# Forecasting the Demand for Housing Services in Canada

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# Contents

# 1 Introduction

## 1.1 Canadian Housing Market

Certain markets in Canada, particularly those of Toronto and Vancouver, have seen strong growth in housing prices in recent years. This growth can, in part, be attributed to a decade of low interest rates and demographic forces that have increased demand while at the same time there has been a relatively slow increase in supply.

***Table 1***. *Home ownership cost relative to income*

| | Aggregate | Single-family, detached |
|---|---|---|
| Canada | 53.9 | 59.2 |
| Calgary | 43.4 | 47.8 |
| Edmonton | 28.2 | 30.3 |
| Montreal | 45.2 | 46.2 |
| Toronto | 75.3 | 90.4 |
| Vancouver | 86.9 | 117.3 |

Source: RBC Affordability Measure (2018).

The crisis being experienced in certain locations is evidenced by homeownership costs as a percentage of income. In particular, home ownership costs, including mortgage payments, utilities, and property taxes, make up 86.9 percent of the average Vancouver households pre-tax median income for all owned housing. This compares to 117.3 percent for single-family detached housing. The second crisis area is Toronto where homeownership costs make up 75.3 percent of median pre-tax income for the aggregate category and 90.4 percent single-family detached. The data used for this table comes from the RBC Affordability Measure for the third quarter of 2018.

Canada is a highly urbanized country and many of its major cities are experiencing housing shortages. These shortages can be caused by increased housing development restrictions

in the form of land-use constraints and other zoning restrictions. Geographical constraints restrict supply as well, as Canada has an abundance of bodies of water, mountains, wetlands, and other landscape attributes that are not suitable for residential development.[1] Demographic forces such as urbanization, migration, and population growth have led to increased demand for overall housing. Additionally, a decade of low interest rates have encouraged consumers to take on more debt. Given that this debt is primarily in the form of mortgages, it is evident this has been a driving force in demand. Although interest rates have increased, they are still low compared to pre-2008 levels and can have an impact on high levels of consumer debt thereby increasing the potential for volatility in the economy.[2] An additional factor in the housing market balancing act is Canada's aging population, with baby boomers potentially to downsize and younger generations not interested in, or not capable of, absorbing these homes.

## 1.2 Objective

In order to understand the demand structure in Canadian markets a more transparent estimation is needed – especially one that accounts for the implications of income and other demographic indicators for housing demand. By extending current methodology relating to the demand for housing services to the Canadian context, this paper seeks to provide a more complete understanding of the relationship between the demand for housing attributes and the characteristics of the Canadian population. With this, we will be able to provide a forecast indicating the implied shift in housing demand over time by allowing the distribution

[1] See Schembri, L. (2015)
[2] See Poloz, S. (2018)

of key demographic attributes to evolve. More specifically, this research aims to answer the following questions: how does household willingness to pay for housing characteristics vary among certain age demographics; and how should we expect housing demand in Canada to evolve in the future with changing age demographics.

## 1.3 Political Landscape

This section seeks to touch on Canada's political landscape relating to housing policy. The importance of discussing this is that the issued warnings and government intervention into the affordability crisis in the Canadian housing market emphasize the need to understand the structure of demand and the extent to which proposed policies will impact the economy.[3] As a current example, CMHC and Budget 2019 recently released information on the First-Time Home Buyer Incentive (FTHBI) – an incentive program allowing eligible first-time home buyers to apply to finance a portion of their home through a shared equity mortgage with CMHC.[4] Given the eligibility rules behind the FTHBI, having high housing prices may make this proposed incentive ineffective in areas of crisis. Thus, we require detailed information about the housing market and propose new ways to think about and estimate the demand for housing in the Canadian context.

The rapidly growing demand in the face of apparent supply constraints in the Canadian market has led to substantial intervention by both federal and provincial government. The following is an outline of the policies that have been put into play, firstly with respect to fiscal related policy and then into monetary policy.

[3]Canada Mortgage and Housing Regulation (2018).

[4]See Government of Canada (2019). There are many eligibility factors, but of immediate importance is that the house can be valued at a maximum of ∼$500,000.

In December of 2015 the federal Finance Minister, Bill Morneau, announced that as of February 2016, rule changes would come into effect for government-backed mortgage insurance.[5] These changes would require that the minimum down payment for new insured mortgages above $500,000 increase from 5 to 10 percent for the portion of the house price above 500,000.[6] This increase was intended to capture the risks of the housing market as well as to support long-term stability of the housing market.

Subsequently, in October of 2016, federal statutes were put in place requiring mortgages with a down payment of less than 20 percent of the property purchase price to qualify at the greater of the mortgage contract rate or the Bank of Canada's five-year fixed posted rate.[7] This effectively requires that the home-buyer pays a premium to account for the risk of mortgage loan losses if the home-buyer defaults, in order to protect the lender for said risks.[8]

In August of 2016, the Liberal government in British Columbia (BC) implemented the Foreign Buyers Tax, a tax requiring all foreign buyers to pay an additional 15 percent on the purchase of housing in Greater Vancouver.[9] This tax was subsequently increased to 20 percent by the New Democratic Party (NDP) government and expanded to include the Fraser Valley, the Capital Regional District, the Nanaimo Regional District and the Central Okanagan.[10] This tax increase along with the Speculation and Vacancy Tax – an addition to the current Empty Homes Tax designed to prevent housing speculation and increase the supply of housing through utilizing vacant properties – were both part of Homes for BC: a

[5]See Department of Finance (2015).
[6]Ibid.
[7]See Department of Finance (2016).
[8]Ibid.
[9]See Kassam, A (2016).
[10]See Proctor, J (2018).

30-Point Plan launched by the BC government in February of 2018 in an attempt to address the housing crisis.[11] The Empty Homes Tax was introduced in 2017 and represents a tax of 1% of the taxable value of properties that are deemed empty.[12] The Speculation and Vacancy Tax is an addition to this tax introduced in 2018, made up of a tax valued at 0.5 percent of the assessed value.[13].

In April of 2017 the Ontario Fair Housing Plan was introduced. This 16-point plan includes many different measures intended to help people find more affordable homes, increase the supply of homes, and to bring stability to the housing market.[14] A major aspect of this plan is the Non-Resident Speculation Tax: a 15 percent tax, resembling Vancouver's foreign buyers tax, on the price of homes in the Greater Golden Horseshoe purchased by individuals who are not citizens or permanent residents of Canada.[15]

Guideline B-20 was introduced by the Office of the Superintendent of Financial Institutions in October of 2017.[16] The new guidelines impose a severe "stress test" on borrowers looking to acquire new uninsured mortgages. It requires that the qualifying rate for uninsured mortgages be the greater of two options: the current contract rate plus 2 percent; or the Bank of Canada's five-year benchmark rate.[17]

Before expanding on what has been done in Canada with regard to monetary policy, it is important to first touch on the recent history of monetary policy and how it has contributed to the stability of the financial system. Monetary policy has important implications for

[11]See Homes for BC (2018).
[12]See City of Vancouver.
[13]See Government of British Columbia
[14]See Ministry of Finance (2017).
[15]Ibid.
[16]See Office of the Superintendent of Financial Instituitions (2017).
[17]Ibid.

the stability of the housing market which can be confirmed by looking no further than the US financial crisis of 2008. The crash of 2008 was caused by the overheating and bursting of a large housing bubble, created through an accumulation of debt, largely in the form of mortgages, further facilitated by a long period of expansionary monetary policy.[18] This collapse initiated a severe economic downturn that resulted in a reduction of the target for the overnight rate from the Bank of Canada. In October of 2008, the target was decreased from 3 to 2.5 percent, followed by subsequent rate cuts until the policy rate reached its lower bound of 0.25 percent. The Bank allows for a 0.25 percent deviation above and below its target, meaning the rate at the time was essentially zero.[19]

The crash of 2008 was a result of the bursting of a housing bubble in the US and several European countries and massive consumer debt in the form of mortgages. We know that Canada is experiencing an overheated housing market, but where does we lie with regard to consumer debt? At the end of 2017, Canada's debt reached just over $2 trillion, with mortgages making up $1.5 trillion.[20] Canada's household debt-to-income ratio is up from 100 percent of its disposable income 20 years ago to approximately 170 percent – meaning for every dollar of income earned the average consumer owes $1.70.[21]

Looking at Canada's debt-service ratio which represents the required payments of interest expressed as a percentage of income, the aggregate ratio on mortgages for Canadian households has been relatively stable since the 1990s within a range of 5 to 7 percent.[22] This tells us that Canadians have taken advantage of low interest rates and have acquired higher

[18]See Gjerstad, S. et al. (2009).
[19]See Gordon, S (2017).
[20]See Poloz, S (2018).
[21]Ibid.
[22]Ibid.

levels of debt. As mentioned, this high amount of debt held by Canadian households can be attributed to the long history of low interest rates in Canada which encouraged consumers to take on more debt. The five interest rate hikes since June of 2017 has made this debt less and less affordable.[23]

These interest rate hikes have started to cool the housing market from a monetary policy standpoint, higher consumer debt creates less incentive to purchase homes; thus decreasing demand. Though this is an upside, these hikes have not yet increased rates to pre-2008 levels, and it is important to bring attention back to how these hikes can have serious implications on highly indebted Canadians as elevated debt levels leave Canadians increasingly vulnerable to economic shocks.

## 1.4 Related Literature

Since the work of Court (1941), hedonic models have been used to estimate implicit prices of characteristics within differentiated products. The method became popular in 1950, but it took nearly a decade for a theoretical foundation established.[24] Rosen (1974) outlines a theoretical structure for an empirical two-stage model with the goal of estimating marginal willingness to pay functions for characteristics of differentiated products. As explained in Rosen (1974), "A class of differentiated products is completely described by a vector of objectively measured characteristics. Observed product prices and the specific amounts of characteristics associated with each good define a set of implicit or "hedonic" prices." The methodology outlined by Rosen has been expanded and used in a vast amount of academic

[23]See Bank of Canada (2018).
[24]See Garcia and Raya (2010).

literature, including numerous applications to the housing sector.

Many scholars expand the work of Rosen (1974), a few with direct application to the housing market. This short literature review focuses on papers that (i) implement the hedonic regression approach with regard to housing and/or estimate willingness to pay functions for the demand for certain characteristics and (ii) extend this methodology to study real house price and housing demand forecasts. According to this criteria, papers of immediate interest are as follows: Harrison and Rubinfield (1976); Dubin and Goodman (1982); Sheppard and Cheshire (1998); Chowhan and Prud'homme (2004); Garcia and Raya (2010); and Green and Lee (2016). The paper of primary interest is Green and Lee (2016).

Harrison and Rubinfield (1976) apply the hedonic methodology to housing and study the willingness to pay for clean air. They investigate the sensitivity of results to model specifications and conclude that results are relatively sensitive to the model specification in the hedonic price equation, but not of the air quality demand equation.[25] This is an interesting application as it shows how far this methodology can go in regard to characteristics related to housing. Similarly, Dubin and Goodman (1982) study the willingness to pay for education and crime neighbourhood characteristics and further discuss the importance of including enough controls to properly measure education and crime effects on housing prices. This is relevant for our analysis as households have little or no control over the neighbourhood surrounding a home. This is why, in the Canada wide analysis, we include census metropolitan area controls, and extend our analysis as far as we can to a few Canadian cities.

For applications directly to the demand for housing services, Sheppard and Cheshire (1998) look at the demand for housing, land, and neighbourhood characteristics in Britain.

[25]See Harrison and Rubinfield (1976).

Similar to section 2 of this paper, Sheppard and Cheshire (1998) discuss how implementing housing-related policies and estimating policy implications can only proceed if there is to exist detailed knowledge on the structure of demand in the housing market.

