best. In addition to using the three models, the accessibility to open space is also investigated in terms of adjacency. Properties that share edges with open spaces receive an adjacency value of one.

6.2.5.3 Employment Access

Accessibility to employment is calculated using cumulative opportunities model at the Traffic Analysis Zone (TAZ) level. A binary threshold is set in the measurement in order to account for the average commute cost. As a result, the generated variable represents the reachable number of jobs given average commute cost. The variable is supplied by Jason Neudorf (2014) using employment data from the Transportation Tomorrow Survey (TTS) (Data Management Group, 2006).

6.2.5.4 In Central Transit Corridor

To investigate the potential influence of renting in Central Transit Corridor (CTC), a dummy variable is developed for whether the observation is within CTC boundary.

$$In\ CTC_i = \begin{cases} 1, & contained\ in\ CTC\ boundary \\ 0, & outside\ of\ CTC \end{cases}$$

Equation 17. In Central Transit Corridor (CTC)

6.2.5.5 In Kitchener

Another dummy variable is developed for whether the observation is in Kitchener to better investigate the potential rent difference between Kitchener and Waterloo.

$$In\ Kitchener_i = \begin{cases} 1, & in\ Kitchener \\ 0, & in\ Waterloo \end{cases}$$

Equation 18. In Kitchener

6.2.6 Behavioural Variables

In addition to the common variable categories described above, 3 behavioural dummy variables are developed from the survey data to investigate the potential locational and behaviour influences, including renting type, housing type match and lease flexibility.

6.2.6.1 Renting Type

Although the rent for room rentals has been adjusted by the number of bedrooms, a dummy variable of whether the observation is renting a room is developed to measure the potential rent different between room renters and the rest.

$$Room_i = \begin{cases} 1, & \text{renting a room} \\ 0, & \text{otherwise} \end{cases}$$

Equation 19. Renting a room

6.2.6.2 Housing Type Match

As mentioned in the descriptive chapter, respondents were asked about their ideal housing types, and many of them prefer a type different from their current housing type. To better understand their stated preference, a dummy variable is created for whether the ideal and current housing type matches for the observations. For instance, if a respondent who is currently renting in a high-rise apartment states that his ideal housing type is still a high-rise apartment, this response receives a "1" for the housing type match variable. It is hypothesized that respondents currently paying higher rents are more satisfied with their housing type of choice, thus their ideal housing type would match their current housing type.

$$Ideal\ and\ Current\ Housing\ Type\ Matches_i = \begin{cases} 1, & \text{ideal housing type matches current housing type} \\ 0, & \text{otherwise} \end{cases}$$

Equation 20. Ideal and current housing type matches

6.2.6.3 Lease Flexibility

Some respondents mentioned that they received discount after a long-term lease. Therefore, a dummy variable is developed for lease flexibility to investigate whether a flexible lease is related to higher rent. A reported lease length of 12 months or shorter is considered as "flexible" and the corresponding observations receive a value of 1.

$$Flexible\ Lease_i = \begin{cases} 1, & \text{lease length of 12 months or shorter} \\ 0, & \text{otherwise} \end{cases}$$

Equation 21. Flexible lease

6.3 Summary Statistics of Candidate Variables

The candidate variables are summarized by variable categories in the following table. Their data sources and statistics are presented. Summary statistics of omitted base group are also reported.

Table 21. Summary of candidate variables (n=143)

Variable		Data Source	Mean	Min	Max	Standard Deviation
Candidate independent variables						
Rent ($)		Survey data	1,028.91	325	2,000	305.81
Adjusted rent ($)		Survey data	1,224.19	705	3,150	482.03
Logged rent		Survey data	6.89	5.78	7.60	0.33
Logged adjusted rent		Survey data	7.05	6.56	8.06	0.31
Candidate independent variables						
Household variables	Household with children (dummy variable)	Survey data	0.20	0	1	--
	One-person household (dummy variable)	Survey data	0.27	0	1	--
	Other household (dummy variable)	Survey data	0.21	1	1	--
	Couple without children (base category)	Survey data	0.32	1	1	--
	Retired household (dummy variable)	Survey data	0.12	0	1	--
	Student household (dummy variable)	Survey data	0.21	0	1	--
	Unemployed household (dummy variable)	Survey data	0.01	0	1	--
	Employed household (base category)	Survey data	0.66	0	1	--
	Household income ($)	Survey data	54,090.91	15,000	200,000	42,491.24
Structural Variables	Number of bedrooms	Survey data	2.17	1	6	1.08
	Number of bathrooms	Survey data	1.17	0	3	0.41
	High-rise apartment (dummy variable)	Survey data	0.35	0	1	--
	Low-rise apartment (dummy variable)	Survey data	0.38	0	1	--
	House (base category)	Survey data	0.27	0	1	--
	Age of residence	Survey data and data from the Region of Waterloo	42.03	2	136	27.53

Note: The summary statistics of dummy variables are interpreted differently from that of continuous variables. The mean of a dummy variable indicates its proportion among all categories. For instance, a mean value of 0.20 for household with children tells that 20% of the observations are households with children. Moreover, the mean (percentage) of different categories of one variable should add up to one. Using the example of housing type, mean of high-rise (0.35) +mean of low-rise (0.38) + mean of house (0.27) =1.

Variable		Data Source	Mean	Min	Max	Standard Deviation
Built environment	Walkability	Region of Waterloo NEWPATH project	-26.18	-1,000	10.59	165.81
Sociodemographic variables	School quality	Waterloo Region District School Board and Fraser Institute	4.90	2.30	7.10	1.13
	Education rate	Calculated by Babin (2016) using Statistics Canada data	51.58	0	70.25	11.42
	Perception of safety	Waterloo Regional Police Service	21.03	0	166.40	31.20
Accessibility variables	Open space access (spatial separation model)	Calculated by Babin (2016) using data from the Region of Waterloo	-219.13	-974.81	-0.52	210.20
	Open space access, count in 1000m (cumulative opportunities model)		11.93	1	34	7.47
	Open space access, area in 1000m (cumulative opportunities model)		450,873.08	26,409.34	1,163,879.14	275,297.02
	Open space access (gravity based model)		43.93	7.37	89.14	20.49
	Open space adjacency		0.24	0	1	0.43
	Regional road adjacency		0.24	0	1	0.43
	Transit access (spatial separation model)		-182.78	-816.81	-10	147.94
	Employment access (cumulative opportunities model)	Calculated by Neudorf (2014) using data from the Data Management Group	109,925.60	65,242	135,051	18,677.13
	In CTC (dummy variable)	Survey data	0.47	0	1	--
	In Kitchener (dummy variable)	Survey data	0.71	0	1	--
Behavioural variables	Renting a room (dummy variable)	Survey data	0.13	0	1	--
	Ideal housing type matches current housing type (dummy variable)	Survey data	0.28	0	1	--
	Flexible lease (dummy variable)	Survey data	0.48	0	1	--

6.4 Results of Spatial Regression Diagnostic

As mentioned in ***Section 5.4***, Moran's I could be used to suggest whether spatial regressions should be used in the model. Therefore Moran's I value is calculated using for the dependent variable of the model, adjusted rents from the survey. Results indicate that the adjusted rents generally exhibit low tendency towards clustering. ***Table 22*** below shows the parameters of the analysis. The Moran's I value is positive, falling close to 0, and the p-value of 0.001 indicates that the null hypothesis of random distribution may be rejected. In other words, the overall distribution of adjusted rents in KW is not random, but the autocorrelation is very weak. In this case, spatial regressions do not seem necessary to be applied to this model.

Comparing to the full sample, the mailing responses have a much lower Moran's I value and show a better sign of random distribution. This is expected and corresponds with the fact that responses collected through the mailing strategy shows a more unbiased representation compared to the census data than the full sample. Again, the strategy of using data collected through mailing only in the hedonic modelling analysis is supported. Model results of spatial regressions using GeoDaSpace are located in **Appendix B.**

Table 22. Moran's I statistics comparing mailing responses and full sample

	Mailing responses (n=143)	Full sample (n=286)
Moran's I value	0.1058	0.4190
E[I]	-0.007	-0.0035
p-value	-0.003	-0.001
z-score	4.1085	23.3096
Standard Deviation	0.0276	0.0189

Note 1: The analysis is conducted using GeoDa. **Note 2**: The spatial weight matrix used in the calculation of Moran's I is k-nearest neighbourhood where k=15. The result is based on a random permutation of 999, which recalculates the statistic 999 times to obtain a reference distribution.

Chapter 7. Model Specification and Results

Chapter Overview

After the pre-regression analysis, this chapter specifies the final model in detail and present the model results. First, bivariate analysis is conducted among various candidate variables to provide guidelines for variable selection. Based on the results, some candidate explanatory variables are dropped from the final model and they are summarized in

Table 33. Next, the final model specification is presented, followed by results of the model. As explained previously, survey data provides individual level demographic information that is not commonly used in hedonic models due to limited data availability. To further investigate the impacts of involving the disaggregated household information, a reference model is specified by excluding household and household behavior variables obtained from the survey from the final model. The two models are then compared in terms of their estimations and regression diagnostics.

7.1 Variable Selection: Bivariate Analysis

This section outlines bivariate relationships of candidate variables through correlation tables. Bivariate analysis is first conducted between the adjusted rent (dependent variable) and each candidate independent variable. The analysis results of built environment, sociodemographic and accessibility variables are presented together as neighbourhood variables in ***Table 25***. Then, pair-wise correlations are investigated by the categories of independent variable. A full correlation matrix of all candidate variables can be found in **Appendix C**.

7.1.1 Correlations between Dependent and Candidate Independent Variables

Most of the correlations signs between dependent and candidate independent variables match expectations. However, many neighbourhood variables have an unexpected negative correlation with the dependent variables, except for *school quality* and *open space access count in 1000m*. The correlations of the logged adjusted rent and adjusted rent are very similar.

Of all candidate independent variables, the *number of bedrooms* is most strongly positively correlated (0.79) with the *logged adjusted rent,* followed *by number of bathrooms* (0.69), *renting a room* (0.60), *other household* (0.50), *student household* (0.38) and *house* (0.32). *Low-rise apartment* (-0.45), *in Kitchener* (-0.40), *one-person household* (-0.33) and *employed household* (-0.31) have moderately negative correlations with the logged adjusted rents. Most neighbourhood variables have weak correlations (-0.3~0.3) with the dependent variables.

Table 23. Correlations between dependent variables and household variables

Demographic variables	Rent	Logged rent	Adjusted rent	Logged adjusted rent
Household with children	0.15	0.18	-0.11	-0.07
One-person household	-0.05	-0.01	-0.28	-0.33
Couple without children	0.28	0.29	-0.10	-0.06
Other household	-0.41	-0.51	0.53	0.50
Retired household	0.20	0.19	-0.02	0.01
Student household	-0.42	-0.47	0.44	0.38
Unemployed household	-0.05	-0.04	-0.08	-0.10
Employed household	0.24	0.28	-0.34	-0.31
Household income ($)	0.47	0.45	-0.05	0.02

Note 1: Except for the correlation between logged adjusted rent (dependent variable) and each independent variable, correlations between rent, logged rent and adjusted rent and each explanatory variable are reported as well as references.

Note 2: All correlations mentioned in the paragraphs are with the logged adjusted rent.