Both Chowhan and Prud'homme (2004) and Garcia and Raya (2011) investigate hedonic regressions to describe implicit prices of housing characteristics. The only Canadian study in this review, Chowhan and Prud'homme (2004), focuses on the Canadian rental market using Statistics Canada data to decompose rental price into each characteristics marginal price. This study uses both structural variables as well as locational characteristics. The key differences from our analysis are that we focus on both owned and rental units, include forecasting, and provide a more current and topical estimation. Garcia and Raya (2011) follow a similar hedonic regression approach but extend their study into characteristic demand functions for housing characteristics in the city of Barcelona.

The most closely related analysis is that of Green and Lee (2016). The goal of our research is to replicate this study, as far as possible, for the Canadian context. Green and Lee (2016) present a very similar two-stage approach as the above-mentioned papers to estimate the marginal prices of housing characteristics. From this, they are able to relate the marginal willingness to pay for a given characteristic to a set of hedonic characteristics of the housing unit as well as attributes of the household.

A key observation when examining related studies is the lack of Canadian literature. With the exception of Chowhan and Prud'homme (2004), the papers above are international studies, posing an opportunity and emphasizing the need to look at the Canadian housing market in a similar way.

# 2 Methodology

## 2.1 Model

According to hedonic theory applied to the housing market, agents (buyers and sellers) on both side of the market take the equilibrium hedonic pricing function – the relationship between housing characteristics and the price of the house – as given and make decisions optimally. In equilibrium, the resulting hedonic function has to be consistent with the choices that agents make. This is analogous (though more complicated) to assuming that buyers and sellers take prices as given when making their decisions but the price ends up being determined by the aggregate of their choices. The equilibrium hedonic pricing function for a given city $k$ is given by

$$P = P(\boldsymbol{Z}) \tag{1}$$

where $\mathbf{Z}$ denotes a vector of $n$ observable housing characteristics.

Households with an observable attribute vector $\mathbf{X}_h$ and a vector of unobservable tastes for each housing characteristic, $\boldsymbol{\nu}_h$, choose housing characteristics and non-housing consumption, $C$, to solve

$$\max \; U\left(\boldsymbol{Z}, C; \boldsymbol{X}_h, \nu_h\right) \tag{2}$$

subject to

$$P(\boldsymbol{Z}) + C \leq Y_h \tag{3}$$

This is different from a standard text book household optimization problem over goods because the budget constraint is non-linear. The first order conditions for household $h's$ optimization problem are

$$U_i\left(\boldsymbol{Z}_h, C_h; \boldsymbol{X}_h, \nu_h\right) = U_C\left(\boldsymbol{Z}_h, C_h; \boldsymbol{X}_h, \nu_h\right) P_i(\boldsymbol{Z}_h) \qquad \forall\ i \in \{1, ..., n\} \tag{4}$$

$$P(\boldsymbol{Z}_h) + C_h = Y_h \tag{5}$$

where marginal utility is $U_i = \frac{\partial U}{\partial Z_i}$, marginal willingness to pay (MWTP) is $P_i = \frac{\partial P}{\partial Z_i}$, $Z_i$ is the $i$th element of the characteristic vector $\boldsymbol{Z}$ and $\boldsymbol{Z}_h$ denotes household $h$'s optimal choice of characteristics. We assume that the second order conditions for a maximum hold.

Following Green and Lee (2016), I make the following functional form assumptions. I assume a Cobb-Douglas (or log-log) hedonic function:

$$P = \exp\left(\alpha_0 + \sum_{i=1}^{n} \alpha_i \ln Z_i\right) \Longleftrightarrow \ln P = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln Z_i \tag{6}$$

I assume a Linear-Quadratic utility function of the form:

$$U\left(\boldsymbol{Z}, C; \boldsymbol{X}_h, \nu_h\right) = \gamma \mathbf{Z} + \frac{\mathbf{B}}{2}\mathbf{Z}^T\mathbf{Z} + \boldsymbol{X}_h^T\boldsymbol{\Psi}^T\mathbf{Z} + \nu_h^T\mathbf{Z} + C \tag{7}$$

Note that since utility is an ordinal ranking, multiplying by any constant would make no difference to the FOCs. I therefore normalize, so that the parameter on consumption is 1.

The implied expressions for the derivatives are:

$$P_{i,h} = \frac{\partial P}{\partial Z_i} = \frac{\alpha_i P_h}{Z_{i,h}} \qquad \forall\ i \in \{1, ..., n\} \tag{8}$$

$$U_i = \frac{\partial U}{\partial Z_i} = \gamma_i + \boldsymbol{\beta}_i \mathbf{Z}_h + \boldsymbol{\Psi}_i \boldsymbol{X}_h + \nu_{i,h} \qquad \forall\ i \in \{1, ..., n\} \tag{9}$$

$$U_C = 1 \tag{10}$$

It follows that the FOCs imply

$$P_{i,h}(\boldsymbol{Z}_h) = \gamma_i + \beta_i \mathbf{Z}_h + \boldsymbol{\Psi}_i \boldsymbol{X}_h + \nu_{i,h} \qquad \forall\ i \in \{1, ..., n\} \tag{11}$$

Note that implicitly, since households optimize by choosing household characteristics, the optimal choices of household $h$, $\mathbf{Z}_h$ depends on the $\nu_{i,h}$'s. This presents an identification problem: if the $\nu_{i,h}$ are treated as residuals in an OLS regression, the parameter vector $\beta_i$ will be biased. For this reason, I follow Green and Lee limiting the analysis to studying the effect of variations in $\mathbf{X}_h$ on MWTP for a constant quality house (in this case, the average house). In effect, I study vertical shifts in the demand curves for characteristics starting from the average house and make no inference about the slopes of the demand curves (which depends on $\beta_i$).

Note that multiplying (8) by $Z_{i,h}$ and adding up across $i$ yields

$$\sum_{i=1}^{n} P_i Z_{i,h} = P_h \sum_{i=1}^{n} \alpha_i \tag{12}$$

If the hedonic pricing function is homogenous of degree 1, then $\sum_{i=1}^{n} \alpha_i = 1$ and so, in equilibrium, we can write

$$P_h = \sum_{i=1}^{n} P_i Z_{i,h} \tag{13}$$

For related literature on the above-mentioned identification problem, Bartik (1987) and Epple (1987) both outline the methodology used by Rosen (1974) and expand their analysis to examine possible difficulties of using such a technique. The key difficulty is an identification problem, explained above, that arises from how consumers endogenously choose both quantities and prices of housing characteristics.[26] This results in a bias on the estimated coefficients as a households choice of characteristics is correlated with unobserved tastes in the residual.[27] Different empirical techniques have been used in an attempt to mitigate this problem, with instrumental variables (IV) being a popular choice. Epple (1987) uses the IV approach and Bartik (1987) and Kahn and Lang (1988) both suggest instrumenting the quantity of a characteristic that a household consumers via market indicator variables. Bishop and Timmins (2019) describe the intuition for the IV approach, being that the differences in supply distribution across markets makes for exogenous variation in the quantity of characteristics picked by a household. They also describe that the IV approach requires strong assumptions and that the amount of variation in the endogenous variable may not be sufficient.[28] Due to the difficulties of finding adequate instruments and the strong assumptions that often come with the IV approach, we circumvent the issue by following the approach of Green and Lee (2016), where the constant-quality house is defined by using mean values for all covariates of the housing units in the given data set. This makes the housing quality predetermined and thus exogenous relative to the demand for a vector of structural characteristics.[29]

[26]See Bartik (1987).
[27]Ibid.
[28]See Bishop and Timmins (2019).
[29]See Green and Lee (2016).

## 2.2 Empirical Approach

Following closely the methodology used in Green and Lee (2016), the following analysis studies the Canadian housing market and focuses, in particular, on the relationship between primary householder age and housing demand. The following is an outline of empirical methodology to followed in this paper.

- The first stage decomposes the value of a house into the implicit value of each of its defined characteristics. This first regression tells us the proportional contribution of each characteristic to the total value of a home. This vector of characteristics is typically comprised of both location and structural characteristics. We will look at both the implications for Canada as a whole, as well as individually for Toronto and Vancouver. This stage ends with calculations of the marginal value for each characteristic.

- The second stage serves to estimate the marginal willingness to pay (MWTP), or in other words demand equations, for each characteristic. This regression uses the implicit value of each characteristic found in stage one and relates the MWTP to a vector of household attributes and other possible demand shifters.

- The third and final stage of this paper consists of a housing demand forecast, accomplished by using the stage two estimates combined with demographic projections.

### 2.2.1 First Stage

In the following model, $P$ represents the flow of housing services consumed in a given year. For rentals, this is assumed to equal the inflation-adjusted annual gross rent. For owners this

is the "user cost", computed using the following equation which mirrors that from Green and Lee (2016) but adjusted for the Canadian economy:

$$usercost_t = (r_t + \rho + \tau_t + \delta - g_t) * v \tag{14}$$

The above equation uses the inflation-adjusted property value ($v$) of a home, and throughout our empirical analysis we assume a value of 6.5% for $(r_t + \rho + \tau_t + \delta - g_t)$.[30] This 6.5% is comprised of: the nominal interest rate, $r_t$; the depreciation rate, $\delta$; a risk premium, $\rho$; property taxes, $\tau_t$; and $g_t$ which refers to the benefit or cost of ownership – all in time t. This estimate of 6.5% comes from Head and Lloyd-Ellis (2016), a paper including estimates for each of the above parameters included in user cost. The implicit flow of housing services is derived according to this equation and the regressions are undertaken pooling both rented and owned units.

As mentioned, the first-stage regression follows a log-log model.

$$\ln P = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln Z_i + \epsilon \tag{15}$$

where $P$ is the flow of housing services (user cost), $Z_i$ is the $i$th characteristic from the $\mathbf{Z}$ vector of $n$ structural characteristics defined above, and $\alpha_i$ represents the proportion of the home value derived from the $i$th characteristic. As seen from (12) and (13), a homogeneity restriction (of degree 1) is placed on the regression coefficients and thus (3) is estimated via constrained linear regression.

The final estimate for the first stage is the marginal value for each of the $n$ structural

[30] See Head and Llyod-Ellis (2016).

characteristics. With the log-log function, the total marginal value of each characteristic is a constant share of the total value of the house:

$$P_i = \frac{\alpha_i P}{z_i} \tag{16}$$

### 2.2.2 Second Stage

To estimate (6), we first estimate (from (5)) the implicit marginal value of a housing characteristic i for household h, $\hat{P_{ih}}$,and regress this onto both vectors $\mathbf{Z}$ and $\mathbf{Y}$ defined above. This gives:

$$\widehat{P_{ih}} = \beta_i \mathbf{Z}_h + \gamma_i \mathbf{A}_h + \tau_i \mathbf{C}_h + \Psi_i \mathbf{X}_h + \sum \Omega_i year_t + e_{ih} \tag{17}$$

where $\mathbf{Z}_h$ is a vector of n housing characteristics of household h, $\mathbf{Y}$ is made up of $A_h$ and $C_h$ which represent a set of dummy variables indicating age and birth cohort of a household h, and $\mathbf{X}_h$, a vector of other demographic attributes for household h. Year fixed-effects are captured by $year_t$. Again, this follows closely Green and Lee (2016).

Given that my analysis focuses on the willingness to pay for certain housing characteristics differs among age groups, it is especially important to estimate age effects correctly. Green and Hendershott (1996) discuss the importance of having both an age and cohort effects within this model. A cohort effect is defined based on the generation to which the primary householder belongs. Although this will be explained further in the data section below, the generations include: New Generation (post-1997); Millenials (1982-1996); Generation X (1965-1982); Baby Boomers (1946-1964); and Old Generation (pre-1945). This categorization of generations comes from Carlson (2008), adjusted to both suit our data and

allow for more recent generations. The importance of including both age and cohort effect comes from how the socioeconomic and demographic make-up in a given age group differs by the generation in which the individual was born. Due to how economy's evolve, different generations have access to differing opportunities – for example, college attainment is not stable over time – and thus it is unrealistic to assume individuals who are 60 years old in the Baby Boomers generation would act the same as those who are 60 years old but from an older or younger generation.

Once the coefficients are estimated, we are able to estimate the average willingness to pay of a household with a v-years old householder in generation w for a given characteristic i:

$$\widehat{P_{ivw}} = \hat{\beta}_i \mathbf{Z}_c + \hat{\gamma}_{iv} + \hat{\tau}_{iw} + \hat{\Psi}_i \overline{\mathbf{X}}_{vw} + \sum \hat{\Omega}_i \overline{year}_t \tag{18}$$

Equation (19) represents the willingness to pay for a characteristic of a constant-quality house, defined above, where $\mathbf{Z}_c$ is a vector of the mean-valued housing characteristics found in $\mathbf{Z}$, $\overline{\mathbf{X}}_{vw}$ is a vector of mean-valued household attributes by age v and cohort w, and $\hat{\gamma}_{iv}$ and $\hat{\tau}_{iw}$ are the age and birth cohort effects, respectively, estimated from the dummy variables in (7).

### 2.2.3 Real House Prices and Demand Forecast

Under the homogeneity restriction, real house prices can be derived by aggregating the dot products of a vector of willingness to pay from (8) with a corresponding vector of average quality characteristics:

$$\widehat{P_{vw}} = \sum_{i=1}^{n} \widehat{p_{ivw}} z_{ci} \tag{19}$$

This gives the willingness to pay for a constant-quality home for a household of age v and cohort w. In present terms, we can estimate the willingness to pay for a constant-quality house by use of population projections. Per-household housing demand can be represented as the weighted average of the willingness to pay for a constant-quality home found from (9), with the share of households by age as weights.[31] The results section below supplements this explanation.

# 3 Data

## 3.1 Data Collection

The main sources of data used are cross-sections from the 2016 Census of the Population Public Use Microdata File (PUMF), the 2011 National Household Survey (NHS) PUMF, and the 2006 Census of the Population PUMF. These datasets are re-coded and merged into one, repeated pooled crosss-sectional dataset, for Canadian households. For the demand forecasts we use Statistics Canada population projections.

The Census program and NHS are detailed surveys providing information on the Canadian population.[32] The datasets provide information on a representative sample of the Canadian population at the individual level, thus the advantage of using such data for this

[31] See Green and Lee (2016). This methodology follows closely what is done throughout this paper.
[32] See Statistics Canada (2016).

analysis is that each provides detailed information on private dwellings and households.[33] The PUMF data sets are quite restricted due to the limited number of variables available relative to the full surveys. It is possible, in principle, to extend our analysis to the full data set. However, due to security issues and time constraints related to accessing Queen's Research Data Centre, such an analysis is outside the scope of this paper.

The population projections used from Statistics Canada give an estimate of the number of persons by age group from 2016-2063.[34] Using the number of persons by age group and the total of all age groups, the share of the population by age group can be estimated for any given year.

## 3.2 Key Variables

Using different census years poses challenges. As 2006 was the most restricted year, 2011 and 2016 variables were re-coded to match how 2006 variables were defined. *Table 2.1* gives unweighted (UW) and weighted (W) frequencies of categorical variables.

The key variable in this paper with respect to estimates and forecasts is age group. We include age groups 3-13 in our analysis, described in *Table 2.* As mentioned, to separate age and cohort effects we generate a birth cohort variable based on the age group and census year. Using different census years allows us to separate the age and cohort effect as we avoid the issue of these variables being perfectly collinear. For housing characteristics we include the number of bedrooms, the number of other rooms, dwelling condition, dwelling type, and tenure. Household attributes include citizenship status, immigrant status, visible minority

[33] Ibid.

[34] See Statistics Canada, Table 17-10-0057-01.

status, marital status, education level, after-tax income, cohort, and age group. Year fixed-effects are included to account for year-to-year variations. To control for location we include a census metropolitan area (CMA) variable.

Another key variable is PRIHM, indicating whether or not the individual responding to the Census survey is the primary household maintainer. Our analysis is conducted only for observations within the data where the respondent is the primary householder, in order to properly measure the influence of socioeconomic/demographic factors have on housing choices.

Reference groups for the categorical variables defined below are chosen to be the most frequently observed category. For Citizenship, the category "Canadian Citizen" is used as reference. "Married" is the category chosen as reference for Marital Status, "High school diploma" for Education Level, "2006" for Year, and "Baby Boomers" for Cohort. We use "No repairs" as reference for the Dwelling Condition variable, and "Other dwelling" for that of Dwelling Type.

In the first-stage, as mentioned, I use log-log hedonic regression models. This involves using log transformations of both the price of a home and physical quality characteristics. To avoid the issue of log zero in these transformations, I add one to all categorical variables and re-code the dummy variables to be one if zero and e (Euler's number) if one. This makes the logs of dummy variables one and zero, as desired.

All observations are weighted using the Census sampling weights provided. These weights serve two key purposes: (1) being that within each year, different observations represent a different number of households, (2) is that across years, the surveys differ in size. Weights are used to ensure consistency over time.

***Table 2**. Key Categorical Variables*

| Variable | Description | Frquency(UW) | Frequency(W) |
|---|---|---|---|
| BedRm – Number of Bedrooms | 0 - No bedrooms | 0.66 | 0.85 |
| | 1 - One bedroom | 8.66 | 8.84 |
| | 2 - Two bedroom | 21.08 | 21.30 |
| | 3 - Three bedroom | 36.84 | 37.27 |
| | 4 - Four bedroom | 23.19 | 22.70 |
| | 5 - Five or more | 9.57 | 9.04 |
| ROOMS – Number of Rooms | 1 - One room | 0.38 | 0.45 |
| | 2 - Two rooms | 1.93 | 1.75 |
| | 3 - Three rooms | 6.48 | 6.31 |
| | 4 - Four rooms | 11.98 | 11.89 |
| | 5 - Five rooms | 14.65 | 14.69 |
| | 6 - Six rooms | 14.55 | 14.61 |
| | 7 - Seven rooms | 14.05 | 14.06 |
| | 8 - Eight rooms | 13.28 | 13.37 |
| | 9 - Nine rooms | 8.60 | 8.64 |
| | 10 - Ten rooms | 7.22 | 7.32 |
| | 11 - Eleven or more | 6.88 | 6.92 |
| REPAIR – Dwelling Condition | 1 - No repairs | 67.09 | 66.85 |
| | 2 - Minor repairs | 26.26 | 26.24 |
| | 3 - Major repairs | 6.65 | 6.90 |
| DTYPE – Dwelling Type | 1 - Single-detached | 62.02 | 63.36 |
| | 2 - Apartment | 26.14 | 25.55 |
| | 3 - Other dwelling | 11.84 | 11.09 |
| Tenur – Tenure | 0 - Rented | 26.26 | 26.24 |
| | 1 - Owned | 73.74 | 73.76 |
| AGEGRP – Age Group | 3 - 15-19 years | 6.22 | 5.77 |
| | 4 - 20-24 years | 7.91 | 8.02 |
| | 5 - 25-29 years | 7.98 | 7.98 |
| | 6 - 30-34 years | 8.20 | 8.14 |
| | 7 - 35-39 years | 8.28 | 8.38 |
| | 8 - 40-44 years | 8.61 | 8.98 |
| | 9 - 45-49 years | 9.10 | 9.58 |
| | 10 - 50-54 years | 9.54 | 9.59 |
| | 11 - 55-64 years | 16.24 | 15.93 |
| | 12 - 65-74 years | 10.60 | 10.28 |
| | 13 - 75+ years | 7.30 | 7.35 |
| COHORT – Generation Group | 1 - New Generation | 4.09 | 2.42 |
| | 2 - Millennials | 21.33 | 19.71 |
| | 3 - Generation X | 24.58 | 24.67 |
| | 4 - Baby Boomers | 38.75 | 39.50 |
| | 5 - Old Generation | 11.25 | 13.69 |
| VisMin – Visible Minority (VM) Status | 0 - Not a VM | 81.49 | 82.55 |
| | 1 - VM | 18.51 | 17.45 |

*(To be continued)*

***Table 2***: *Key Categorical Variables*

| Variable | Description | Frquency(UW) | Frequency(W) |
|---|---|---|---|
| Citizen – Citizenship Status | 1 - Citizen | 74.96 | 75.73 |
| | 2 - Citizen by naturalization | 18.68 | 18.39 |
| | 3 - Not a citizen | 6.36 | 5.88 |
| IMM - Immigrant Status | 0 - Not an immigrant | 75.94 | 76.42 |
| | 1 - Immigrant | 24.06 | 23.58 |
| PRIHM – Primary household maintainer | 0 - Not primary maintainer | 50.27 | 49.82 |
| | 1 - Primary maintainer | 49.73 | 50.18 |
| MarStH – Martial Status | 1 - Divorced | 6.01 | 6.07 |
| | 2 - Married | 59.44 | 59.62 |
| | 3 - Separated | 2.42 | 2.48 |
| | 4 - Never Married | 27.19 | 26.73 |
| | 5 - Widowed | 4.94 | 5.10 |
| HDGREE – Education Level | 1 - No diploma or degree | 18.73 | 19.18 |
| | 2 - High school | 26.28 | 26.18 |
| | 3 - Apprenticeship | 10.30 | 10.68 |
| | 4 - College | 19.12 | 18.89 |
| | 5 - Univ certificate below bachelors | 3.48 | 3.89 |
| | 6 - Bachelor's degree | 14.74 | 13.99 |
| | 7 - Univ certificate above bachelors | 7.35 | 7.20 |
| Year – Census Year | 1 - 2006 | 19.77 | 31.52 |
| | 2 - 2011 | 21.52 | 33.81 |
| | 3 - 2016 | 58.71 | 34.67 |
| CMA – Census metropolitan area | 462 - Montreal | 11.81 | 11.63 |
| | 535 - Toronto | 16.85 | 16.53 |
| | 825 - Calgary | 3.76 | 3.65 |
| | 835 - Edmonton | 3.60 | 3.51 |
| | 933 - Vancouver | 7.07 | 6.99 |
| | 999 - Other | 56.90 | 57.69 |

# 4 Results

## 4.1 First Stage

### *CANADA*

Within our first stage we estimate equation (15) separately for each year – allowing for the implicit marginal value of each housing characteristic to potentially adjust over time. We use the log of the flow of housing services - represented through the log of the user cost defined in (2), and regress this on our defined vector of housing and location characteristics. The coefficients for the vector of structural characteristics (*single-detached, apartment, minor repairs, major repairs, no. of bedrooms, no. of other rooms, and tenure*) in *Table 3* can be interpreted as the proportion of the home value derived from the $i$th characteristic. Recall that this comes from how the hedonic function is defined and that our homogeneity restriction requires that the coefficients on the vector of structural characteristics sum to one.

Looking at *Table 3*, the characteristic to derive the most value from a home in Canada, for 2006, is the number of other rooms. The proportion of value this derives is 0.569 in 2006, and decreases to 0.294 by 2016. For the number of bedrooms, we see the coefficient increase from 0.466 to 0.668 throughout 2006 to 2016 – bedrooms take up the largest proportion from 2011 onward. The dwelling type categories show that an apartment takes up more proportion of the value of a home than a single-family, detached house does – 0.204 for apartment in 2016 compared to 0.142 for single-family. The coefficients on minor and major repairs remain negative throughout all years but both see a slight increase from 2006 to 2011, followed by a decline from 2011 to 2016.