Table 24. Correlations between dependent variables and structural variables

Structural variables	Rent	Logged rent	Adjusted rent	Logged adjusted rent
Number of bedrooms	-0.18	-0.28	0.81	0.79
Number of bathrooms	0.04	-0.05	0.68	0.69
High-rise apartment	0.38	0.38	0.09	0.15
Low-rise apartment	-0.32	-0.24	-0.38	-0.45
House	-0.07	-0.14	0.31	0.32
Age of residence	-0.22	-0.22	-0.09	-0.13

Table 25. Correlations between dependent variables and neighbourhood variables

Neighbourhood variables		Rent	Logged rent	Adjusted rent	Logged adjusted rent
Walkability		0.03	0.04	-0.07	-0.09
School quality		0.15	0.11	0.12	0.15
Education rate		0.21	0.18	-0.10	-0.03
Perception of safety		-0.05	-0.04	-0.06	-0.07
Open Space Access	Spatial separation	0.22	0.23	-0.22	-0.19
	Count in 1000m	0.24	0.21	-0.03	0.02
	Area in 1000m	0.03	0.06	-0.10	-0.09
	Gravity-based	0.18	0.16	-0.10	-0.06
	Adjacency	-0.08	-0.07	-0.15	-0.16
Regional road adjacency		0.15	-0.08	0.15	-0.06
Transit access		-0.10	-0.07	-0.09	-0.06
Employment access		0.00	0.13	-0.04	0.14

In CTC	0.08	0.02	0.19	0.20
In Kitchener	0.14	0.21	-0.41	-0.40

Table 26. Correlations between dependent variables and behavioural variables

Behavioural variables	Rent	Logged rent	Adjusted rent	Logged adjusted rent
Renting a room	-0.65	-0.77	0.66	0.60
Ideal housing type matches current housing type	0.10	0.10	-0.04	-0.01
Flexible lease	-0.04	-0.01	-0.14	-0.14

7.1.2 Correlation between Candidate Independent Variables by Categories

The correlation matrixes are then presented by variable categories. *Student household* is moderately and positively correlated with *other household* (0.58), which corresponds with the fact that many students rent with people out of their census family (see ***Section 4.1.1.1***). *Household income* has a moderate positive correlation *with employed household* (0.35) and a moderate *negative correlation* with student household (-0.48), which is expected. Employed households generally have higher household income than student households. Correlations between categories of one variable (e.g. household type and employment status) do not make sense and are not reported in the following table.

Table 27. Correlations of household variables

Household variables	Household with children	One-person	Other household	Couple without children	Retired household	Student household	Unemployed household	Employed	Household income ($)
Household with children	1								
One-person	--	1							
Other household	--	--	1						
Couple without children	--	--	--	1					
Retired household	-0.18	0.21	-0.19	0.12	1				

d									
Student household	-0.21	-0.16	0.58	-0.17	--	1			
Unemployed household	0.09	0.06	-0.06	-0.08	--	--	1		
Employed household	0.28	-0.02	-0.35	0.09	--	--	--	1	
Household income ($)	-0.06	-0.05	-0.31	0.36	0.13	-0.48	-0.11	0.35	1

In terms of structural variables, the *number of bathrooms* and *number of bathrooms* are moderately and positively correlated (0.55). *Age of residence* is also moderately and negatively correlated with *high-rise apartment* (-0.38).

Table 28. Correlations of structural variables

Structural variables	Number of bedrooms	Number of bathrooms	High-rise apartment	Low-rise apartment	House	Age of residence
Number of bedrooms	1					
Number of bathrooms	0.55	1				
High-rise apartment	-0.13	0.17	1			
Low-rise apartment	-0.26	-0.31	--	1		
House	0.43	0.16	--	--	1	
Age of residence	0.01	-0.26	-0.38	0.12	0.27	1

In the case of sociodemographic variables, *school quality* has a moderate positive correlation (0.39) with *education rate*, which is expected. In the final model specification, only one of them is tested in the final model specification to control multicollinearity.

Table 29. Correlations of sociodemographic variables

Sociodemographic variables	Walkability	School quality	Education rate	Perception of safety
Walkability	1			
School quality	0.04	1		
Education rate	0.02	0.39	1	
Perception of safety	0.06	0.10	0.10	1

As expected, different measurements of open space access are somewhat correlated. Therefore, only one measurement of open space access could be in the final model to limit potential multicollinearity.

Table 30. Correlations of open space access variables

Open space access variables	Spatial separation	Count in 1000m	Area in 1000m	Gravity-based	Adjacency
Spatial separation	1				
Count in 1000m	0.48	1			
Area in 1000m	0.17	0.09	1		
Gravity-based	0.66	0.84	0.44	1	
Adjacency	0.42	0.11	0.02	0.30	1

Table 36 shows a subset of candidate independent variables that appeared to be correlated due to centrality in Babin's thesis (2016). *Employment access* and *in CTC* are the most correlated (0.35), indicating that city cores are associated with better access to employment. Overall, the correlations for the rental data are not as strong as Babin's findings as seen from ***Table 31***.

Table 31. Correlations of centrality related variables

Centrality related variables	In CTC	Transit access	Walkability	Employment access	Age of residence	Perception of safety
In CTC	1					
Transit access	-0.22	1				
Walkability	-0.08	0.01	1			
Employment access	0.35	-0.13	0.15	1		
Age of residence	0.11	0.06	0.14	0.29	1	
Perception of safety	0.20	0.05	0.06	0.30	0.07	1

Table 32. Correlations of centrality related variables in Babin's thesis (2016)

Centrality related variables	In CTC	Transit access	Walkability	Employment access	Age of residence	Perception of safety
In CTC	1					
Transit access	0.12	1				
Walkability	0.48	0.49	1			
Employment access	0.3	0.44	0.66	1		
Age of residence	0.49	0.36	0.68	0.6	1	
Population density	0.07	0.4	0.49	0.33	0.25	1
Perception of safety	0.37	0.09	0.34	0.26	0.38	-0.09

7.1.3 Dropped Candidate Independent Variables

Based on the bivariate analysis and some model testing, twelve candidate explanatory variables are decided to be dropped from the final hedonic model. The variables and the reasons for dropping them are listed in the table below.

Table 33. Summary of dropped candidate independent variables

Dropped candidate independent variable	Reasons for dropping
Couple without children	Omitted base category in household types
Employed household	Omitted base category in employment statuses
House	Omitted base category in housing types
Living area and yard size	Data limitation
Education rate	It is moderately correlated with school quality (0.39), which measures the similar dimension. Moreover, as explained previously, two CTs have education rate of zero, which is unrealistic.
Open space access (count in 1000m, area in 1000m and gravity-based)	Through different model testing, open space adjacency and open space (spatial separation) appear to be more significant than other measurements. Both of them are kept in the final model because they measure different dimensions of open space. Other candidates are dropped to control multicollinearity.
Employment access	Weak correlation with dependent variable (0.14); not significant in tested models.
In Kitchener	It is moderately correlated with many variables, including employed household (0.32), student household (-0.39), school quality (-0.39), education rate (-0.39) and renting type (-0.41). Therefore, in Kitchener is dropped to control multicollinearity.
Housing type match	Very weak correlation with dependent variable (-0.01); not significant in tested models.
Flexible lease	Weak correlation with dependent variable (-0.14); not significant in tested models.

7.2 Model Specification

Equation 22 shows the specification of the final model. It is developed from the general form of the hedonic model (see Equation 1). As explained previously in ***Section 6.4*** *(*Results of Spatial Regression Diagnostic*)*, the general hedonic model (OLS) is used since conducting spatial regressions is unnecessary in this thesis.

$$Y_i = \alpha + \beta_0 * Household + \beta_1 * Residential + \beta_2 * Neighbourhood + \beta_3 * Behavioural + \varepsilon$$

Equation 22. Final model

As explained previously (see 5.3.1), the functional form of the final model is decided to be log-level, with the dependent variable logged and independent variables remain untransformed. The vectors of household, structural, neighbourhood and behavioural variables are specified as follows:

$$Y_i = Logged\ adjusted\ rent$$

$$Household_i = \begin{bmatrix} Household\ with\ children_i \\ One-person\ household_i \\ Other\ household_i \\ Retired\ household_i \\ Student\ household_i \\ Unemployed\ household_i \\ Household\ income_i \end{bmatrix}$$

$$Residential_i = \begin{bmatrix} Number\ of\ bedrooms_i \\ Number\ of\ bathrooms_i \\ High-rise\ apartment_i \\ Low-rise\ apartment_i \\ Age\ of\ residence_i \end{bmatrix}$$

$$Neighbourhood_i = \begin{bmatrix} Walkability_i \\ School\ quality_i \\ Perception\ of\ safety_i \\ Open\ space\ access_i \\ Open\ space\ adjacency_i \\ Regional\ raod\ adjacency_i \\ Transit\ access_i \\ In\ CTC_i \end{bmatrix}$$

$$Behavioural_i = Renting\ type_i$$

Equation 23. Final model variables

It should be noted that, although some variables, such as *regional road adjacency* and *transit access*, do not have a strong correlation with the dependent variable nor do they appear to be significant in the final regression, they are still kept in the model. From a theoretical point of view, it is beneficial to cover variables from various categories in one hedonic model; some "unimportant" variables in this model have been commonly used in other hedonic literature. From a statistical aspect, adding these variables into the final model regression allows comparison with Babin's model results in terms of coefficients and significance level.

7.3 Model Result

The following sections detail the results of hedonic models using GeoDa. The final model is compared with the specification where household and behavioural variables are excluded. ***Table 34*** presents the detailed regression results, including significance level and estimated coefficients of each explanatory variable, as well as measures of model fitness. ***Table 35*** presents model indicators, including multicollinearity condition number and diagnostics for spatial dependence.

Table 34. Model results, comparing model with and without household and behavioural variables

Variable	Model: OLS estimation			Number of observations: 143		
	With survey variables Number of variables: 22			Without survey variables Number of variables: 14		
	Significance	Prob.	Coefficient	Significance	Prob.	Coefficient
CONSTANT	***	0.00000	6.4310200	***	0.00000	6.3741900
Household variables						
Household with children	*	0.01845	-0.0912397	--	--	--
One-person household	**	0.00809	-0.0853124	--	--	--
Other household		0.22324	-0.0575221			
Retired household		0.22055	-0.0492396	--	--	--
Student household	**	0.00912	0.1034060	--	--	--
Unemployed household		0.53568	-0.0605813			
Household income	***	0.00069	0.0000012	--	--	--
Structural variables						
Number of bedrooms	***	0.00000	0.1501560	***	0.00000	0.1628840
Number of bathrooms	***	0.00000	0.1802280	***	0.00002	0.2176490
High-rise apartment	*	0.04142	0.0782776		0.46087	0.0306563
Low-rise apartment	*	0.01538	-0.0838742	**	0.00555	-0.1062690
Age of residence		0.21110	-0.0006306		0.36688	-0.0005037
Neighbourhood variables						
Walkability		0.13085	0.0001116		0.26295	0.0000932
School quality		0.51476	0.0074620		0.23932	0.0150745
Perception of safety		0.08648	-0.0007081		0.21023	-0.0005735
Open space access		0.48306	-0.0000481		0.07558	-0.0001326
Open space adjacency		0.05175	-0.0611496		0.0808	-0.0616748
Regional road adjacency		0.23193	0.0361045		0.58768	0.0183836
Transit access		0.80290	-0.0000217		0.68702	0.0000375
In CTC	**	0.00650	0.0747787	*	0.01869	0.0713147
Behavioural variables						
Renting a room	*	0.04335	0.1203930	--	--	--
Measures of fit						
R^2	0.850556			0.792523		
Adjusted R^2	0.824619			0.771614		
Log Likelihood	98.9561			75.4972		
AIC	-153.912			-122.994		
Schwarz criterion	-88.7297			-81.5145		

Significance level: *P<0.05, **P<0.01, ***P<0.001. Generally, a probability smaller than 0.05 suggests rejection of the null hypothesis of coefficient = 0.

Table 35. Model indicators

Test	Model with survey variables		Model without survey variables	
	Value	Prob.	Value	Prob.
Multicollinearity condition number	28.568462	--	22.894821	--
Diagnostics for spatial dependence For Weight Matrix: k-nearest neighbourhood k=15, row-standardized weights				
Moran's I (error)	-0.9961	0.31921	0.2431	0.80789
Lagrange Multiplier (lag)	2.0813	0.14911	0.3117	0.57662
Robust Lagrange Multiplier (lag)	0.885	0.34683	0.775	0.37867
Lagrange Multiplier (error)	1.9379	0.1639	0.1995	0.65511
Robust Lagrange Multiplier (error)	0.7416	0.38915	0.6628	0.41557
Lagrange Multiplier (SARMA)	2.8229	0.24378	0.9745	0.6143

7.3.1 Model Performance Comparison: with and without Survey Variables

Both models have a R^2 higher than 0.75, indicating that over 75% of the dependent variable variation could be explained in the model. By excluding household and household behavioural variables in the second model, R^2 dropped from 0.850556 to 0.792523, suggesting that the explanatory power of the independent variables in the second model is lower than that of the first model and the first model is a better fit of the data. Moreover, 4 out of 7 household variables turn out to be significant in the first model, which also states the necessity of including the individual household information in the model. Meanwhile, even though the survey "exclusive" variables are left out, the second model still has much of its variation explained, showing that many important variables are already included in the model.