***Table 3***. *The first stage hedonic regression results for Canada, 2006-2016*

| *DV: log of user cost* | 2006 | 2011 | 2016 |
|---|---|---|---|
| *CMA (ref. Other)* | | | |
| Montreal | 0.262*** | 0.195*** | 0.166*** |
| | (0.00951) | (0.00638) | (0.00282) |
| Toronto | 0.730*** | 0.617*** | 0.737*** |
| | (0.00963) | (0.00596) | (0.00276) |
| Calgary | 0.682*** | 0.593*** | 0.536*** |
| | (0.0151) | (0.00890) | (0.00413) |
| Edmonton | 0.332*** | 0.468*** | 0.407*** |
| | (0.0177) | (0.00959) | (0.00418) |
| Vancouver | 0.853*** | 0.803*** | 0.858*** |
| | (0.0170) | (0.00964) | (0.00470) |
| *Dwelling Type (ref. Other)* | | | |
| Single-family, detached | 0.191*** | 0.161*** | 0.142*** |
| | (0.0130) | (0.00734) | (0.00295) |
| Apartment | 0.287*** | 0.228*** | 0.204*** |
| | (0.0110) | (0.00569) | (0.00257) |
| *Dwelling condition (ref. No repairs needed)* | | | |
| Minor repairs | -0.152*** | -0.0967*** | -0.103*** |
| | (0.00783) | (0.00516) | (0.00222) |
| Major repairs | -0.361*** | -0.194*** | -0.204*** |
| | (0.0171) | (0.00949) | (0.00402) |
| *Other characteristics* | | | |
| No. of bedrooms | 0.466*** | 0.557*** | 0.668*** |
| | (0.0133) | (0.00928) | (0.00377) |
| No. of other rooms | 0.569*** | 0.345*** | 0.294*** |
| | (0.0127) | (0.00744) | (0.00315) |
| Tenure | 0.273*** | 0.424*** | 0.397*** |
| | (0.0113) | (0.00627) | (0.00288) |
| Constant | 7.390*** | 7.776*** | 7.927*** |
| | (0.0154) | (0.0105) | (0.00435) |
| *N* | 94084 | 129643 | 354685 |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

These coefficients ultimately lead to the implicit valuation of each housing characteristic, found from (17). With regard to bedrooms, the implicit price of a bedroom rose 16.75% from 2006 to 2011 and 19.62% from 2011 to 2016. Similarly for other rooms, the implicit price saw a large increase from 2006 to 2011 of 34.25%. Though less in magnitude, the implicit price saw an increase from 2011 to 2016 of 28.153%. The largest increase can be seen through the implicit value of single-detached housing – up 41.93% from 2006 to 2011. A summary table

(*Table 4*) of values in 2016 inflation-adjusted dollars can be seen below.

***Table 4***. *Implicit marginal value of housing characteristics for Canada in 2016 dollars*

| | 2006 | 2011 | 2016 |
|---|---|---|---|
| No. of bedrooms | 2,185.63 | 2,551.69 | 3,052.45 |
| *Growth (%)* | | 16.75 | 19.62 |
| No. of other rooms | 2,123.46 | 2,850.78 | 3,653.35 |
| *Growth (%)* | | 34.25 | 28.153 |
| Tenure | 2,009.273 | 2,678.42 | 3,342.90 |
| *Growth (%)* | | 33.30 | 24.81 |
| Single-family, detached | 1,650.61 | 2,342.79 | 2,934.07 |
| *Growth (%)* | | 41.93 | 25.24 |
| Apartment | 4,704.70 | 5,520.59 | 6,723.63 |
| *Growth (%)* | | 17.34 | 21.79 |

In the following two sections, we compare growth in the implicit value of characteristics in the two largest cities in Canada, Toronto and Vancouver, to that of Canada as a whole. This will supplement our results by showing how growth differs in these areas relative to the rest of Canada. The separate analysis for Toronto and Vancouver will be extended into the second stage to compare how the willingness to pay for housing characteristics in these cities differs from the rest of Canada. We will also look at how the willingness to pay for a constant-quality house has evolved.

### *TORONTO*

A key difference between the Canada-wide and city-specific analyses is the inclusion of CMA controls. When looking at an individual CMA, this control is no longer necessary. The first stage regression results for Toronto from 2006-2016 can be seen in *Table 5*.

Comparing Toronto and Canada we see that for Toronto, a homes value is greatly derived by bedrooms in all years. Similar to what we see in the Canada-wide results, the coefficient

on the number of bedrooms increases from 2006 to 2016, and the coefficient on number of other rooms declines. The coefficients on bedrooms and other rooms are smaller than what we see in all of Canada, but we now see single-family detached homes taking on more of the value compared to Canada. Similarly, apartments are taking up less proportion of the home value than we see in Canada. Again, the coefficients on minor and major repairs are negative in all years, with minor repairs becoming more negative from 2006 to 2016 and major repairs following the same increase and then decrease we see in Canada.

***Table 5***. *The first stage hedonic regression results for Toronto, 2006-2016*

| *DV: log of user cost* | 2006 | 2011 | 2016 |
|---|---|---|---|
| *Dwelling Type (ref. Other)* | | | |
| Single-family, detached | 0.310*** | 0.279*** | 0.308*** |
| | (0.0310) | (0.0146) | (0.00618) |
| Apartment | 0.114*** | 0.117*** | 0.0681*** |
| | (0.0242) | (0.0113) | (0.00578) |
| *Dwelling condition (ref. No repairs)* | | | |
| Minor repairs | -0.0173 | -0.0213* | -0.0369*** |
| | (0.0189) | (0.0106) | (0.00504) |
| Major repairs | -0.0929** | -0.0572** | -0.103*** |
| | (0.0307) | (0.0187) | (0.00960) |
| *Other characteristics* | | | |
| No. of bedrooms | 0.352*** | 0.438*** | 0.537*** |
| | (0.0288) | (0.0165) | (0.00849) |
| No. of other rooms | 0.334*** | 0.245*** | 0.226*** |
| | (0.0355) | (0.0135) | (0.00653) |
| Tenure | 0.521*** | 0.600*** | 0.633*** |
| | (0.0244) | (0.0126) | (0.00688) |
| Constant | 8.361*** | 8.531*** | 8.733*** |
| | (0.0382) | (0.0198) | (0.0102) |
| *N* | 11973 | 19920 | 54976 |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

These coefficients lead to the implicit valuation of each characteristic, seen in *Table 6*. The implicit price of a bedroom in Toronto rose 27.69% from 2006 to 2011, and 61.96% from 2011 to 2016. Clearly, this growth has been much greater than that in all of Canada. Interestingly for other rooms we see a drop in value from 2006 to 2011, but a large increase of 32.74% from 2011 to 2016. Looking at dwelling type, the marginal valuation of single-family detached housing increased throughout the years – especially from 2011 to 2016, and apartments saw a decline in their implicit marginal value by -14.45% overall.

***Table 6***. *Implicit marginal value of housing characteristics for Toronto in 2016 dollars*

| | 2006 | 2011 | 2016 |
|---|---|---|---|
| No. of bedrooms | 2,542.85 | 3,244.40 | 5,254.79 |
| *Growth (%)* | | 27.69 | 61.96 |
| No. of other rooms | 1,945.59 | 1,746.87 | 2,318.87 |
| *Growth (%)* | | -10.21 | 32.74 |
| Tenure | 5,810.08 | 7,901.72 | 11,450.54 |
| *Growth (%)* | | 36.00 | 44.92 |
| Single-family, detached | 4,435.28 | 4,971.63 | 7,518.38 |
| *Growth (%)* | | 12.09 | 51.23 |
| Apartment | 2,878.86 | 3,074.76 | 2,462.95 |
| *Growth (%)* | | 6.8 | -19.90 |

### *VANCOUVER*

Looking at how the coefficients in *Table 7* compare to that of Toronto and Canada, Vancouver follows a very similar trend to what we see in Toronto. The coefficient on the number of bedrooms increases from 0.367 to 0.703 throughout 2006 to 2016, and the coefficient on the number of other rooms declines. Vancouver differs from Toronto and Canada in that single-family detached housing derives the largest proportion of the home value in 2006, but this declines so that the number of bedrooms is the highest from 2011 onward. The proportion

of the home value derived from being an apartment is higher than that in Toronto, but lower than that in Canada, and follows the trend of declining from 2006 to 2016 as we see in both other analyses. Again, these coefficients lead to the implicit valuations shown in *Table 8*.

***Table 7***. *The first stage hedonic regression results for Vancouver, 2006-2016*

| *DV: log of user cost* | 2006 | 2011 | 2016 |
|---|---|---|---|
| *Dwelling Type (ref. Other)* | | | |
| Single-family, detached | 0.588*** | 0.377*** | 0.391*** |
| | (0.0537) | (0.0288) | (0.0125) |
| Apartment | 0.181*** | 0.170*** | 0.130*** |
| | (0.0543) | (0.0211) | (0.00943) |
| *Dwelling condition (ref. No repairs)* | | | |
| Minor repairs | -0.0953* | -0.0133 | -0.0886*** |
| | (0.0404) | (0.0172) | (0.00965) |
| Major repairs | -0.371*** | -0.191*** | -0.282*** |
| | (0.0916) | (0.0386) | (0.0154) |
| *Other characteristics* | | | |
| No. of bedrooms | 0.367*** | 0.532*** | 0.703*** |
| | (0.0490) | (0.0260) | (0.0134) |
| No. of other rooms | 0.331*** | 0.125*** | 0.147*** |
| | (0.0593) | (0.0231) | (0.0122) |
| Tenure | 0.620*** | 0.866*** | 0.854*** |
| | (0.0464) | (0.0166) | (0.00995) |
| Constant | 8.292*** | 8.555*** | 8.611*** |
| | (0.0699) | (0.0309) | (0.0155) |
| *N* | 4983 | 8863 | 24290 |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In the case of Vancouver, the largest increase can be seen in the valuation of tenure from 2006 to 2011 – an increase of 77.94%. The implicit value increased further from 2011 to 2016 by 32.56%. Large increases can also be seen in the bedrooms and other rooms from 2011 to 2016. For bedrooms, we see an increase in the valuation by 55.8% from 2011 to 2016 and 70.72% from 2011 to 2016. Other rooms saw a large decline of 49.47% from 2006 to 2011,

followed by a sharp increase of 63.89% from 2011 to 2016. For dwelling type, we see little change for apartments, but a large increase of 45.63% for single-family housing from 2011 to 2016.

***Table 8***. *Implicit marginal value of housing characteristics for Vancouver in 2016 dollars*

| | 2006 | 2011 | 2016 |
|---|---|---|---|
| No. of bedrooms | 3,432.78 | 5,349.36 | 9,132.50 |
| *Growth (%)* | | 55.8 | 70.72 |
| No. of other rooms | 2,481.24 | 1,253.86 | 2,054.99 |
| *Growth (%)* | | -49.47 | 63.89 |
| Tenure | 8,605.80 | 15,312.88 | 20,298.88 |
| *Growth (%)* | | 77.94 | 32.56 |
| Single-family, detached | 10,979.32 | 9,917.34 | 14,442.97 |
| *Growth (%)* | | -9.67 | 45.63 |
| Apartment | 5,474.75 | 5,516.23 | 5,474.74 |
| *Growth (%)* | | -0.76 | 0.75 |

## 4.2 Second Stage

The second stage results utilize the pooled cross-sectional data – estimating (17) by regressing each housing characteristic on our defined vector of housing characteristics, a vector of housing attributes, and year controls. In the Canada-wide analysis, we include CMA controls as well. *Table 5* shows the regression results of selected housing characteristics where the coefficients estimated are used in (18) along with mean-valued (average) housing characteristics. This allows us to calculate the average willingness to pay of a household of age v and cohort w for each housing characteristic of a constant-quality house.

## *CANADA*

***Table 9***. *Results of second stage hedonic regression of selected housing characteristics for Canada*

| | No. of bedrooms | No. of other rooms | Single-family, detached | Apartment | Tenure |
|---|---|---|---|---|---|
| ***Household attributes*** | | | | | |
| *Citizenship status (ref. Citizen)* | | | | | |
| Canadian citizen by naturaliz.. | 282.2*** | 274.6*** | 223.9*** | 194.8** | 396.5*** |
| | (31.66) | (43.37) | (34.73) | (69.93) | (32.06) |
| Not a Canadian citizen | 130.7*** | 114.1** | 93.08** | -176.7** | 312.5*** |
| | (27.33) | (37.07) | (30.29) | (59.77) | (28.50) |
| *Marital status (ref. Married)* | | | | | |
| Divorced | -307.4*** | -342.1*** | -298.3*** | -512.8*** | -332.3*** |
| | (8.527) | (9.637) | (8.464) | (17.63) | (7.355) |
| Separated | -254.3*** | -306.4*** | -243.8*** | -543.2*** | -249.0*** |
| | (11.54) | (13.30) | (11.20) | (25.22) | (10.63) |
| Never married | -252.4*** | -319.9*** | -269.8*** | -398.5*** | -314.8*** |
| | (6.828) | (7.608) | (6.760) | (13.72) | (5.962) |
| Widowed | -158.8*** | -180.8*** | -157.8*** | -317.6*** | -168.4*** |
| | (10.31) | (11.40) | (9.777) | (21.94) | (8.804) |
| *Education (ref. High school)* | | | | | |
| No diploma or degree | -226.7*** | -244.8*** | -125.7*** | -426.9*** | -236.6*** |
| | (7.189) | (8.349) | (6.953) | (15.93) | (6.481) |
| Apprenticeship | -108.3*** | -142.5*** | -85.54*** | -243.1*** | -109.7*** |
| | (7.661) | (8.752) | (7.086) | (17.44) | (6.934) |
| College/CEGEP | 60.01*** | 52.59*** | 34.57*** | 119.7*** | 55.87*** |
| | (6.996) | (8.049) | (6.631) | (15.96) | (6.376) |
| Univ certificate below bach.. | 189.9*** | 203.9*** | 138.3*** | 372.2*** | 182.8*** |
| | (14.26) | (17.12) | (13.86) | (31.82) | (12.59) |
| Bachelor's degree | 514.7*** | 525.4*** | 421.2*** | 1121.9*** | 481.3*** |
| | (8.708) | (10.27) | (8.583) | (20.20) | (7.905) |
| Univ certificate above bach.. | 823.4*** | 850.6*** | 717.7*** | 1796.1*** | 773.5*** |
| | (11.88) | (13.76) | (12.15) | (27.64) | (10.65) |
| *Birth cohort (ref. Baby Boomers)* | | | | | |
| New Generation | -103.4 | -127.6 | -53.00 | -1207.6*** | 119.5 |
| | (79.81) | (104.1) | (87.61) | (154.4) | (83.82) |
| Millenials | -17.78 | -4.882 | 22.09 | -193.3*** | 75.70*** |
| | (19.06) | (22.73) | (18.83) | (43.90) | (17.58) |
| Generation X | 31.64** | 47.99** | 45.66*** | 202.9*** | 58.24*** |
| | (12.27) | (14.81) | (12.21) | (29.90) | (11.46) |
| Old Generation | 23.58 | 45.10* | 33.11* | 68.26* | 87.41*** |
| | (15.17) | (17.75) | (15.29) | (34.44) | (13.40) |
| *Age group (ref. 55-64 years)* | | | | | |
| 15-19 years | 351.6*** | 452.0*** | 229.6*** | 1165.2*** | 167.8** |
| | (54.76) | (69.20) | (56.35) | (122.6) | (57.19) |
| 20-24 years | 110.3*** | 159.7*** | 50.82* | 189.8*** | 23.73 |
| | (23.11) | (26.98) | (22.51) | (51.62) | (21.65) |
| 25-29 years | -114.7*** | -99.66*** | -137.4*** | -507.6*** | -144.0*** |
| | (19.80) | (22.76) | (18.97) | (45.06) | (17.78) |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

***Table 9 (cont.)***. *Results of second stage hedonic regression of selected housing characteristics for Canada*

| | No. of bedrooms | No. of other rooms | Single-family, detached | Apartment | Tenure |
|---|---|---|---|---|---|
| 30-34 years | -174.8*** | -175.4*** | -184.0*** | -740.4*** | -208.9*** |
| | (17.60) | (20.33) | (16.84) | (40.62) | (15.98) |
| 35-39 years | -140.1*** | -140.3*** | -137.6*** | -666.5*** | -156.1*** |
| | (15.61) | (18.71) | (15.45) | (37.44) | (14.49) |
| 40-44 years | -85.64*** | -71.79*** | -83.56*** | -419.2*** | -91.18*** |
| | (13.07) | (14.66) | (12.05) | (31.02) | (11.69) |
| 45-49 years | -31.97** | 3.829 | -32.73** | -197.4*** | -27.84** |
| | (10.81) | (12.12) | (10.06) | (25.26) | (9.660) |
| 50-54 years | -10.33 | 28.11* | -3.360 | -43.52 | 0.984 |
| | (9.346) | (11.03) | (9.138) | (22.39) | (8.543) |
| 65-74 years | -3.986 | -59.88*** | -6.494 | -39.50 | -44.87*** |
| | (12.06) | (14.92) | (12.87) | (27.91) | (10.93) |
| 75+ years | 88.90*** | -3.420 | 53.50** | 35.68 | 16.57 |
| | (18.59) | (21.23) | (18.44) | (41.23) | (16.20) |
| *Other attributes* | | | | | |
| Immigrant | -46.16 | 99.73* | -28.83 | 385.8*** | -189.6*** |
| | (30.16) | (41.73) | (33.42) | (66.72) | (30.98) |
| Visible Minority | -144.8*** | 195.5*** | -70.50*** | -221.9*** | -140.5*** |
| | (11.37) | (14.35) | (12.06) | (25.53) | (10.26) |
| After-tax income | $3x10^{-6}$*** | $2x10^{-6}$** | $2x10^{-6}$*** | $4x10^{-6}$*** | $3x10^{-6}$*** |
| | ($5x10^{-7}$) | ($6x10^{-7}$) | ($5x10^{-7}$) | ($1x10^{-6}$) | ($5x10^{-7}$) |
| ***CMA controls*** (*ref. Other CMA)* | | | | | |
| Montreal | 314.2*** | 267.2*** | 225.8*** | 938.3*** | 265.6*** |
| | (6.113) | (6.465) | (6.279) | (12.77) | (5.460) |
| Toronto | 1681.6*** | 1758.7*** | 1390.0*** | 3809.9*** | 1630.7*** |
| | (9.182) | (10.30) | (8.657) | (21.43) | (8.244) |
| Calgary | 1214.9*** | 1274.9*** | 883.5*** | 2830.6*** | 1197.4*** |
| | (12.91) | (14.54) | (11.24) | (31.12) | (11.92) |
| Edmonton | 733.0*** | 772.0*** | 463.7*** | 1654.2*** | 747.5*** |
| | (10.45) | (12.00) | (8.706) | (24.22) | (9.996) |
| Vancouver | 2782.7*** | 3165.4*** | 2671.6*** | 5683.4*** | 2629.8*** |
| | (19.92) | (24.44) | (21.21) | (46.03) | (17.77) |
| ***Year fixed-effects*** (*ref. 2006)* | | | | | |
| 2011 | 372.2*** | 430.4*** | 298.1*** | 761.8*** | 356.0*** |
| | (6.777) | (7.173) | (5.995) | (15.11) | (5.820) |
| 2016 | 867.4*** | 1064.8*** | 802.3*** | 1783.5*** | 916.0*** |
| | (7.358) | (8.090) | (6.833) | (16.78) | (6.497) |
| ***Housing characteristics*** | | | | | |
| *Dwelling type (ref. Other)* | | | | | |
| Single-family, detached | 202.7*** | 245.0*** | -1315.5*** | 687.8*** | 174.4*** |
| | (4.524) | (5.484) | (5.848) | (9.948) | (3.996) |
| Apartment | 237.3*** | 229.2*** | 197.9*** | -1486.1*** | 126.3*** |
| | (5.382) | (6.385) | (7.658) | (9.586) | (4.825) |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

***Table 9 (cont.)***. *Results of second stage hedonic regression of selected housing characteristics for Canada*

| | No. of bedrooms | No. of other rooms | Single-family, detached | Apartment | Tenure |
|---|---|---|---|---|---|
| *Dwelling condition (ref. No repairs)* | | | | | |
| Minor repairs | -138.0*** | -154.4*** | -90.33*** | -366.5*** | -128.6*** |
| | (3.136) | (3.695) | (3.053) | (7.317) | (2.855) |
| Major repairs | -200.5*** | -237.7*** | -123.2*** | -548.8*** | -186.6*** |
| | (5.446) | (6.092) | (5.134) | (11.70) | (4.753) |
| *Other characteristics* | | | | | |
| No. of bedrooms | -325.3*** | 446.0*** | 400.5*** | 825.1*** | 411.3*** |
| | (3.646) | (3.982) | (3.683) | (7.152) | (2.962) |
| No. of other rooms | 161.3*** | -466.3*** | 127.5*** | 401.0*** | 154.4*** |
| | (1.961) | (2.587) | (1.801) | (4.618) | (1.736) |
| Tenure | 609.5*** | 704.3*** | 820.9*** | 330.2*** | -800.0*** |
| | (4.528) | (4.971) | (5.104) | (7.305) | (3.982) |
| Constant | 338.5*** | 66.71* | 87.40** | -653.7*** | 1026.8*** |
| | (25.63) | (29.47) | (32.92) | (51.74) | (23.55) |
| $N$ | 562440 | 562440 | 562440 | 562440 | 562440 |
| $R^2$ | 0.324 | 0.370 | 0.428 | 0.451 | 0.366 |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

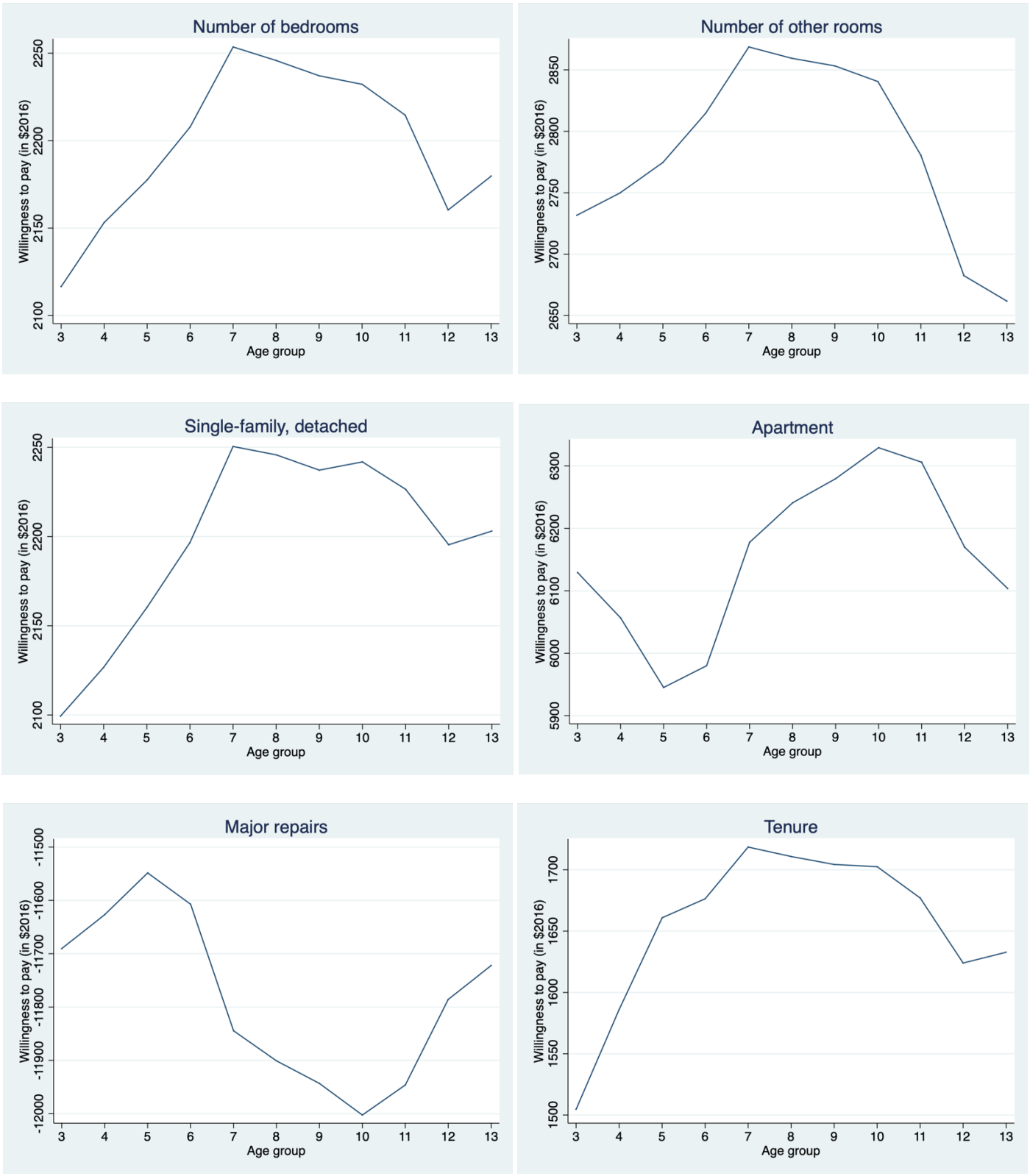



**Figure 1.** Willingness to pay for selected housing characteristics by age group in Canada
Age groups: 3 = 15-19 years, 4 = 20-24 years, 5 = 25-29 years, 6 = 30-34 years, 7 = 35-39 years, 8 = 40-44 years, 9 = 45-49 years, 10 = 50-54 years, 11 = 55-64 years, 12 = 65-74 years, 13 = 75+ years