As to multicollinearity, the condition numbers of both models are under 30, suggesting that the correlation between explanatory variables has been well controlled in the estimation. The multicollinearity condition number of the first model (28.568462) is higher than that of the second model (22.894821). Generally, the more independent variables in a model, the higher the condition number is. The variance inflation factor (VIF), another measurement of multicollinearity, is also calculated, and the results also indicate that there is no significant multicollinearity issue in the model.

In terms of coefficient estimations, the biggest difference is the estimated coefficient for high-rise apartment: the estimations is lower in the second model (0.0306563) than in the first model (0.0782776) High-rise apartment loses its significance in the second model, while low-rise apartment

becomes more significant. In CTC also becomes less significant in the second model when survey variables are excluded. The differences of model results indicate that different respondent groups may have different preferences for residential and neighbourhood characteristics. Therefore, it is necessary to account for the potential influence of demographics by including household variables in the model. When these variables are excluded, too high of a contribution to value may be attributed to structural characteristics.

For both models, the diagnostics for spatial dependence do not show significant results for either spatial lag or spatial error. This is consistent with the result of Moran's I (see Section 5.4), indicating that the null hypothesis of a standard linear regression specification (OLS) cannot be rejected. Therefore, although spatial models were planned to be implemented initially, they were deemed unnecessary. Comparing the non-spatial and spatial models (see **Appendix B** for spatial model results), the results are very similar. The directions of estimated coefficients remain the same, while the significance levels of some variables change. The spatial model generally fits slightly better, with a higher log likelihood and a lower AIC.

7.3.2 Significant Results from the Model

All numbers reported in this section come from the first model (with household and household behavioural variables). Among all 21 independent variables (CONSTANT excluded), 10 appear to be significant ($p<0.05$). Household income, number of bedrooms and number of bathrooms are the three most significant independent variables ($p<0.001$). Most household and structural variables are significant, while only one neighbourhood variable (in CTC) is significant. The impacts of significant variables are summarized in the following table.

Table 36. Contributions of effects of significant variables

Category	Significant variables	Direction of effect	Effect per unit increase
Household variables	Household with children	-	-9.12397%
	One-person household	-	-8.53124%
	Student household	+	10.34060%
	Household income	+	0.00012%
Structural variables	Number of bedrooms	+	15.01560%
	Number of bathrooms	+	18.02280%
	High-rise apartment	+	7.82776%
	Low-rise apartment	-	-8.38742%
Neighbourhood variable	In CTC	+	7.47787%
Behavioural variable	Renting a room	+	12.03930%

Household variables play an important role in the final model. Four household variables appear to be significant in the model results: household with children, one-person household, student household and household income. $10,000 increase in household income is associated with a 1.2% increase in rental price. In light of household types, households with children are estimated to pay 9.1% less rent than couples without children, while one-person households are estimated to pay 8.5% less. In terms of employment status, student households are estimated to pay 10.3% more in comparison to employed households with the same levels of other variables.

Structural variables are also important in the final model. Number of bedrooms and number of bathrooms appear to be two of the most significant factors (***; $p<0.001$). The model estimates 15.0% and 18.0% increase for each additional bedroom and bathroom, respectively. As to housing types, the monthly rent of high-rise apartments are estimated to be 7.8% higher than houses, whereas low-rise apartments are estimated to rented for 8.4% less than that of houses.

Only one neighbourhood variable (In CTC) is significant in the model result. Rents of housing located in CTC are estimated to be 7.5% higher than those located outside CTC. The only behavioural variable, renting a room, is also significant. Households renting rooms are estimated to pay 12.0% more than those renting a whole house or apartment.

7.3.3 Interpretations of Multi-Category Dummy Variables

As explained in ***Section 6.2***, the estimated coefficients of dummy variables can be interpreted relative to the base category. In fact, their pair-wise relationships could also be revealed through comparing the estimated difference between any two groups. Using the example of household type variables, households with children are estimated to pay 9.1% less rent than couples without children, and one-person households are estimated to pay 8.5% less. Then, the estimated difference, 9.1%-8.5%=0.6%, means that household with children pay 0.6% less than one-person households. It should be noted that although "other household" is not significant in the model result, it is still compared with the rest of household type dummies in terms of their coefficients. Moreover, the significance level of the base category (household without children) could not be identified through the model result.

Household Type

According to hedonic model result, rents for couples without children are the highest, followed by other household, one-person household, and household with children. This roughly corresponds with the statistically analysis (see ***Table 16***), where other households pay higher price on average ($1310) to rent a house/apartment and one-person household have the lowest average rent ($1035). However, the model showing that households with children actually pay the lowest rents is still a little surprising. Considering that the rent in the model has been adjusted by number of bedrooms, it could be because households with children potentially have more persons per bedroom than other household types, and they pay less rent overall as one household.

Employment Status

The model also result shows that student households pay the highest rent, followed by employed households, retired household and unemployed household. The higher rents for student households could be related to the potential inelastic demand for proximity to school and transit for students. According to the descriptive analysis, students prioritize the accessibility to campus and public transit in their renting decision. Therefore, their demand for proximity is less likely to be influenced by higher rental prices. On the other hand, student renters might be the less preferred renter group for landlords in the rental housing market. As a result, student households may have to pay higher rent

in order to be accommodated. Finally, it is also possible that rents in the student market are not fully competitive, due to the relatively small number of student rental companies.

Housing Type

The model also result shows that high-rise apartment is the most expensive to rent, followed by houses and low-rise apartment. This is expected because high-rise apartments are generally in newer buildings with better room conditions and amenities.

Chapter 8. Conclusions and Recommendations

Chapter Overview

This chapter summarizes thesis findings, presents recommendations and suggests next steps and areas for future work. The first section uses findings of the descriptive analysis and modeling results to answer the research questions. The next section presents some general discussion in survey design, followed by finding-based planning implications for planners, developers and government agencies. Finally, this chapter concludes with challenges, limitations and suggestions for future work.

8.1 Research Questions and summary of findings

The following sections summarize findings of the research questions raised in ***Chapter 1 Introduction***.

8.1.1 Objective 1: To understand the structure of demand in the current rental market in KW

8.1.1.1 What are the distributions of renter subgroups in terms of household type, age group, household income and employment status?

The distributions of the different resident subgroups are summarized in the table below. Mailing responses are used in order to provide a more representative distribution of census data. As to spatial distributions, student households are found to show some spatial clustering in Waterloo, especially around the two local universities. A similar pattern also applies to "other household" and the 18-24 age group, which is mainly because the three categories overlap with each other very much. Except for students, the distributions of other subgroups do not show notable clustering in space.

Table 37. Summary of distributions of respondent and household groups (mailing responses only)

	Category	Percentage
Household type (n=176; 100%)	Couple with children	10%
	Couple without children	28%
	Lone-parent family	13%
	One-person	28%
	Other	22%
Age group (n=147; 100%)	18-24	19%
	25-34	39%
	35-54	19%
	55 & 55+	22%
Household income bracket (n=136; 100%)	Less than $29,999	23%
	$30,000-$49,999	26%
	$50,000-$74,999	21%
	$75,000-$99,999	15%
	$100,000-$249,999	15%
Employment status (n=154; 100%)	Employed	66%
	Retired	12%
	Student	20%
	Unemployed	2%

8.1.1.2 What are the differences and competition among renter subgroups?

Throughout the statistical analysis, couples with children, senior and students seem to stand out among all different subgroups. The features of these three groups are summarized below, covering their residential location choices and renting behaviours.

Couples with Children

Couples with children are generally considered a target market for medium-low density dwellings, with strong desire towards single-detached houses with a medium-small yard. At the time of the study, couples with children have a higher proportion living in single-detached houses (22%) than any other resident group. They also have the greatest desire towards renting a house in comparison to any other household type (63% for single-detached houses, 19% for row houses and 11% for semi-detached houses). The ideal housing size for couples with children is generally larger than that of other groups; many of them prefer a residence of 1500 sq. ft. or larger. In light of yard size, medium and small yards are ideal to most of the couples with children. In terms of number of bedrooms, although most couples with children are currently living in 2-bedroom or 3-bedroom residences, they generally prefer residences with 3 or 4 bedrooms. 2-bedroom residences are actually not very ideal to them especially considering their family size. As to neighbourhood characteristics, school quality and accessibility to school are prioritized in the location choice decision of couples with children when considering children's education. This also applies to lone-parent families.

Retired Households

Retired households are generally seniors aged 65 years or older (80%). They could be considered a target market for high-density dwellings. Most retired households are living in apartment buildings at the time of the study. Generally, retired respondents prefer apartments to houses, and they are mostly attracted to patio, deck or balcony instead of a yard. Important as rental price is, retired households are more concerned with residential characteristics such as central air conditioning, availability of parking and ease of maintenance. Ease of walking and traffic noise are also regarded as important by responding seniors. In terms of accessibility characteristics, most senior households consider accessibility to retail and services, open space, urban center and distance to family/friends

as important in their location choice decision. In fact, 55% of them indicate that they have been motivated to move to their current residence by better accessibility to retail and services. Compared to other groups, retired households are less concerned about school quality, accessibility to school or work, as well as commuting time and cost. This is in line with their retirement living style.

Students

Most student households are aged 18-24 in an "other household". Many university students moved to KW to attend school; therefore, they are more likely to rent and live with people outside of their census family. Some of the students are non-Canadian-born, and they are generally newer to Canada, with an average arrival year of 2008. Similar to senior households, students are a target market for high-density dwellings as well. They generally prefer apartments to house. They are also more attracted to patio, deck or balcony and small yard. According to survey result, most 5-bedroom residences are occupied by students; meanwhile, student households generally prefer 2-bedroom and 3-bedrrom to 5-bedroom residences. In light of residential and neighbourhood characteristics, student households find ease of walking, school quality, accessibility to school and accessibility to bus stops very important. In fact, 40% of student households note that better accessibility to transit has motivated them to live in their current residence. Student's high valuation of accessibility to transit and school could be reflected on the concentration of student renters in the "Columbia/Lakeshore Neighbourhood", where two universities are located. Different from any other resident group, students are more frequent movers, and they account for most surveyed subtenants.

8.1.2 Objective 2: To investigate the relationship between renters' preferences and urban residential pattern.

8.1.2.1 What are renters' preferences for residential and neighbourhood characteristics?

Important residential and neighbourhood characteristics are summarized in the table below. It includes all accessibility variables listed in the survey questionnaire.

Table 38. Summary of important residential and neighbourhood characteristics

Categories		Important characteristics
Residential characteristics		rental price, ease of maintenance, housing type, size of room/residence, number of bedrooms, availability of parking, flexibility of lease/contract, number of full bathrooms, central air, private bathroom
Neighbourhood characteristics	Built environment	ease of walking, traffic noise, land use mix, ease of cycling, density of housing
	Socio-demographic	safety level/crime rate, school quality, similarity of education level, similarity of age
	Accessibility	commuting time, accessibility to workplace, commuting cost, accessibility to retail and services, accessibility to school public, accessibility to open space, distance to family/friends, and distance to highway exits

Note: Characteristics listed in this table are characteristics with an average importance value of 3.0 or higher, sorted from largest to smallest. The mean values are calculated based on a scale of 1 (not at all important) to 5 (very important) rated by survey respondents. For more details, see **Figure 16** and **Figure 17**.

8.1.2.2 How do renters' current residences compare to their ideal location in terms of residential characteristics?

The current and ideal characteristics are compared in terms of housing type, number of bedrooms and built year range. Since actual housing size and yard size of renters' current residences are not available, only ideal housing size and yard size are summarized. Ideal yard sizes of renters are also compared with those home owners using Emma DeFields' (2013) data. More detailed comparisons by respondent and household characteristics can be found in ***Section 4.3 Residential Location Choice***.

Housing type

Housing type is generally perceived as an important residential characteristic. According to the survey results, low-rise apartments and high-rise apartments represent the greatest proportion (69%) of rental housing in KW, with low-rise greater in Kitchener and high-rise greater in Waterloo. Similarly, the most preferred housing type is also apartment, with high-rise apartment and low-rise apartment ideal to 27% and 20% of survey respondents. Although only 12% respondents are currently living in single-detached houses, 35% consider single-detached houses as most ideal.

Many respondents prefer a different type of rental housing than their current housing type. For respondents currently renting in semi-detached houses, row houses and duplexes, single-detached appear to be the most ideal. Meanwhile, respondents who are renting in single-detached houses and apartments seem to be more satisfied with their current choice of housing; they generally find the current housing type the most ideal.