(*Recall: Values come from (8) using estimated coefficients in Table 5 and mean values for all covariates.)*

Looking at the results in *Table 9* for the number of bedrooms, both being a Canadian citizen by naturalization and not being a Canadian citizen are positively related to WTP for a bedroom relative to being a Canadian citizen. All marital status' exhibit a negative relationship relative to being married, and all higher education levels (with the exception of apprenticeship) are associated with increased positive coefficients – relative to having a high school diploma. For age and cohort group, being in the New Generation or Millenial group is negatively associated with WTP for a bedroom, whereas Generation X and the Old Generation experience positive demand – all relative to the Baby boom population. For age groups relative to those 55-64, younger groups (<25) have a positive relationship with WTP for a bedroom, where middle-old groups (30-54 and 65-75) experience a negative relationship. Being 75 and older is positively associated with WTP for a bedroom. For other household attributes, both being an immigrant and a visible minority are negatively associated with WTP for a bedroom, relative to being neither. We see that bedrooms are a normal good, as the income effect is positive.

For the number of other rooms, the relationships follow a similar trend. All citizenship, marital status, and education categories maintain the same relationship with other rooms as bedrooms discussed above – relative to each corresponding reference categories. For birth and age group, those 50-54 years now have a positive relationship with WTP for an other room, and the relationship for those 75 and above is now negative. The relationships for cohort group remain the same. For other rooms, for being an immigrant and of visible minority are positively related to WTP for an other room, and the income effect remains positive and significant.

For all other normal goods (single-family detached, apartment, tenure), the relationships

for marital status and education with WTP remain unchanged. The citizenship variable remains unchanged with the exception of a negative relationship between not being a Canadian citizen and the WTP for an apartment. For age and cohort group, we see similar results with a few exceptions, and for the first time we see opposite signs on the immigrant and visible minority dummy variables. This occurs with regard to the WTP for an apartment, where being an immigrant has a positive relationship and being of visible minority is negative.

For year-fixed effects, all regressions give the result of positive coefficients for 2011 and 2016 relative to 2006, similar to the CMA controls which all exhibit positive relationships, relative to the rest of Canada, with the WTP for normal goods.

Figure 1 depicts the different WTP for key characteristics among age groups in Canada. In most cases, younger and older age groups have a lower willingness to pay for normal goods, and a higher willingness to pay for inferior goods (major repairs – a positive scalar of minor repairs). The high willingness to pay for apartments relative to single-detached housing can be seen when looking at the corresponding coefficients for each of these regressions in *Table 9*. The coefficients for the apartment column are much larger in magnitude than that for single-family, detached housing – likely attributed to how a building/house comprised of rental units adds a substantial amount of additional value to the property.

## *TORONTO*

***Table 10***. *Results of second stage hedonic regression of selected housing characteristics for Toronto*

| | No. of bedrooms | No. of other rooms | Single-family, detached | Apartment | Tenure |
|---|---|---|---|---|---|
| ***Household attributes*** | | | | | |
| *Citizenship status (ref. Citizen)* | | | | | |
| Canadian citizen by naturaliz.. | 324.5*** | 150.6*** | 435.5*** | 67.96 | 884.2*** |
| | (60.18) | (32.75) | (89.03) | (42.34) | (140.2) |
| Not a Canadian citizen | 346.1*** | 169.0*** | 459.3*** | 83.38* | 946.6*** |
| | (55.28) | (29.62) | (80.77) | (38.54) | (131.7) |
| *Marital status (ref. Married)* | | | | | |
| Divorced | -313.7*** | -160.7*** | -561.7*** | -191.3*** | -774.8*** |
| | (25.96) | (13.33) | (42.25) | (18.42) | (50.35) |
| Separated | -306.8*** | -189.4*** | -566.3*** | -217.6*** | -756.4*** |
| | (31.01) | (16.03) | (48.77) | (23.47) | (64.82) |
| Never Married | -197.6*** | -122.2*** | -446.6*** | -104.7*** | -631.9*** |
| | (21.33) | (10.65) | (34.82) | (14.02) | (41.36) |
| Widowed | -192.8*** | -103.3*** | -370.7*** | -134.6*** | -434.3*** |
| | (32.83) | (16.73) | (50.45) | (24.66) | (62.78) |
| *Education (ref. High school)* | | | | | |
| No diploma or degree | -173.2*** | -84.92*** | -215.4*** | -86.43*** | -484.9*** |
| | (23.60) | (12.61) | (36.04) | (18.31) | (47.09) |
| Apprenticeship | -92.22** | -71.96*** | -113.3* | -86.47*** | -219.8*** |
| | (30.09) | (16.00) | (45.52) | (24.94) | (61.51) |
| College/CEGEP | 42.91* | 15.38 | 77.89* | 42.46* | 134.6** |
| | (21.24) | (11.21) | (31.75) | (16.83) | (43.02) |
| Univ certificate below bach.. | 349.3*** | 178.2*** | 506.0*** | 261.0*** | 851.2*** |
| | (36.44) | (21.31) | (57.84) | (31.55) | (75.68) |
| Bachelor's degree | 738.1*** | 330.9*** | 1071.9*** | 515.9*** | 1662.0*** |
| | (22.05) | (11.80) | (34.35) | (17.90) | (45.41) |
| Univ certificate above bach.. | 1096.3*** | 502.8*** | 1607.9*** | 757.7*** | 2404.8*** |
| | (27.15) | (14.20) | (43.28) | (21.91) | (54.79) |
| *Birth cohort (ref.Baby Boomers)* | | | | | |
| New Generation | -122.5 | 88.72 | 524.1 | 304.9 | 1074.7 |
| | (449.6) | (286.2) | (795.8) | (227.2) | (920.2) |
| Millenials | -73.52 | 48.96 | 114.1 | 67.29 | 78.69 |
| | (57.36) | (30.93) | (90.05) | (44.28) | (116.5) |
| Generation X | 78.33* | 40.03* | 132.5* | -12.05 | 203.6** |
| | (34.42) | (19.27) | (54.90) | (29.87) | (72.21) |
| Old Generation | 38.42 | 47.10 | 119.2 | 159.6*** | 341.1*** |
| | (51.98) | (25.67) | (80.17) | (35.65) | (98.18) |
| *Age group (ref. 55-64 years)* | | | | | |
| 15-19 years | 802.0* | 313.5 | 872.7 | 78.98 | 1136.2 |
| | (314.7) | (245.9) | (591.3) | (209.5) | (676.4) |
| 20-24 years | 431.0*** | 132.5** | 334.1** | -4.117 | 787.9*** |
| | (75.77) | (40.44) | (115.5) | (55.83) | (158.4) |
| 25-29 years | 63.55 | -45.08 | -157.5 | -220.9*** | 91.91 |
| | (60.52) | (33.15) | (94.93) | (48.50) | (121.8) |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

***Table 10***. *Results of second stage hedonic regression of selected housing characteristics for Toronto*

| | No. of bedrooms | No. of other rooms | Single-family, detached | Apartment | Tenure |
|---|---|---|---|---|---|
| 30-34 years | -114.1* | -86.48** | -267.5*** | -195.9*** | -267.4* |
| | (50.87) | (28.35) | (80.78) | (43.94) | (104.0) |
| 35-39 years | -166.1*** | -67.89** | -212.0** | -95.12* | -300.2** |
| | (44.18) | (24.58) | (70.45) | (38.41) | (92.43) |
| 40-44 years | -169.2*** | -71.55*** | -244.6*** | -101.5** | -322.6*** |
| | (36.12) | (21.45) | (58.48) | (34.29) | (75.64) |
| 45-49 years | -67.59* | -28.56 | -127.1** | -52.40 | -117.1 |
| | (29.77) | (16.95) | (47.80) | (29.31) | (63.24) |
| 50-54 years | -72.05** | -29.10* | -121.1** | -71.59** | -134.3* |
| | (26.56) | (14.33) | (41.11) | (22.99) | (56.06) |
| 65-74 years | 88.17* | 12.05 | 124.9 | -26.37 | -14.16 |
| | (44.06) | (19.83) | (65.22) | (22.37) | (80.48) |
| 75+ years | 92.90 | -24.11 | 147.1 | -127.0** | -67.34 |
| | (61.41) | (30.43) | (93.95) | (43.14) | (116.5) |
| *Other attributes* | | | | | |
| Immigrant | -387.1*** | -156.7*** | -579.5*** | -66.13 | -995.2*** |
| | (57.70) | (31.56) | (84.90) | (40.28) | (136.1) |
| Visible Minority | -276.3*** | -108.0*** | -569.0*** | -160.4*** | -720.2*** |
| | (17.77) | (9.613) | (28.45) | (13.89) | (36.49) |
| After-tax income | $3x10^{-5}$*** | $2x10^{-5}$*** | $4x10^{-5}$** | $2x10^{-5}$*** | $6x10^{-5}$*** |
| | ($8x10^{-6}$) | ($3x10^{-6}$) | ($1x10^{-5}$) | ($5x10^{-6}$) | ($2x10^{-5}$) |
| ***Year fixed-effects*** (*ref. 2006)* | | | | | |
| 2011 | 1172.6*** | -218.8*** | 153.5*** | 467.1*** | 1951.5*** |
| | (19.77) | (11.38) | (31.68) | (18.70) | (39.52) |
| 2016 | 3246.7*** | 239.4*** | 2535.5*** | -0.455 | 5226.1*** |
| | (22.98) | (12.49) | (36.00) | (18.29) | (45.09) |
| ***Housing characteristics*** | | | | | |
| *Dwelling type (ref. Other)* | | | | | |
| Single-family, detached | 586.5*** | 326.4*** | -2868.7*** | 590.8*** | 1148.2*** |
| | (12.39) | (6.920) | (24.69) | (10.18) | (24.51) |
| Apartment | 168.1*** | 58.60*** | 6.373 | -682.6*** | 421.6*** |
| | (14.47) | (7.494) | (31.57) | (9.065) | (28.16) |
| *Dwelling condition (ref. No repairs)* | | | | | |
| Minor repairs | -97.69*** | -44.01*** | -94.60*** | -81.04*** | -255.7*** |
| | (9.864) | (5.234) | (15.49) | (8.127) | (20.23) |
| Major repairs | -161.6*** | -78.66*** | -232.3*** | -92.90*** | -417.3*** |
| | (17.14) | (9.012) | (26.63) | (13.41) | (35.06) |
| *Other characteristics* | | | | | |
| No. of bedrooms | -555.0*** | 275.8*** | 853.9*** | 297.6*** | 1242.2*** |
| | (11.40) | (5.395) | (17.15) | (7.621) | (20.10) |
| No. of other rooms | 226.3*** | -367.9*** | 313.9*** | 180.3*** | 480.9*** |
| | (6.243) | (3.648) | (9.187) | (5.134) | (12.32) |
| Tenure | 1124.0*** | 532.9*** | 1935.5*** | 290.9*** | -1782.1*** |
| | (12.61) | (5.932) | (20.34) | (6.797) | (24.17) |
| $N$ | 85558 | 85558 | 85558 | 85558 | 85558 |
| $R^2$ | 0.386 | 0.370 | 0.422 | 0.585 | 0.374 |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

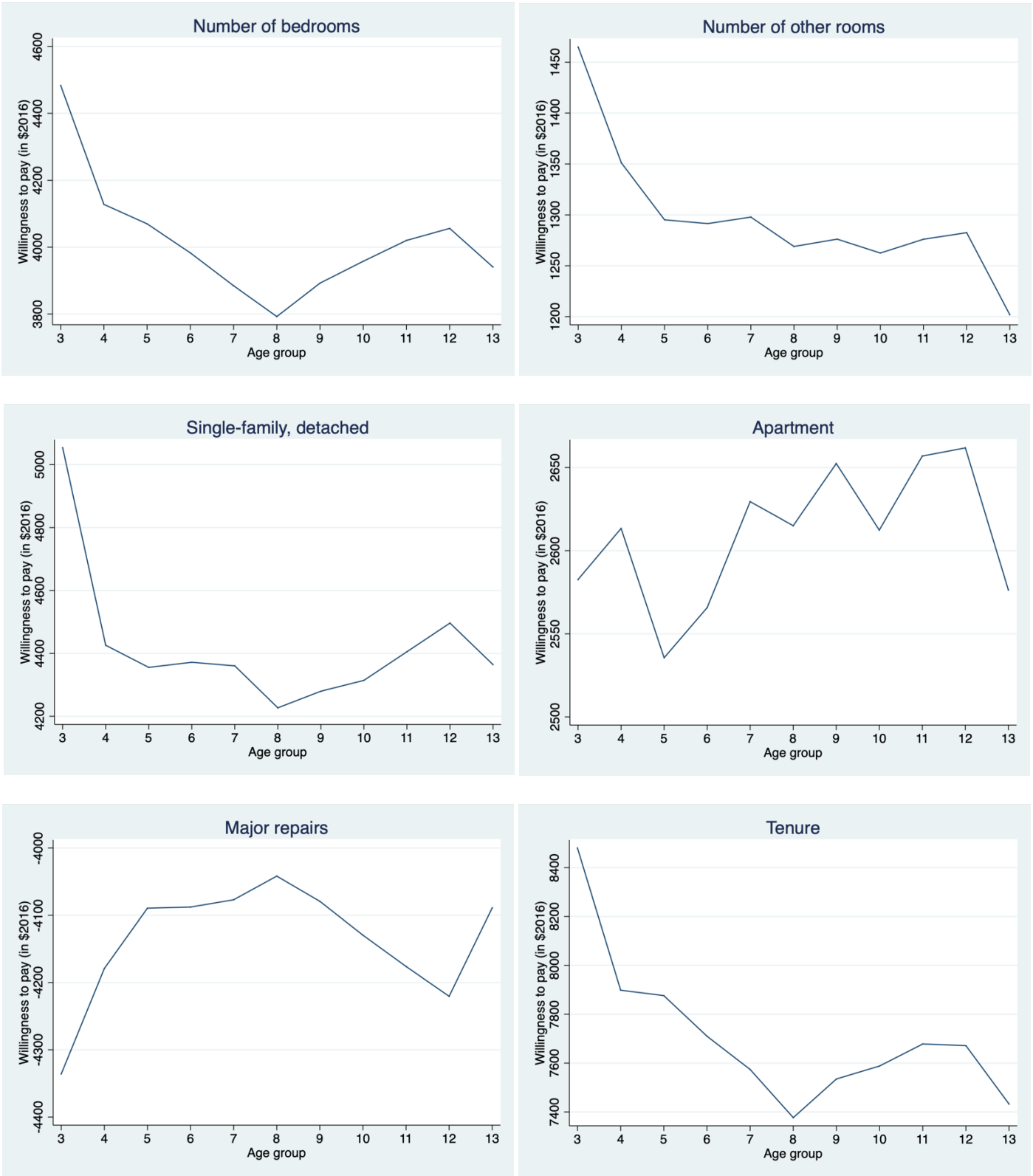



**Figure 2.** Willingness to pay for selected housing characteristics by age group in Toronto.
Age groups: 3 = 15-19 years, 4 = 20-24 years, 5 = 25-29 years, 6 = 30-34 years, 7 = 35-39 years, 8 = 40-44 years, 9 = 45-49 years, 10 = 50-54 years, 11 = 55-64 years, 12 = 65-74 years, 13 = 75+ years

(*Recall: Values come from (8) using estimated coefficients in Table 5 and mean values for all covariates.)*

Comparing the results for Canada (*Table 9*) and Toronto (*Table 10*), the largest discrepancy comes from regressing apartment on all selected variables. We can see now, compared to a negative relationship for Canada, a positive relationship with not being a Canadian citizen and WTP for an apartment. For cohort groups, the New Generation and Millenials now have a positive relationship with WTP for an apartment, compared to Canada as a whole which exhibits a negative relationship within these groups. Generation X now has a negative relationship. Similarly with age groups, those 20-24 and 75+ are negatively associated with WTP for an apartment – compared to a positive relationship within the same age groups mentioned in Canada-wide results.

For the number of bedrooms, the only difference for Canada and Toronto lies in the relationships between age groups. For Toronto, those aged 25-29 and 65-74 have a positive relationship with willingness to pay for a bedroom – as opposed to negative for Canada. For other rooms, all cohort groups relative to Baby Boomers have a positive relationship with WTP, where as for Canada as a whole the New Generation and Millenial groups are negatively related. Older age groups differ in sign as well, with those aged 45-54 and 65-74 seeing opposite relationships with Canada. Being an immigrant or a visible minority in Toronto is associated with a negative demand/WTP for other rooms, compared to all of Canada where both coefficients are positive.

For single-detached and tenure, the only differences between Toronto and Canada arise within age and cohort groups. Looking at single-detached housing, the New Generation has a higher WTP than the Baby boom population – the opposite holds when looking at all of Canada. The only difference in age group is for those aged 65-74 which is now positive, though still insignificant. The demand for ownership (tenure) sees only minor differences.

Those aged 25-29 now have a positive demand for ownership, and those 50-54 and 75+ are now negative (though for the most part insignificant).

To conclude, the main differences when looking at the regression outputs for Canada and Toronto (*Table 9* and *Table 10*) come from age and cohort effects. There exists an interaction between age group, cohort, and year – with the net effects differing between Toronto and the rest of Canada.

With reference to *Figure 3*, we now see a different trend compared to Canada. Attention should be given to the values on the y-axis as they differ from the Canada-wide analysis. For example, when looking at tenure, we now have a range of WTP from ∼$7,400 to ∼$8,600, compared with a range for Canada of ∼$1,500 to ∼$1,750. Households in Toronto are implicitly less likely to avoid housing in need of major repairs than households in all of Canada, exhibiting less sensitivity to inadequate dwelling conditions. Another example is how Toronto experiences a higher WTP for a bedroom and a lower WTP for other rooms.

## *VANCOUVER*

***Table 11****. Results of second stage hedonic regression of selected housing characteristics for Vancouver*

| | No. of bedrooms | No. of other rooms | Single-family, detached | Apartment | Tenure |
|---|---|---|---|---|---|
| ***Household attributes*** | | | | | |
| *Citizenship status (ref. Citizen)* | | | | | |
| Canadian citizen by naturaliz.. | 265.2 | 11.15 | 556.8 | -232.7 | 947.6* |
| | (162.5) | (49.25) | (320.6) | (132.2) | (373.2) |
| Not a Canadian citizen | 447.3*** | 108.7** | 812.3** | 167.5 | 1652.6*** |
| | (132.9) | (38.90) | (265.7) | (104.0) | (313.5) |
| *Marital status (ref. Married)* | | | | | |
| Divorced | -543.4*** | -183.4*** | -1300.3*** | -285.6*** | -1274.5*** |
| | (80.45) | (22.91) | (156.2) | (62.83) | (157.8) |
| Separated | -604.4*** | -141.6*** | -1488.9*** | -246.5** | -1447.8*** |
| | (100.6) | (30.10) | (189.1) | (89.79) | (208.8) |
| Never Married | -154.3* | -81.92*** | -665.7*** | 147.2** | -471.9*** |
| | (60.46) | (17.01) | (115.4) | (45.72) | (118.9) |
| Widowed | -34.42 | -26.97 | -282.9 | -0.253 | -209.2 |
| | (115.8) | (34.33) | (220.3) | (96.50) | (226.5) |
| *Education (ref. High school)* | | | | | |
| No diploma or degree | -259.1** | -123.8*** | -405.8* | -330.5*** | -730.1*** |
| | (80.16) | (24.26) | (159.2) | (68.50) | (167.0) |
| Apprenticeship | -233.4** | -90.64*** | -358.4* | -393.0*** | -596.8*** |
| | (80.19) | (23.87) | (151.7) | (73.17) | (171.1) |
| College/CEGEP | 184.5** | 36.59 | 201.3 | 109.9 | 366.6** |
| | (67.07) | (19.77) | (128.4) | (59.51) | (140.1) |
| Univ certificate below bach.. | 606.6*** | 169.6*** | 1228.5*** | 470.2*** | 1474.4*** |
| | (111.0) | (36.04) | (221.2) | (102.7) | (234.9) |
| Bachelor's degree | 1273.2*** | 296.2*** | 1952.8*** | 1040.4*** | 2929.7*** |
| | (72.22) | (21.19) | (134.7) | (64.28) | (153.4) |
| Univ certificate above bach.. | 1969.8*** | 436.9*** | 3187.8*** | 1504.1*** | 4378.7*** |
| | (93.01) | (26.28) | (175.2) | (82.31) | (195.7) |
| *Birth cohort (ref. Baby Boomers)* | | | | | |
| New Generation | -2233.0*** | -166.7 | -2638.8* | -710.1 | -2967.2* |
| | (599.3) | (159.2) | (1112.0) | (628.2) | (1392.3) |
| Millenials | -1132.3*** | 16.05 | -638.8 | -288.8 | -1316.3*** |
| | (174.6) | (58.29) | (355.8) | (153.3) | (371.1) |
| Generation X | -50.09 | 17.12 | 107.6 | 72.14 | 342.9 |
| | (114.3) | (37.63) | (231.8) | (106.5) | (250.4) |
| Old Generation | -583.2*** | -117.1* | -527.0 | -90.54 | -510.2 |
| | (174.1) | (46.42) | (311.1) | (142.0) | (344.3) |
| *Age group (ref. 55-64 years)* | | | | | |
| 15-19 years | 1579.5*** | 73.48 | 1841.8* | 383.3 | 2204.3* |
| | (365.0) | (116.4) | (808.6) | (573.4) | (1047.5) |
| 20-24 years | 1187.8*** | -49.73 | 482.6 | 125.8 | 1518.9*** |
| | (208.5) | (67.90) | (427.7) | (181.1) | (447.1) |
| 25-29 years | 615.0*** | -111.4 | -457.9 | -171.3 | 506.2 |
| | (178.3) | (64.75) | (384.7) | (166.6) | (381.5) |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