Number of bedrooms

Number of bedrooms is another essential structural characteristic in the renting decision of respondents. The reported number of bedrooms ranges from 1 to 7, with 2-bedroom residence being the most common type. 5-bedroom residences represent 21% of the rental housing, but they are mostly occupied by students. In terms of ideal homes, respondents generally prefer 2-bedroom and 3-bedroom residences, while rental housing of 5 bedrooms or more are not very ideal.

Built year rage

Age of residence is generally perceived as unimportant and many renters do know the age of their residences. The reported built years range from 1890 to 2016, with high-rise apartments and row houses being newer while duplex and single-detached houses being older. Similarly, many respondents do not have an ideal built year. For those who indicate a preference, newer residences built since 2010 seem more ideal.

Ideal housing size

In respondents' renting decision, housing size is generally considered an important residential characteristic. A housing size of 1000-1499 sq. ft. is the most ideal, followed by a smaller size of less than 1000 sqft, and a larger size of 2000-2499 sq. ft. Houses with a size of 2500 sq. ft. or larger are generally not vey ideal.

Ideal yard size: Renters vs. Home Owners

Emma DeFields (2013) conducted a survey in 2012 with households living in KW with private yards and asked questions regarding yard landscaping and maintenance practices and property

preferences. The majority of DeFields' respondents are home owners (96%). DeFields' findings are compared with the renters' survey in terms of households' ideal yard sizes to investigate the potential similarities and differences between home owners and renters.

Through comparison, it generally shows that renters generally prefer a smaller yard than home owners. Renters find patio, deck or balcony the most ideal yard size, followed by small yard and medium yard. Some renters indicate that they do not want any outdoor space, and not many prefer yard or very large yard size. Meanwhile, according DeFields' survey, home owners generally prefer having a home with a yard of medium-to-large size. Some find a patio, deck, or balcony ideal, but only very few respondents prefer having no outdoor space. This observation applies to different respondent and household groups. In the case of retired households, most retired renters find patio, deck or balcony very ideal, meanwhile retired home owners prefer small yards the most.
The fact that renters prefer a smaller yard is expected. It is because convenience and responsibility are two of the biggest reasons that renters chose renting instead of buying according to the survey result (see ***Section 4.4.5***). In comparison to home owners, renters would prefer to live with a smaller yard for less responsibility of maintenance. In the meantime, many responsive renters are living with people out of their census family, which might have made their yard maintenance more difficult and complex to organize within the households.

8.1.2.3 How do different household, residential and neighbourhood characteristics influence rental price? Are renters willing to pay for neighbourhood characteristics?

According to hedonic model results, many household and structural variables are associated with rental prices. Rents for couples without children are the highest, followed by other household, one-person household, and household with children. Student households pay the highest rent, followed by employed households, retired household and unemployed household. Higher numbers of bedrooms and number of bathrooms are associated with higher rental prices, which is consistent with expectations. As to housing types, a high-rise apartment is the most expensive to rent, followed by houses and low-rise apartment.

In addition, hedonic model results show that neighbourhood variables are not strongly associated with rental prices, which is consistent with the fact the most neighbourhood variables are weakly correlated with rental price. Living within CTC area is estimated to be the only significant neighbourhood variable in the model result. Rents of housing located in CTC are estimated to be 7.5% higher than those located outside CTC.

8.1.3 Objective 3: To understand renters' renting behaviours and the renting process

8.1.3.1 What factors have motivated renters to move to their current residence and neighbourhood?

Affordability is the most important motivation in renters' renting decision, followed by better accessibility to facilities (shopping and services), better accessibility to transit, better neighbourhood environmental quality, getting a new job, downsizing and upsizing.

8.1.3.2 How do renters rent?

Most respondents have a rental lease of 12 month or shorter lease length. As to how they normally find rental information, various online and off-line sources have been used. Except for Kijiji being the most popular web source, other online information comes from social media, housing company's websites, Google search and Craigslist. Off-line rental information sources generally include word of mouth, housing agents, rent signs, newspapers and street advertisements/posters. On average, each respondent spent 6 weeks and visited about 3 places before making their final decisions.

8.1.3.3 What are renters' attitudes towards buying a home?

Renters generally do not plan to be renting forever, and many of them (75%) are planning to buy a home in the future. However, affordability, convenience and responsibility are the three biggest concerns that motivated renters to choose renting instead of buying. Many respondents indicate that renting meets their short-term housing needs and makes it easier when they move. The convenience of the renting process versus buying process also attracts some people to rent. In fact,

24% of the renters used to be home owners, and many of them choose renting during the survey period for less responsibility and downsizing.

8.1.4 Objective 4: To investigate the potential influence of the pending development of LRT on the rental market in KW.

8.1.4.1 What are renters' general attitudes towards CTC and LRT?

Survey respondents generally hold neutral attitudes towards the up-coming LRT system in KW, with those renting inside the CTC area slightly more positive than those living outside. Currently, there are slightly more respondents (54%) renting inside the CTC area, and the percentage is higher in Waterloo than in Kitchener. Meanwhile, not many (21%) have considered residences inside the CTC area during their search process. Except for the fact that some people may have little knowledge of CTC boundary, higher rental price within CTC area and LRT construction noise have also influenced their location decision. The hedonic model result demonstrates that renting in CTC is estimated to be 7.4% more expensive than renting outside CTC, keeping other variables fixed.

On the other hand, many factors of LRT still seem appealing and may make renters more likely to rent inside the CTC area in the future, including fast speed, on-time arrival, avoiding traffic congestion and saving driving cost. Many respondents indicate that they might use the LRT system for social activities and school/work activities. Meanwhile, there is a group of people noting that they will not use LRT for any trip purposes (19%) and finding LRT not at all important at all in their future location choice decisions (22%). Furthermore, some of these people state that they are used to driving and do not normally use public transit.

8.2 Discussion on Survey

8.2.1 Low Response Rate of Mailing

Overall, the survey has a 6.4% response rate of the mailing approach, which is lower than the response rate of 16.8% in DeFields' survey conducted in 2013. Several reasons might have led to

the lower response rate. According to the Tailored Design Method suggested by Dillman (2000), there are five key elements to obtain high response rates: “(1) a respondent-friendly questionnaire, (2) up to five contacts with the questionnaire recipient, (3) inclusion of stamped return envelopes, (4) personalized correspondence, and (5) a token financial incentive that is sent with the survey request” (p. 150). This guideline was followed wherever possible in the survey design and recruitment process. However, due to the time and budget constraint of this study, some key elements could not be met, which might have contributed to the low response rate. On the other hand, researchers have found that survey response rates have been declining throughout years (Sinclair, O'Toole, Malawaraarachchi, & Leder, 2012).

8.2.2 Recruitment Strategy and Survey Incentive

In this thesis, three major approaches were implemented to recruit survey participants: mailing, Facebook posting and contacting Neighbourhood Associations. The mailing approach recruited 60.7% of the 290 responses while Facebook posting recruited 31%. Although social media is an effective and low-cost recruitment channel, the overrepresentation of student households of the full sample demonstrates that recruiting through social media might introduce unexpected bias. In the end, the over sampling of student households is alleviated in responses recruited through the mailing strategy. The mailing responses generally show a more unbiased representation of the census in terms of many household characteristics, including household types, age groups, birth places and ethnicity as well as housing types. Even the “hard to reach” senior group is well represented in mailing responses.

Meanwhile, some household characteristics are not well represented in the survey responses regardless which recruitment strategy is used. These include sex ratio, education level and income level. The choice of incentive, a fitness tracker, might have contributed to a higher ratio of females given that the incentive might be more appealing to females than males. As to the underrepresentation of respondents with education level of lower than high school and the overrepresentation of graduate respondents, it is possible that potential participants with an education level lower than high school are less likely to complete the questionnaire due to lower literacy. The same reason might have also led to a lower response rate of low-income households. Low-income households might also have less spare time for participation in the survey since they spend more time working.

8.3 Planning Implications

The findings of this thesis generate four potential implications for planners, developers, and government agencies. The four recommendations include: to develop rental housing related policies, to increase the variety of rental housing options, to monitor the development of rental housing geared at students, and to promote social inclusion and integration within renters

8.3.1 Develop Rental Housing Related Policies

A primary planning implication of this research is to develop rental housing related policies. According to the overview of local planning policies, there exists a gap of planning policies focused on the rental housing market; nothing at a policy level is specifically geared towards renters or rental housing. Meanwhile, the complexity of the rental market unveiled by this study demonstrates the necessity of developing rental housing related policies. On one hand, affordability was a big concern for respondents currently renting outside CTC area. According to survey results, very few (21%) respondents renting outside CTC indicated that they have considered residences inside CTC during their search process, and higher rental price, noise level and on-going LRT construction made them less willing to rent inside the CTC area. The results of the hedonic rental price model actually estimate a 7% higher rental price within CTC. Therefore, providing or developing affordable rental housing within the CTC area for intensification could be a challenge for the local governments. Except for developing relevant policies to keep monitoring rental price increase, the governments could also consider providing affordable rental housing outside the CTC area, considering that not every renter desires or could afford living within CTC. Further research and investigation is needed regarding the relationship between CTC and rental housing intensification.

On the other hand, survey results clearly show that renters have a variety of visions regarding their ideal housing type just like homeowners. Instead of forming a homogeneous group, renters are divided in to different subgroups (students, seniors and families), and different renter groups may have different preferences for housing and neighbourhood characteristics. Future rental housing policies should take these diverse preferences into consideration. There is no one rental housing strategy suitable for all renters considering their heterogeneous preferences. Separate strategies need to be developed for each group to accommodate their unique housing needs.

Student renters and seniors have some similarities in terms of housing and locational preferences. Both groups generally prefer apartments to houses. A patio, deck or balcony also appears to be their most ideal yard size. Both students and seniors find a rental housing of 1499 sq. ft. or smaller the most ideal. Although they share similar preferences towards structural characteristics, the ideal neighbourhoods of students and seniors do not appear to be the same. While students prioritize accessibility to school and transit, seniors do not used public transit very much, and they consider the ease of walking, accessibility to retail, services and urban center as important in their location choice decision. Therefore, the aging population could be a market for high-density rental housing. The ideal locations could be potentially within the CTC, considering senior's high valuation of amenities. However, given senior's low transit usage, some seniors may prefer lower cost locations outside the CTC, if they would also provide them desired access to amenities.

Couples and lone-parent families are very different from student and senior renters. Families or future families generally prefer houses to apartments considering their larger household size. Among all, couples with children have the strongest desire towards a home of 1500 sq. ft. or larger. Families also prefer more bedrooms in the residences than other groups, and medium to small yards are the most ideal. In terms of neighbourhood characteristics, school quality is prioritized in their location choice decision considering their children's education. Although families find single-detached houses the most ideal, affordability could be an issue, especially for houses located within CTC considering the higher rental prices. Instead, it could be more affordable to provide rental housing appealing to this group outside the CTC, in conjunction with the nodes and corridors that provide good accessibility to transit and services.

8.3.2 Increase the Variety of Rental Housing Options

Findings of this research support the necessity of providing a variety of rental housing options in the local market, which is in line with the objective of "plan for an appropriate range and mix of housing choices" in the Regional Official Plan (2015). According to survey results, renters in KW are currently living in different types of housing, ranging from houses to apartments, and form low-rise to high-rise. However, some rental housing types appear to be over dominant in the market comparing to others, such as high-rise and low-rise apartments as well 1-2-bedroom units. Moreover, a potential lack of single-detached houses and 3-bedroom residences in the local rental market is also suggested by the survey results. Therefore, the local government should work towards providing a better mix of

rental housing options to accommodate the special needs of different renter groups, especially for groups such as family renters.

While only a few renters are living in single-detached houses at the time of the survey, they generally find single-detached houses very ideal. Couples with children and couples without express the strongest desire towards renting a single-detached house, although most of them are living in apartment buildings. Couple families, especially young couples, may be planning to expand their family size in the future. For them, single-detached houses are deemed to provide a larger living area and at least some yard space than other housing types. The notable difference between current and ideal housing type for couple families indicate a lack of single-detached houses in the rental market. Meanwhile, proposing to build more single- detached houses for rental is not very realistic, considering the high development cost and potential higher rental prices. On the other hand, townhouses, with relatively lower building costs, could also provide some private open space and a larger living area than apartments and. In this case, townhouses could be promoted as close substitutes to single-detached houses for family renters.

Beyond the fact that there may be fewer single-detached houses in the rental market, the quality of the existing houses may also hold back couple families from choosing a single-detached house over a newly built apartment with good amenities. The reported built year of single-detached houses is 1946 on average, while the averages of low-rise and high-rise apartments are 1979 and 1997, respectively. Therefore, landlords of single-detached houses could also consider renovating old houses to improve their overall quality and to attract more potential tenants. This recommendation also applies to duplex apartments, which are generally the least desirable units.

Currently, 3-bedroom residences only account for a small proportion of the rental housing market. Meanwhile, couples with children and lone-parent families both indicate very strong preferences towards renting a 3-bedroom residence. They generally have more household members than other household types. Considering their different household structure, the most common type, 2-bedroom residences, might not satisfy the needs of households with children. Therefore, developers should consider building more 3-bedroom apartments or houses targeting at households with children.

8.3.3 Monitor the Development of Rental Housing Geared at Students

The third planning implication of this thesis is to keep monitoring the development of student rental housing, which is in line with the City of Waterloo's Official Plan (2016). This may result in a higher vacancy rate for older student housing that are not as nice and as close. In Waterloo, more than 1,800 beds of student housing were completed in 2016, which has exceeded the student housing demand (CMHC, 2017). Another 1,400 were also under construction at the end of 2016. The student housing surplus has generated a series of issues in the rental housing market. From survey results, there are multiple signs showing that student renters in Waterloo may be shifted towards living in newer buildings with modern amenities and closer to campuses. Surveyed students appear to be clustering around the campuses, and they are more attracted to apartments with good accessibility to transit. This leads to a higher vacancy rate in older student buildings that are not as nice and as close to school. For government agencies and planners, it is important to monitor the development of rental housing geared at students to prevent further student housing surplus. Potential housing development policies could be introduced. The government may consider encouraging older student housing to remarket at nonstudent renters, like families, in order to keep a healthy and more balanced market. On the other hand, developers and realtors could also target more of the condominium projects to population groups other than students, such as young professionals.

8.3.4 Promote Social Inclusion and Integration within Renters

Findings of this research show that renters in KW form a very inclusive and integrated group. According to survey results, responding renters seem to be quite tolerant to the diversity of their neighborhood households. When asked about the importance of socio-demographic characteristic in their renting decision, over 30% of the respondents indicate that the similarity of ethnicity, education level, age, household income and household size to themselves are not important. Although survey respondents have various ethnic backgrounds, the similarity of ethnicity to themselves is marked as the least important socio-demographic characteristic, with “not important” and “not at all important” chosen by 23% and 45%. The inclusion and integration found within renter group also meet the objectives of “plan for an older and more culturally diverse population” and “promote social inclusion and improve access to human services” in the Regional Official Plan. Potential future research could focus on investigating the communication and interaction between renters and their neighbourhood

households. This will help measure and further understand the sense of communities for these temporary residents.

8.4 Limitations

This section outlines the limitations of this research in terms of the renters' survey and the hedonic modelling.

8.4.1 Survey

8.4.1.1 Conducting the Survey

Social media could be a very effective recruitment strategy if the targeted survey sample is only students or younger generations. However, when the targeted sample is the whole population covering all census groups (like in this study), social media might not be the best channel to obtain unbiased responses. Instead, the mailing approach is more promising even though the process can be expensive and time consuming. In future work, offering multiple incentive options of the same value could be considered. If the invited households have multiple choices, the attractiveness of the incentive will be equal across different demographics.

8.4.1.2 Underrepresentation of Renters with Lower Education Level

Overall, survey respondents have a higher level of education than the census. Respondents with an education level of lower than high school are underrepresented; only one respondent has received an education level of lower than high school. Potential participants with an education level lower than high school may be less likely to complete the questionnaire due to lower literacy and less free time. This indicates that the survey results may not be able to reflect the preferences and needs of renters with lower education levels.

8.4.1.3 Rental Housing Address Collection on Kijiji

The rental housing addresses for mailing were collected through Kijiji. Although the survey results show that Kijiji cover a fair amount of rental housing advertisements, some rental addresses exclusive to other sources may be missed, such as rental housing only listed on Craigslist.

8.4.1.4 Answers to Ideal Questions

The answers to ideal questions may not reflect the “true” preferences of respondents. There exist respondents indicating that their ideal housing is an apartment with a large yard, which is unrealistic in reality. However, this kind of “unreliable” response could not be validated.

8.4.2 Model

8.4.2.1 Data Limitations

Due to data limitations, some theoretically important variables are not included in the hedonic price model, such as living area and yard size. If living area data is available, using rent per sq. ft. as the dependent variable may generate better model result.

8.5 Future Work

This section presents some directions of potential future work.

8.5.1 Discrete Choice Model

Hedonic regression theory is based on an assumption of homogeneous preferences, where different households have the same preferences for residential and neighbourhood attributes. However, in reality, different types of households may value characteristics differently, which could not be reflected through the estimations of hedonic models. In future work, discrete choice model should be

considered, which could describe, explain and predict housing choices of different types of households. The small sample size of this thesis limits the applicable of discrete choice model because there is not enough number of observations for some household types to generate statistically significant results.

8.5.2 Separate Hedonic Models for Each Housing Type

In future work, separate hedonic models could be built for each housing type. In this way, the model estimations of different housing types become comparable. It was not implemented in this study due to limited number of observations.

8.5.3 Before and after the Operation of LRT

Although “In CTC” is included as an independent variable in the final model, it could not capture the influence of LRT on rental prices on the demand side because theoretically there should be no influence of LRT before the full operation of LRT. Renters could not enjoy the services and amenities of LRT during their lease period; hence, their willingness to pay for the upcoming LRT should be zero. Therefore, findings of this research could not answer how LRT will potentially influence renters’ residential location choice. In future research, it would be interesting to conduct a similar survey and build similar models after the full operation of LRT to see if renters’ attitudes towards LRT and CTC have changed and see if the influence of renting inside CTC area becomes more significant in the model.

8.5.4 Compare with 2016 Census

The survey was conducted in 2016, the same year of the latest census. However, 2016 census data was not released during the time of the analysis. In future work, it would be interesting to analyze the 2016 census data together with the survey results.

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Appendix A: Survey Questionarrie

RENTERS' SURVEY QUESTIONNAIRE

This questionnaire will ask information on your renting experience. (approximately 25 minutes)	
Part A	Residential characteristics
Part B	Residential location choice
Part C	Renting behaviours
Part D	LRT and location choice
Part E	Household characteristics and travel behavior

Part A - Residential Characteristics

1. What is the address of your residence?

Unit No.	
House No.	
Full Street Name	
City	
Postal Code	

2. What type of housing are you renting?

- ○ A room
- ○ A house
- ○ An apartment/condo (not a basement apartment)
- ○ A basement apartment
- ○ Other, please specify... _____

3. What type of building do you live in?

- ○ Single detached house
- ○ Semi-detached house
- ○ Duplex house (with an upper and lower unit in same house)
- ○ Townhouse/row house
- ○ Apartment in a building of 3 storeys or lower
- ○ Apartment in a building of 4 storeys or higher
- ○ Other, please specify... _____

4. When was the building built approximately?

- ○ Year _____
- ○ I don't know

5. Please provide the number of each of the following in your residence.

No. of bedrooms	
No. of full bathrooms	
No. of half bathrooms	
Total no. of floors in your residence (basement and attic/loft excluded)	
No. of other people sharing housing with you	
No. of total parking spaces	

6. What other facilities or features are available in your residence? (Please select all that apply)

- ☐ Finished basement
- ☐ Walk-out basement
- ☐ Fireplace
- ☐ Deck/porch
- ☐ Balcony
- ☐ Attic/loft
- ☐ Fenced yard
- ☐ Shed
- ☐ Backs onto greenbelt
- ☐ Carpet free
- ☐ Central air
- ☐ Other, please specify... _____

7. Please indicate whether the following building features are included in your rent. If not included, please indicate the additional fee per month if applicable.

Building Feature	Is it included in your rent?		If not, what is the additional fee every month?	Not Applicable
Heat	Y	N		○
Hydro/electricity	Y	N		○
Water	Y	N		○
Internet	Y	N		○
Cable TV	Y	N		○
Laundry	Y	N		○
Furnished	Y	N		○
Maintenance	Y	N		○
Snow removal	Y	N		○

Weeding	Y	N		○
Pool	Y	N		○
Guest suites	Y	N		○
Party room	Y	N		○
Library/study room	Y	N		○
Gym	Y	N		○
Roof-top deck	Y	N		○
Other 1, please specify _____	Y	N		○
Other 2, please specify _____	Y	N		○

8. How many parking spaces are included in your rent?

9. If your rent does not include parking, how much do you pay every month for each car?

10. What is your average monthly rent?

11. Do you have a private bathroom?

○ Yes

○ No

12. If you are renting a room, please estimate the size of your room.

You can estimate the size of your room using your height. The distance between your fingertips with your arms stretched to the sides is roughly the same as your height.

○ Square Feet _____

○ Square Meters _____

13. If you are renting a house, an apartment/condo, or a basement apartment, please estimate the size of your living area.

○ Square Feet _____

○ Square Meters _____

Part B - Residential Location Choice

14. What reasons have motivated you to move to and live in your current residence? (Please select all that apply)

☐ Getting a new job

☐ Seeking new job opportunities

☐ Getting married/partnership

☐ Moving closer to my or my partner's workplaces

☐ Expanding family size

☐ For my or my partner's education

☐ For child's education/childcare

☐ Supporting my or my partner's parents

☐ More affordable

☐ Better neighbourhood environmental quality

☐ Better accessibility to facilities (shopping and services)

☐ Better accessibility to transit

☐ Upsize

☐ Downsize

☐ Other, please specify... _____

15. Residential characteristics

Please rate the importance of each residential characteristic in your decision to ***move to your current residence*** (**15-1**) and please indicate your **ideal residence** with respect to each attribute (**15-2**).

15-1. Please rate the *importance* of each characteristic in your renting decision.

Residential Characteristics	Importance (1-not at all important; 5-very important)					Not Applicable
Rental price	1	2	3	4	5	○
Housing type	1	2	3	4	5	○
Size of the room/residence	1	2	3	4	5	○
Age of your residence	1	2	3	4	5	○
Number of bedrooms	1	2	3	4	5	○
Number of full bathrooms	1	2	3	4	5	○
Number of half bathrooms	1	2	3	4	5	○
Number of floors in the residence	1	2	3	4	5	○
Private bathroom	1	2	3	4	5	○
Availability of parking	1	2	3	4	5	○
Ease of maintenance	1	2	3	4	5	○
Furnished	1	2	3	4	5	○
Quality of furnishing	1	2	3	4	5	○
Flexibility of lease/contract	1	2	3	4	5	○
Central air	1	2	3	4	5	○
Yard size	1	2	3	4	5	○
Finished basement	1	2	3	4	5	○
Fireplace	1	2	3	4	5	○
Fenced yard	1	2	3	4	5	○
Pool	1	2	3	4	5	○
Deck/porch	1	2	3	4	5	○
Condo amenities (gym, laundry, building security etc.)	1	2	3	4	5	○
Other 1, please specify_____	1	2	3	4	5	○
Other 2, please specify_____	1	2	3	4	5	○

15-2. Please indicate your *ideal* home with respect to each residential characteristic.

Rental price (given your budget)	☐
Housing type	○ Single detached house ○ Semi-detached house ○ Duplex house ○ Townhouse/row house ○ Apartment in a building of 3 storeys or lower ○ Apartment in a building of 4 storeys or higher
Housing square foot	○ Less than 1000 ○ 2000-2499 ○ 1000 -1499 ○ 2500-2999 ○ 1500 -1999 ○ More than 2999
Yard size	○ No outdoor space ○ Patio or deck or balcony ○ Small yard (area of 0-4 single car garages) ○ Medium yard (area of 5-9 single car garages) ○ Large yard (area of 10-16 single car garages) ○ Very large yard (area of 17+ single car garages)
Number of bedrooms	☐
Number of full bathrooms	☐
Number of half bathrooms	☐
Number of floors in the residence	☐
Total parking spaces	☐

Built year range (please select all that apply)	☐	No preference	☐	1980-1989	☐	1940-1949
	☐	2010-2016	☐	1970-1979	☐	1930-1939
	☐	2005-2009	☐	1960-1969	☐	1920-1929
	☐	2000-2004	☐	1950-1959	☐	before 1920
	☐	1990-1999				
Other, please specify...	☐					

16. Neighbourhood characteristics

Neighbourhood is defined as an area within 10-minute walk to your residence.

Please rate the importance of each neighbourhood characteristic in your decision to move to your ***current neighbourhood*** and please indicate your ***ideal neighbourhood*** with respect to each characteristic.

16-1. Built environment

1-a. Please rate the *importance* of each characteristic in your renting decision.

Built Environment	**Importance** (1-not at all important; 5-very important)					**Not Applicable**
Density of housing	1	2	3	4	5	○
Land use mix (residential, retail, commercial, employment center)	1	2	3	4	5	○
Ease of walking	1	2	3	4	5	○
Ease of cycling	1	2	3	4	5	○
Traffic noise	1	2	3	4	5	○

1-b. Please indicate your *ideal* neighbourhood with respect to each characteristic.

Built Environment	**Ideal** Neighbourhood (1- low level; 5-high level)					**Not Applicable**
Density of housing	1	2	3	4	5	○

Land use mix (residential, retail, commercial, employment center)	1	2	3	4	5	○
Ease of walking	1	2	3	4	5	○
Ease of cycling	1	2	3	4	5	○

16-2. Socio- demographics

2-a. Please rate the *importance* of each characteristic in your renting decision.

Socio-demographics	**Importance** (1-not at all important; 5-very important)					**Not Applicable**
Similarity of household size to yourself	1	2	3	4	5	○
Similarity of household income to yourself	1	2	3	4	5	○
Similarity of education level to yourself	1	2	3	4	5	○
Similarity of age to yourself	1	2	3	4	5	○
Similarity of ethnicity to yourself	1	2	3	4	5	○
Safety level/crime rate	1	2	3	4	5	○
School quality	1	2	3	4	5	○

2-b. Please indicate your *ideal* neighbourhood with respect to each characteristic relative to yourself.

Socio-demographics	**Ideal** Neighbourhood (1-not similar; 5-very similar)					**Not applicable**
Similarity of household size to yourself	1	2	3	4	5	○
Similarity of household income to yourself	1	2	3	4	5	○

Similarity of education level to yourself	1	2	3	4	5	○
Similarity of age to yourself	1	2	3	4	5	○
Similarity of ethnicity to yourself	1	2	3	4	5	○

16-3. Accessibility

3-a. Please rate the *importance* of each characteristic in your renting decision.

Accessibility	**Importance** (1-not at all important; 5-very important)					**Not Applicable**
Commuting time	1	2	3	4	5	○
Commuting cost	1	2	3	4	5	○
Accessibility to school	1	2	3	4	5	○
Accessibility to workplace	1	2	3	4	5	○
Accessibility to retail and services	1	2	3	4	5	○
Accessibility to public open space	1	2	3	4	5	○
Accessibility to urban center	1	2	3	4	5	○
Accessibility to bus stops	1	2	3	4	5	○
Distance to highway exits	1	2	3	4	5	○
Distance to your family/friends	1	2	3	4	5	○

3-b. Please indicate your *ideal* neighbourhood with respect to each characteristic.

Accessibility	**Ideal Accessibility Level (1-low level; 5-high level)**					**Not Applicable**
Accessibility to school	1	2	3	4	5	○
Accessibility to workplace	1	2	3	4	5	○
Accessibility to retail and	1	2	3	4	5	○

services						
Accessibility to public open space	1	2	3	4	5	○
Accessibility to urban center	1	2	3	4	5	○
Accessibility to bus stops	1	2	3	4	5	○

Distance	**Ideal Distance (1-near; 5-far)**					**Not Applicable**
Distance to highway exits	1	2	3	4	5	○
Distance to your family/friends	1	2	3	4	5	○

Part C - Renting Behaviour

17. Is your current residence a sublet?

○ Yes

○ No

17-1. If your current residence is a sublet, please indicate the original monthly rent.

○ The original monthly rent is $ _____

○ I don't know

18. How long is your current lease/contract?

○ No lease/contract

○ Month to month

○ 4 months

○ 8 months

○ 12 months

○ More than 12 months

○ Other, please specify... _____

19. Please indicate how you normally find rental information? (Please select all that apply)

☐ Kijiji

- ☐ Craiglist
- ☐ University of Waterloo's off campus housing website
- ☐ Someone you know: friends, family …
- ☐ Housing agent
- ☐ Street advertisements/posters
- ☐ Newspaper
- ☐ For rent signs
- ☐ Other, please specify... _____

20. How much time did you spend searching before you found your current residence?

_____ Week(s)

21. How many places did you visit before choosing your current residence (include your current residence)?

_____ Place(s)

22. Have you received discount after a long-time lease/contract?

- ○ Yes
- ○ No
- ○ Not applicable

23. Have you owned a home before?

- ○ Yes
- ○ No

24. Why do you choose renting instead of buying? (Please select all that apply)

- ☐ Downsizing
- ☐ Can’t afford mortgage/down payment
- ☐ Not being able to keep up with monthly payments
- ☐ Short term housing needs
- ☐ Convenience of renting process versus buying process
- ☐ Less responsibility (e.g. repairs and maintenance)
- ☐ No debt
- ☐ Easy to move

☐ Other, please specify... _____

25. Do you plan to buy a home in the future?

○ Yes

○ No

26. If you plan to buy a home in the future, please estimate the time.

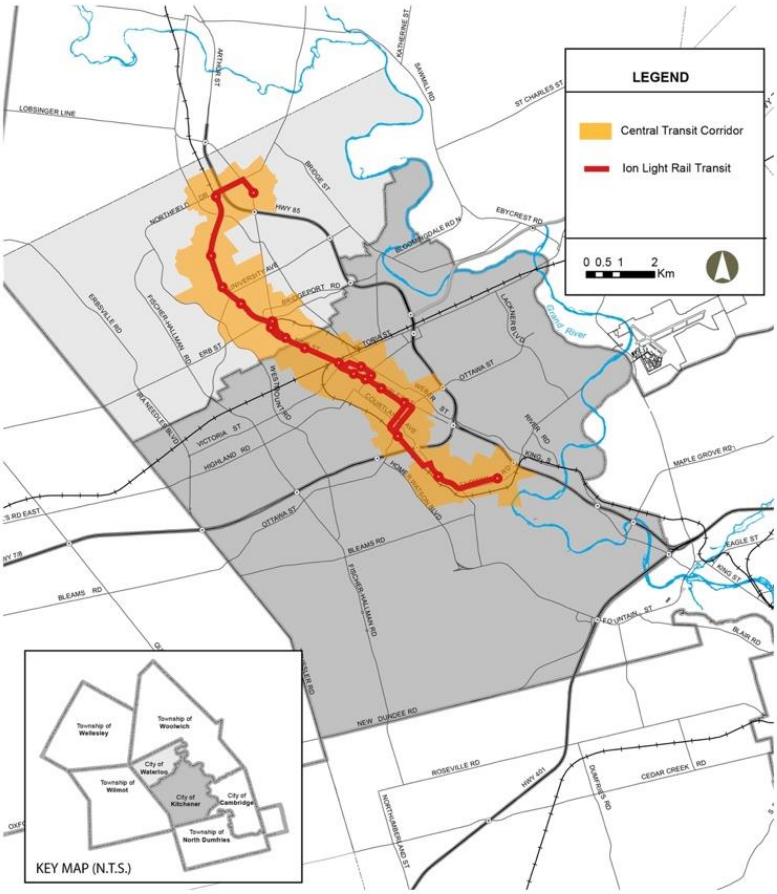
In [ ] years

Part D - LRT and Location Choice

A 19-km light rail transit (LRT) line connecting Fairview Park Mall and Conestoga Mall is under construction in Kitchener-Waterloo. The system is set to begin service in early 2018. The map of the LRT line with future stops and the Central Transit Corridor (CTC) area is shown.

The Central Transit Corridor (CTC) is defined as the area within **around 800 meters or roughly a 10-minute walk** distance from the future LRT stops. It is a **theoretical boundary** used in this research.

There is a web-based lookup tool for you to check whether this home is inside the CTC area or not by **http://research.wici.ca/survey/ctc.html.**



27. Is your current residence *inside the CTC area*?

○ Yes (Please skip Q28 and Q29)

○ No

28. If your current residence is *outside the CTC area*, have you considered residences *inside the CTC area* during your search process?

○ Yes

○ No

29. If your current residence is *outside the CTC area*, did any of the factors below influence your decision not to rent *inside the CTC area*? (Please select all that apply)

☐ LRT construction

☐ Potentially heavier traffic in CTC area

☐ Potential crowding in CTC area

- ☐ Less safety in CTC area
- ☐ Less cleanness in CTC area
- ☐ More noise in CTC area
- ☐ Inconvenience for parking and driving
- ☐ Not economical (higher rental price within CTC area)
- ☐ Other, please specify... _____

30. What is your general attitude towards the LRT system in Kitchener-Waterloo?

- ○ Very positive
- ○ Positive
- ○ Neutral
- ○ Negative
- ○ Very negative

31. Among the following features of the future LRT services, which might be important to you? (Please select all that apply)

- ☐ Transit fare
- ☐ Hours of operation
- ☐ Facilities for people with disabilities
- ☐ Service frequency
- ☐ Shelter/Station facilities
- ☐ On time performance
- ☐ Convenience for walking to the LRT stations
- ☐ Convenience for bus connections and transfers
- ☐ Availability of scheduling information
- ☐ Availability of mobile updated information
- ☐ Having helpful staff
- ☐ Crowdedness/comfort
- ☐ Wi-Fi
- ☐ Other, please specify... _____

32. To what extent will the LRT influence your future location choice decision?

- ○ Very Important
- ○ Important
- ○ Neutral
- ○ Somewhat Important
- ○ Not at all Important

33. What features of LRT, if any, will make you more likely to rent *inside the CTC area* in the future? (Please select all that apply)

- ☐ Faster than buses
- ☐ Quieter than buses
- ☐ More reliable than buses (on-time performance)
- ☐ Safer than buses
- ☐ More comfortable than buses
- ☐ Able to be productive during commuting
- ☐ Able to avoid traffic congestion
- ☐ Safer than driving
- ☐ Lower cost than driving (saving gas costs and parking rates)
- ☐ No need for finding parking
- ☐ Freeing up household car
- ☐ Environment-friendly
- ☐ Saving travel time

☐ Other, please specify...
_____

34. For what trip purposes might you use the LRT system? (Please select all that apply)

☐ School / Work Activities
☐ Service Activities (e.g. visiting banks or other services)
☐ Grocery Shopping / Farmer's Market Activities
☐ Other Shopping Activities (e.g. shopping for housewares, clothing or other personal items)
☐ Social Activities (e.g. meeting with friends or family, attending events, or helping others)
☐ Recreational Activities (e.g. exercising, playing team sports, or visiting parks)
☐ Chaperone Activities (e.g. accompanying others to their own activities)
☐ I will not use LRT
☐ Other, please specify... _____

Part E - Household Characteristics and Travel Behaviour

A household is a person or group of persons **living in the same residence**. They do not have a usual place of residence elsewhere in Canada or abroad.

E1. Household Characteristics

35. Were you born in Canada?

○ Yes
○ No

36. If you were born in Canada, please select the province or territory that you were born in.

○ Newfoundland
○ Prince Edward Island
○ Nova Scotia
○ New Brunswick
○ Quebec
○ Ontario
○ Manitoba
○ Saskatchewan
○ Alberta
○ British Columbia
○ Yukon
○ North West Territories
○ Nunavut

37. If you were born outside Canada, which country were you born in?

38. If you were born outside Canada, what year did you arrive in Canada?

39. Would you describe yourself as_____? (Please select all that apply)

- ☐ White
- ☐ South Asian (e.g., East Indian, Pakistani, Sri Lankan, etc.)
- ☐ Chinese
- ☐ Black
- ☐ Filipino
- ☐ Latin American
- ☐ Arab
- ☐ Southeast Asian (e.g., Vietnamese, Cambodian, Malaysian, Laotian, etc.)
- ☐ West Asian (e.g., Iranian, Afghan, etc.)
- ☐ Korean
- ☐ Japanese
- ☐ Aboriginal (First Nations (North American Indian), Métis or Inuk (Inuit))
- ☐ Other, please specify... _____

40. What is the range of your household income before taxes (*Gross income of all members*) for year 2015?

- ○ Less than $29,999
- ○ $30,000-$49,999
- ○ $50,000-$74,999
- ○ $75,000-$99,999
- ○ $100,000-$149,999
- ○ $150,000-$249,999
- ○ $250,000-$499,999
- ○ $500,000 and over
- ○ Decline to answer

41. What is the size of your household?

42. Please describe each of your household members.

Note: If there is more than one person having the same relationship to you, please indicate them separately with a number. E.g., if you have 3 children, please enter *child 1; child 2; child 3* into the "*Relationship to you*" box.

Relationship to you	**Sex**		**Age**	**Highest education**				**Labour force status**						**Own a transit pass**	**Own a driver's license**
	Male	Female	(Years)	Lower than high school	High school	Post-secondary	Graduate	Full time	Part time	Student	Retired	Unemployed	Other		
Yourself															

E2. Travel Behaviour

43. How many cars does your household currently own or lease?

☐

44. Are you a member of any car-share organization? (For example, Community CarShare, Student CarShare)

○ Yes

○ No

45. Compared to 3 years ago, have there been changes in your travel habits? (Please select all that apply)

☐ Yes, I use more public transit

☐ Yes, I have increased the use of car

☐ Yes, I walk more

☐ Yes, I cycle more

☐ No changes

☐ Other, please specify... _____

46. Please rank the following types of activities in terms of its priority when your household makes decisions on its household travel schedule,

where 1 is the **highest** priority activity type that is very important to accomplish, and 7 is the **lowest** priority activity type that may be deferred to another day.

_____ School / Work Activities

_____ Service Activities (e.g. visiting banks or other services)

_____ Grocery Shopping/Farmer's Market Activities

_____ Other Shopping Activities (e.g. shopping for housewares, clothing or other personal items)

_____ Social Activities (e.g. meeting with friends or family, attending events, or helping others)

_____ Recreational Activities (e.g. exercising, playing team sports, or visiting parks)

_____ Chaperone Activities (e.g. accompanying others to their own activities)

47. Please describe each of your household members' current commuting behaviour.

Relationship to you	Workplace/school location (postal code or name)	Commuting time - one way (min)	Current main commuting mode						Other commuting mode (please specify)
			Driving	Car passenger	Walking	Cycling	School bus	Taking GRT	
Yourself									

48. What is the importance of each factor influencing your household's current commuting mode choice?

Factors	Importance (1-not at all important; 5-very important)					Not applicable
Shortest commuting time	1	2	3	4	5	○
Cheapest commuting cost	1	2	3	4	5	○
Shortest waiting time	1	2	3	4	5	○
Reliable time schedule	1	2	3	4	5	○
Availability of owning car and travel by car	1	2	3	4	5	○
Vehicle that is environmental friendly	1	2	3	4	5	○
Safety of the travel mode	1	2	3	4	5	○
Healthy travel mode	1	2	3	4	5	○
Workplace or school is close to transit stop	1	2	3	4	5	○
Home is close to transit stop	1	2	3	4	5	○
Flexible schedule	1	2	3	4	5	○
Comfort/ freedom	1	2	3	4	5	○
Factors that influence driving (such as low traffic volume)	1	2	3	4	5	○

49. How does traffic congestion influence your daily commute?

○ Very seriously

○ Somewhat seriously

○ Not seriously

50. How many days per week do you use public transit approximately?

○ Every day (7 days)

○ Every weekday (5 days)

○ 3-4 days

○ 1-2 days

○ Rarely or never

How did you hear of this survey? (Please select all that apply)

- ☐ I received your survey package by mail
- ☐ I saw your recruitment post in public libraries
- ☐ I saw your recruitment message on Facebook
- ☐ I was contacted by Kitchener Waterloo Neighbourhood Associations
- ☐ I was contacted directly by the researchers/researchers' friends
- ☐ Other, please specify... _____

Thank you for your participation.

Please indicate below whether you would like to receive further updates on this project and an invitation to attend a briefing session on the results of this study, and whether you would like to be entered into the prize draw.

- ☐ **Yes**, I would like to receive further updates.
- ☐ **Yes**, I would like to be entered into the prize draw.
- ☐ **No**, I would not like to receive further updates or be entered into the prize draw.

If you choose **Yes**, please enter your **email address** _____**,** or **provide your name** _____ **and mailing address**_____. We will send/email a feedback letter to you in the next step.

If you have any questions or concerns, please contact myself (xpi@uwaterloo.ca, 519-888-4567 x31545), Dr. Parker (dparker@uwaterloo.ca, 519-888-4567 x38888), or Dr. Casello (jcasello@uwaterloo.ca, 519-888-4567 x37538) at the University of Waterloo, or you can fill out the additional comments box below.

We would like to assure you that this study has been reviewed by, and received ethics clearance through the Office of Research Ethics. If you have any questions regarding your participation in this study, please contact Dr. Maureen Nummelin, Chief Ethics Officer, Office of Research Ethics at maureen.nummelin@uwaterloo.ca or 519-888-4567 Ext. 36005.

Additional Comments:

_____

_____

_____

Appendix B: Spatial Regression Results

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SPATIAL LAG MODEL

REGRESSION
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SUMMARY OF OUTPUT: MAXIMUM LIKELIHOOD SPATIAL LAG (METHOD = FULL)
-----------------------------------------------------------------
Data set            :143ln_0730.dbf
Weights matrix      :File: 143ln_0730_15.gwt
Dependent Variable  :  ln_rent_ad               Number of Observations:         143
Mean dependent var  :      7.0539               Number of Variables   :          23
S.D. dependent var  :      0.3144               Degrees of Freedom    :         120
Pseudo R-squared    :      0.8529
Spatial Pseudo R-squared:  0.8512
Sigma-square ML     :       0.014               Log likelihood        :     100.017
S.E of regression   :       0.120               Akaike info criterion :    -154.034
                                                Schwarz criterion     :     -85.888

------------------------------------------------------------------------------------
            Variable     Coefficient       Std.Error     z-Statistic     Probability
------------------------------------------------------------------------------------
            CONSTANT       7.4041412       0.6870460      10.7767760       0.0000000
          OS_Adjacen      -0.0630986       0.0284152      -2.2205938       0.0263785
               OS_SS      -0.0000467       0.0000624      -0.7485897       0.4541046
             RegRoad       0.0395115       0.0274450       1.4396607       0.1499634
            TransAcc      -0.0000202       0.0000792      -0.2546665       0.7989807
        W_ln_rent_ad      -0.1434575       0.0996382      -1.4397838       0.1499286
            bathroom       0.1791865       0.0333704       5.3696201       0.0000001
             bedroom       0.1510770       0.0165890       9.1070568       0.0000000
          d_children      -0.0992536       0.0351734      -2.8218331       0.0047750
          d_one_pers      -0.0840500       0.0289184      -2.9064517       0.0036555
             d_other      -0.0672558       0.0432744      -1.5541698       0.1201439
           d_retired      -0.0550088       0.0366433      -1.5011974       0.1333045
              d_room       0.1420131       0.0556333       2.5526625       0.0106903
           d_student       0.1170739       0.0365491       3.2031927       0.0013591
          d_unemploy      -0.0525055       0.0891191      -0.5891614       0.5557530
            highrise       0.0781049       0.0346854       2.2518056       0.0243346
               in_ctc      0.0807326       0.0250877       3.2180170       0.0012908
               income      0.0000012       0.0000003       3.7888713       0.0001513
             lowrise      -0.0809574       0.0312182      -2.5932782       0.0095066
           resid_age      -0.0005984       0.0004579      -1.3068457       0.1912651
              safety      -0.0006407       0.0003761      -1.7033862       0.0884958
          school_qua       0.0138832       0.0109533       1.2674929       0.2049791
          walkabilit       0.0001227       0.0000672       1.8263626       0.0677957
------------------------------------------------------------------------------------
================================ END OF REPORT ====================================
```

SPATIAL ERROR MODEL

EGRESSION

SUMMARY OF OUTPUT: MAXIMUM LIKELIHOOD SPATIAL ERROR (METHOD = FULL)

Data set :143ln_0730.dbf
Weights matrix :File: 143ln_0730_15.gwt
Dependent Variable : ln_rent_ad Number of Observations: 143
Mean dependent var : 7.0539 Number of Variables : 22
S.D. dependent var : 0.3144 Degrees of Freedom : 121
Pseudo R-squared : 0.8447
Sigma-square ML : 0.013 Log likelihood : 102.052
S.E of regression : 0.116 Akaike info criterion : -160.105
Schwarz criterion : -94.922

Variable	Coefficient	Std.Error	z-Statistic	Probability
CONSTANT	6.3624518	0.0765973	83.0636508	0.0000000
OS_Adjacen	-0.0585493	0.0299047	-1.9578614	0.0502463
OS_SS	-0.0000474	0.0000619	-0.7649538	0.4442991
RegRoad	0.0306199	0.0266487	1.1490190	0.2505482
TransAcc	-0.0000382	0.0000786	-0.4864768	0.6266291
bathroom	0.1506097	0.0328378	4.5864771	0.0000045
bedroom	0.1556358	0.0164770	9.4456406	0.0000000
d_children	-0.1070627	0.0344086	-3.1115115	0.0018613
d_one_pers	-0.0880502	0.0274449	-3.2082541	0.0013354
d_other	-0.0618462	0.0423610	-1.4599789	0.1442959
d_retired	-0.0532109	0.0351339	-1.5145172	0.1298947
d_room	0.1163643	0.0505041	2.3040597	0.0212193
d_student	0.1032452	0.0330038	3.1282793	0.0017583
d_unemploy	-0.0634020	0.0811444	-0.7813468	0.4345985
highrise	0.0925995	0.0334305	2.7699113	0.0056072
in_ctc	0.0663055	0.0206670	3.2082729	0.0013353
income	0.0000012	0.0000003	3.8322018	0.0001270
lambda	-0.9788900	0.2338631	-4.1857403	0.0000284
lowrise	-0.0854841	0.0295426	-2.8935834	0.0038087
resid_age	-0.0003946	0.0004155	-0.9497839	0.3422221
safety	-0.0005893	0.0003984	-1.4792763	0.1390665
school_qua	0.0243835	0.0098531	2.4747090	0.0133345
walkabilit	0.0001258	0.0000668	1.8820322	0.0598316

================================ END OF REPORT ======================================

SPATIAL LAG + ERROR MODEL

REGRESSION

SUMMARY OF OUTPUT: SPATIALLY WEIGHTED TWO STAGE LEAST SQUARES (HOM)

Data set   :143ln_0730.dbf
Weights matrix   :File: 143ln_0730_15.gwt
Dependent Variable : ln_rent_ad   Number of Observations: 143
Mean dependent var :   7.0539   Number of Variables   :   23
S.D. dependent var :   0.3144   Degrees of Freedom   :   120
Pseudo R-squared   :   0.8519
Spatial Pseudo R-squared: 0.8503
N. of iterations   :   1

Variable	Coefficient	Std.Error	z-Statistic	Probability
CONSTANT	7.0236791	0.6463676	10.8663852	0.0000000
OS_Adjacen	-0.0644184	0.0296358	-2.1736664	0.0297302
OS_SS	-0.0000482	0.0000626	-0.7702429	0.4411558
RegRoad	0.0404719	0.0272753	1.4838280	0.1378545
TransAcc	-0.0000252	0.0000787	-0.3196465	0.7492363
W_ln_rent_ad	-0.0914560	0.0955504	-0.9571494	0.3384919
bathroom	0.1714661	0.0330695	5.1850221	0.0000002
bedroom	0.1533509	0.0166788	9.1943859	0.0000000
d_children	-0.1004363	0.0350564	-2.8649920	0.0041702
d_one_pers	-0.0835973	0.0281886	-2.9656468	0.0030205
d_other	-0.0658772	0.0435929	-1.5111917	0.1307396
d_retired	-0.0547683	0.0364259	-1.5035548	0.1326960
d_room	0.1352016	0.0548190	2.4663282	0.0136506
d_student	0.1150125	0.0363307	3.1657125	0.0015470
d_unemploy	-0.0579346	0.0844767	-0.6858057	0.4928356
highrise	0.0834709	0.0340317	2.4527390	0.0141773
in_ctc	0.0776627	0.0225983	3.4366583	0.0005889
income	0.0000012	0.0000003	3.8227474	0.0001320
lowrise	-0.0828668	0.0302951	-2.7353203	0.0062320
resid_age	-0.0005278	0.0004309	-1.2248707	0.2206239
safety	-0.0006272	0.0003941	-1.5916836	0.1114558
school_qua	0.0166981	0.0110117	1.5163954	0.1294194
walkabilit	0.0001273	0.0000680	1.8726870	0.0611116
lambda	-0.5928218	0.4226698	-1.4025649	0.1607466

Instrumented: W_ln_rent_ad
Instruments: W_OS_Adjacen, W_OS_SS, W_RegRoad, W_TransAcc, W_bathroom,
W_bedroom, W_d_children, W_d_one_pers, W_d_other, W_d_retired,
W_d_room, W_d_student, W_d_unemploy, W_highrise, W_in_ctc,
W_income, W_lowrise, W_resid_age, W_safety, W_school_qua,
W_walkabilit
================================ END OF REPORT =====================================

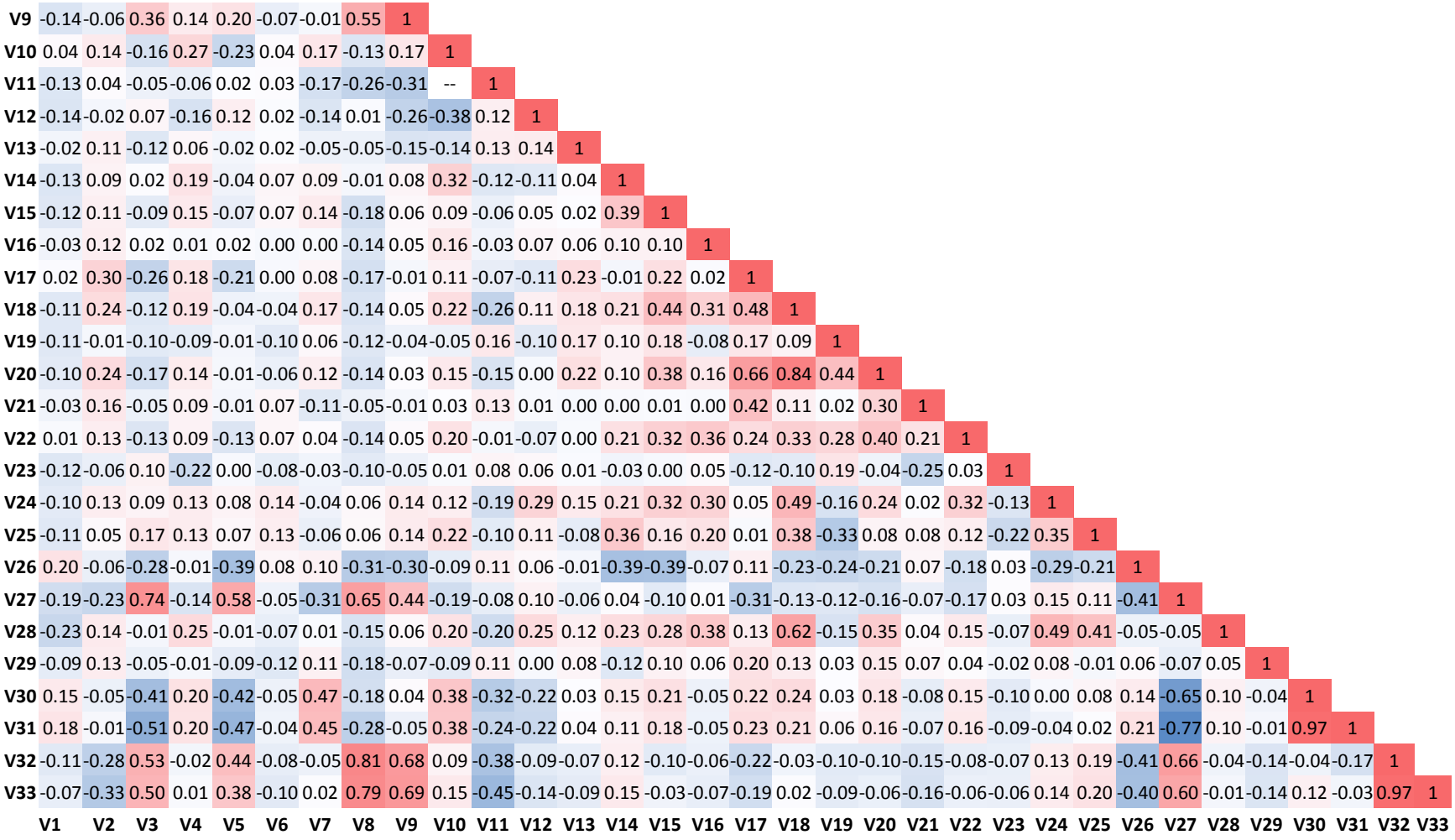
Appendix C: Correlation Matrix

Table C-1. Candidate variables

V1	Household with children	**V12**	Age of residence	**V23**	Transit access
V2	One-person household	**V13**	Walkability	**V24**	Employment access
V3	Other household	**V14**	School quality	**V25**	In CTC
V4	Retired household	**V15**	Education rate	**V26**	In Kitchener
V5	Student household	**V16**	Perception of safety	**V27**	Renting a room
V6	Unemployed household	**V17**	Open space, spatial separation model	**V28**	Housing type match
V7	Household income ($)	**V18**	Open space, count in 1000m	**V29**	Lease flexibility
V8	Number of bedrooms	**V19**	Open space, area in 1000m	**V30**	Rent
V9	Number of bathrooms	**V20**	Open space, gravity based model	**V31**	Logged rent
V10	High-rise apartment	**V21**	Open space adjacency	**V32**	Adjusted rent
V11	Low-rise apartment	**V22**	Regional road adjacency	**V33**	Logged adjusted rent

Table C-2. Correlation Matrix of candidate variables

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20	V21	V22	V23	V24	V25	V26	V27	V28	V29	V30	V31	V32	V33
V1	1																																
V2	--	1																															
V3	--	--	1																														
V4	-0.18	0.21	-0.19	1																													
V5	-0.21	-0.16	0.58	--	1																												
V6	0.09	0.06	-0.06	--	--	1																											
V7	-0.06	-0.05	-0.31	0.13	-0.48	-0.11	1																										
V8	0.12	-0.36	0.56	-0.06	0.43	-0.07	-0.22	1																									



	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20	V21	V22	V23	V24	V25	V26	V27	V28	V29	V30	V31	V32	V33
V9	-0.14	-0.06	0.36	0.14	0.20	-0.07	-0.01	0.55	1																								
V10	0.04	0.14	-0.16	0.27	-0.23	0.04	0.17	-0.13	0.17	1																							
V11	-0.13	0.04	-0.05	-0.06	0.02	0.03	-0.17	-0.26	-0.31	--	1																						
V12	-0.14	-0.02	0.07	-0.16	0.12	0.02	-0.14	0.01	-0.26	-0.38	0.12	1																					
V13	-0.02	0.11	-0.12	0.06	-0.02	0.02	-0.05	-0.05	-0.15	-0.14	0.13	0.14	1																				
V14	-0.13	0.09	0.02	0.19	-0.04	0.07	0.09	-0.01	0.08	0.32	-0.12	-0.11	0.04	1																			
V15	-0.12	0.11	-0.09	0.15	-0.07	0.07	0.14	-0.18	0.06	0.09	-0.06	0.05	0.02	0.39	1																		
V16	-0.03	0.12	0.02	0.01	0.02	0.00	0.00	-0.14	0.05	0.16	-0.03	0.07	0.06	0.10	0.10	1																	
V17	0.02	0.30	-0.26	0.18	-0.21	0.00	0.08	-0.17	-0.01	0.11	-0.07	-0.11	0.23	-0.01	0.22	0.02	1																
V18	-0.11	0.24	-0.12	0.19	-0.04	-0.04	0.17	-0.14	0.05	0.22	-0.26	0.11	0.18	0.21	0.44	0.31	0.48	1															
V19	-0.11	-0.01	-0.10	-0.09	-0.01	-0.10	0.06	-0.12	-0.04	-0.05	0.16	-0.10	0.17	0.10	0.18	-0.08	0.17	0.09	1														
V20	-0.10	0.24	-0.17	0.14	-0.01	-0.06	0.12	-0.14	0.03	0.15	-0.15	0.00	0.22	0.10	0.38	0.16	0.66	0.84	0.44	1													
V21	-0.03	0.16	-0.05	0.09	-0.01	0.07	-0.11	-0.05	-0.01	0.03	0.13	0.01	0.00	0.00	0.01	0.00	0.42	0.11	0.02	0.30	1												
V22	0.01	0.13	-0.13	0.09	-0.13	0.07	0.04	-0.14	0.05	0.20	-0.01	-0.07	0.00	0.21	0.32	0.36	0.24	0.33	0.28	0.40	0.21	1											
V23	-0.12	-0.06	0.10	-0.22	0.00	-0.08	-0.03	-0.10	-0.05	0.01	0.08	0.06	0.01	-0.03	0.00	0.05	-0.12	-0.10	0.19	-0.04	-0.25	0.03	1										
V24	-0.10	0.13	0.09	0.13	0.08	0.14	-0.04	0.06	0.14	0.12	-0.19	0.29	0.15	0.21	0.32	0.30	0.05	0.49	-0.16	0.24	0.02	0.32	-0.13	1									
V25	-0.11	0.05	0.17	0.13	0.07	0.13	-0.06	0.06	0.14	0.22	-0.10	0.11	-0.08	0.36	0.16	0.20	0.01	0.38	-0.33	0.08	0.08	0.12	-0.22	0.35	1								
V26	0.20	-0.06	-0.28	-0.01	-0.39	0.08	0.10	-0.31	-0.30	-0.09	0.11	0.06	-0.01	-0.39	-0.39	-0.07	0.11	-0.23	-0.24	-0.21	0.07	-0.18	0.03	-0.29	-0.21	1							
V27	-0.19	-0.23	0.74	-0.14	0.58	-0.05	-0.31	0.65	0.44	-0.19	-0.08	0.10	-0.06	0.04	-0.10	0.01	-0.31	-0.13	-0.12	-0.16	-0.07	-0.17	0.03	0.15	0.11	-0.41	1						
V28	-0.23	0.14	-0.01	0.25	-0.01	-0.07	0.01	-0.15	0.06	0.20	-0.20	0.25	0.12	0.23	0.28	0.38	0.13	0.62	-0.15	0.35	0.04	0.15	-0.07	0.49	0.41	-0.05	-0.05	1					
V29	-0.09	0.13	-0.05	-0.01	-0.09	-0.12	0.11	-0.18	-0.07	-0.09	0.11	0.00	0.08	-0.12	0.10	0.06	0.20	0.13	0.03	0.15	0.07	0.04	-0.02	0.08	-0.01	0.06	-0.07	0.05	1				
V30	0.15	-0.05	-0.41	0.20	-0.42	-0.05	0.47	-0.18	0.04	0.38	-0.32	-0.22	0.03	0.15	0.21	-0.05	0.22	0.24	0.03	0.18	-0.08	0.15	-0.10	0.00	0.08	0.14	-0.65	0.10	-0.04	1			
V31	0.18	-0.01	-0.51	0.20	-0.47	-0.04	0.45	-0.28	-0.05	0.38	-0.24	-0.22	0.04	0.11	0.18	-0.05	0.23	0.21	0.06	0.16	-0.07	0.16	-0.09	-0.04	0.02	0.21	-0.77	0.10	-0.01	0.97	1		
V32	-0.11	-0.28	0.53	-0.02	0.44	-0.08	-0.05	0.81	0.68	0.09	-0.38	-0.09	-0.07	0.12	-0.10	-0.06	-0.22	-0.03	-0.10	-0.10	-0.15	-0.08	-0.07	0.13	0.19	-0.41	0.66	-0.04	-0.14	-0.04	-0.17	1	
V33	-0.07	-0.33	0.50	0.01	0.38	-0.10	0.02	0.79	0.69	0.15	-0.45	-0.14	-0.09	0.15	-0.03	-0.07	-0.19	0.02	-0.09	-0.06	-0.16	-0.06	-0.06	0.14	0.20	-0.40	0.60	-0.01	-0.14	0.12	-0.03	0.97	1