***Table 11***. *Results of second stage hedonic regression of selected housing characteristics for Vancouver*

| | No. of bedrooms | No. of other rooms | Single-family, detached | Apartment | Tenure |
|---|---|---|---|---|---|
| 30-34 years | -111.5 | -189.4*** | -1078.5*** | -569.6*** | -919.6** |
| | (149.4) | (50.98) | (310.5) | (145.4) | (333.7) |
| 35-39 years | -575.5*** | -193.1*** | -1327.4*** | -751.7*** | -1632.3*** |
| | (141.6) | (46.52) | (288.3) | (134.6) | (313.6) |
| 40-44 years | -433.1*** | -161.1*** | -1025.0*** | -601.3*** | -1307.3*** |
| | (116.5) | (42.49) | (246.4) | (118.4) | (257.7) |
| 45-49 years | -158.0 | -70.42* | -432.3* | -327.3*** | -501.3* |
| | (89.25) | (31.31) | (193.7) | (96.95) | (208.3) |
| 50-54 years | -61.03 | -16.91 | -195.6 | -123.8 | -167.2 |
| | (92.24) | (26.77) | (173.0) | (84.10) | (196.6) |
| 65-74 years | 634.6*** | 106.2** | 750.4** | 333.8** | 881.5** |
| | (157.7) | (35.95) | (260.6) | (103.1) | (293.6) |
| 75+ years | 1143.2*** | 181.2** | 1111.4** | 512.5** | 1736.6*** |
| | (205.6) | (56.16) | (378.1) | (165.8) | (404.0) |
| *Other attributes* | | | | | |
| Immigrant | -63.53 | 49.58 | -278.3 | 353.3** | -642.1 |
| | (149.3) | (45.78) | (300.2) | (121.8) | (352.2) |
| Visible Minority | 288.9*** | 147.7*** | 377.7** | 384.8*** | 481.7*** |
| | (66.37) | (18.29) | (126.6) | (55.58) | (138.9) |
| After-tax income | $-3x10^{-6}$ | $-4x10^{-7}$ | $5x10^{-6}$ | $3x10^{-6}$ | $5x10^{-6}$ |
| | ($1x10^{-5}$) | ($3x10^{-6}$) | ($2x10^{-5}$) | ($1x10^{-5}$) | ($3x10^{-5}$) |
| ***Year fixed-effects*** (*ref. 2006)* | | | | | |
| 2011 | 2671.3*** | -1178.9*** | -2328.6*** | 682.6*** | 5565.8*** |
| | (56.66) | (22.00) | (123.3) | (61.93) | (122.9) |
| 2016 | 6421.4*** | -543.4*** | 1207.2*** | 953.4*** | 10114.7*** |
| | (78.39) | (25.50) | (145.9) | (66.57) | (149.8) |
| ***Housing characteristics*** | | | | | |
| *Dwelling type (ref. Other)* | | | | | |
| Single-family, detached | 1713.5*** | 519.3*** | -4074.6*** | 2279.1*** | 3480.8*** |
| | (45.70) | (13.66) | (89.26) | (42.53) | (91.55) |
| Apartment | 975.4*** | 224.2*** | 2358.6*** | -1082.3*** | 2148.4*** |
| | (38.65) | (11.01) | (95.60) | (28.09) | (78.46) |
| *Dwelling condition (ref. No repairs)* | | | | | |
| Minor repairs | -96.37** | -19.57* | -143.9* | -167.0*** | -271.0*** |
| | (32.90) | (9.952) | (60.93) | (30.18) | (70.05) |
| Major repairs | -249.7*** | -89.16*** | -550.2*** | -275.4*** | -597.7*** |
| | (58.00) | (14.77) | (98.46) | (44.69) | (106.3) |
| *Other characteristics* | | | | | |
| No. of bedrooms | -521.7*** | 328.5*** | 2755.8*** | 610.9*** | 2812.5*** |
| | (30.92) | (8.236) | (59.43) | (23.20) | (61.01) |
| No. of other rooms | 374.7*** | -342.6*** | 662.6*** | 314.6*** | 814.5*** |
| | (21.30) | (6.578) | (37.27) | (19.64) | (44.26) |
| Tenure | 2468.8*** | 625.1*** | 4459.2*** | 958.9*** | -612.4*** |
| | (33.23) | (8.476) | (58.25) | (20.98) | (60.02) |
| $N$ | 37037 | 37037 | 37037 | 37037 | 37037 |
| $R^2$ | 0.338 | 0.383 | 0.355 | 0.544 | 0.352 |

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$


**Figure 3.** Willingness to pay for selected housing characteristics by age group in Vancouver.
Age groups: 3 = 15-19 years, 4 = 20-24 years, 5 = 25-29 years, 6 = 30-34 years, 7 = 35-39 years, 8 = 40-44 years, 9 = 45-49 years, 10 = 50-54 years, 11 = 55-64 years, 12 = 65-74 years, 13 = 75+ years

(*Recall: Values come from (8) using estimated coefficients in Table 5 and mean values for all covariates.)*

The following is a comparison of second stage regression results for Vancouver to that of Toronto and Canada. Looking at the number of bedrooms, the results for Vancouver are consistent with both Toronto and Canada in citizenship, martial status, and education level. Again the differences are seen primarily within age and birth groups. For Vancouver, Generation X and the Old Generation have a negative association with the WTP for a bedroom. This compares to a positive relationship for both cohort groups in the Toronto and Canada analysis. For age groups, the results for Vancouver are consistent with what is seen in Toronto, and in Vancouver being a visible minority is positively associated with the WTP for a bedroom.

Again we see that for almost all other regressions shown, the relationship between citizenship, marital status, and education level with WTP are consistent to all previous analyses – the effects of both citizen categories are positive relative to being a Canadian citizen, those of all marital status categories are negative relative to being married, and those of higher education levels with the exception of being an apprentice are increasingly positive. The one case where this doesn't hold is when looking at the apartment regression for Vancouver, where being a Canadian citizen by naturalization is negatively related to WTP for an apartment and where never being married ss positively related – relative to being married.

The age and cohort groups are where the most significant discrepancy can be seen, resulting in different WTP structures among groups in Vancouver. The trends seen in *Figure 3* are consistent with what would be expected when looking at the coefficients in *Table 11*. Compared to Toronto, the key difference can be seen in how younger age groups no longer have the higher WTP for normal goods. The WTP for major repairs is substantially less in Vancouver than Toronto, seen by looking at the values on the y-axis. The WTP for to own

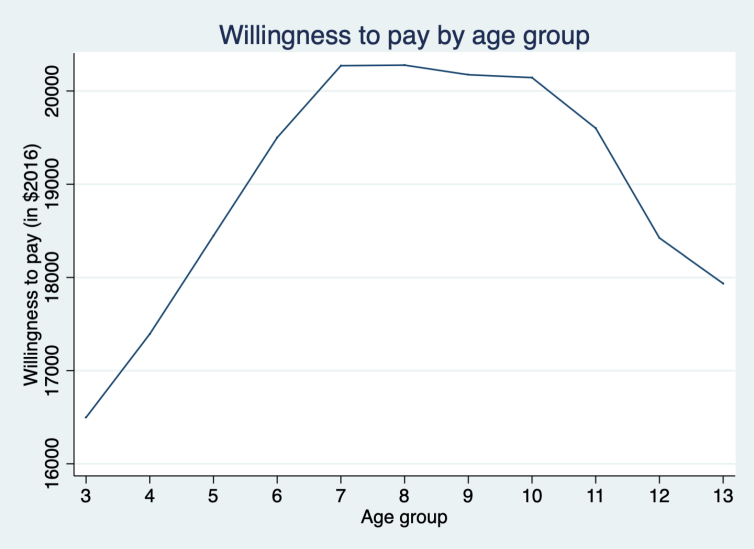
rather than rent now ranges from ∼$27,600 to ∼$29,200 – much higher than that for both Canada and Toronto. The magnitude of WTP for all characteristics other than other rooms are generally much higher than for Canada and Toronto, where Toronto sees the lowest WTP for other rooms, followed by Vancouver and Canada experiences the highest. This shows how the value of homes in Vancouver and Toronto appear to be more driven by the number of bedrooms, and having other rooms isn't as relevant with regard to pricing.

## 4.3 Real House Prices and Demand Forecast

### 4.3.1 Real House Prices

We defined real house prices as the willingness to pay for a constant-quality house for each age group. This can be found by use of (19) for each of the above mentioned locations. Note that the respective constant-quality house is estimated within each location separately and that these numbers are averaged over age and cohort group.

***Figure 4***. *Willingness to pay for a constant-quality house in Canada, by age group*



Looking first at *Figure 4* we see that the willingness to pay for a constant-quality house in Canada is lowest within younger and older age groups, and highest in middle aged groups. This is what we would intuitively expect when thinking of the demand structure in the housing market. Younger and older age groups are shown to have the lowest demand for a constant-quality home, with middle-old aged groups experiencing the highest.

***Figure 5***. *Willingness to pay for a constant-quality house in Toronto, by age group*


Looking next at *Figure 5* we see that the willingness to pay for a constant-quality house in Toronto is much higher overall. For Canada we saw the y-axis range from roughly $16,000 to $20,500, and for Toronto we see values from just under $44,000 to just over $50,000. Another dramatic difference between Canada and Toronto is how younger age groups now have a higher willingness to pay for a constant-quality house. This can likely be attributed to how younger age groups in Toronto are almost always renting, and thus end up paying much more for a home of constant-quality. The willingness to pay stays moderately stable in middle/older age groups.

***Figure 6***. *Willingness to pay for a constant-quality house in Vancouver, by age group*


Lastly looking at *Figure 6* we see the willingness to pay for a constant-quality house in Vancouver is the lowest in age groups 7 and 8 (40-49 years) and highest in older age groups. Compared to that of Canada and Toronto, Vancouver is consistent with Canada in that younger age groups are less willing to pay for a constant-quality house. It differs in how older groups are now more willing to pay. The magnitude of willingness to pay is much higher in Vancouver compared to both Toronto and Canada – ranging from $134,000 to just under $144,000.

### 4.3.2 Demand Forecast

The following analysis is undertaken using Canada-wide results as the forecasts of the population-age structure are not available at the CMA level.

With the foundation estimates in **4.3.1** for Canada we are able to predict future housing demand at the per-household level. This can be done by use of Statistics Canada population projections. These projections, as mentioned in the data section above, give estimates for

the population by age group. Using these estimates and the total population, we calculate the share of the population found within each age group. The population projections done by Statistics Canada include different growth-scenarios and those used within this paper are the Low-growth scenario, Medium-growth scenario using 2009/2010 to 2010/2011 trends, and High-growth scenario.

Using the share of the population and the estimates from (19) we estimate the per-household willingness to pay for a constant-quality house. This is the weighted average of estimates from (19), where (19) gives single average willingness to pay for each age group – seen in *Figure 4*. The weight used is the share of the population of each given age group – allowing the distribution to change over time. Using the per-household willingness to pay for a constant-quality house, we are able to provide the results in aggregate as well. This is done using the number of households in 2016, given by Statistics Canada Census 2016, and assuming the number of households grows in proportion to the population. We can then use the same population projections used for the per-household WTP to calculate how the population is expected to evolve over time, and multiply each per-household WTP by the estimated number of households in a given year. *Table 12* gives predicted demand for housing services per household, in 2016 dollars, and as an aggregate, in 2016 billion dollars, for 2016-2040. Annualized growth rates are given in the table as well, assuming the growth is evenly distributed across years. Note that these estimates effectively assume that the composition of the housing stock (ie. the distribution of characteristics) will evolve with the demands of the population.

***Table 12***. *Projected housing demands in 2016 dollars, 2016-2040*

| | 2016 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|
| *Aggregate (in 2016 billion dollars)* | | | | | | |
| Low-growth | 241.808 | 248.171 | 256.651 | 261.889 | 267.081 | 270.515 |
| Medium-growth | 241.689 | 250.468 | 261.838 | 273.191 | 284.651 | 295.607 |
| High-growth | 241.438 | 252.279 | 267.636 | 283.665 | 301.371 | 320.324 |
| *Annualized growth (%)* | | | | | | |
| Low-growth | | 0.65784 | 0.68340 | 0.40819 | 0.39653 | 0.25712 |
| Medium-growth | | 0.90808 | 0.90788 | 0.86714 | 0.83901 | 0.76977 |
| High-growth | | 1.12257 | 1.21744 | 1.19786 | 1.24836 | 1.25777 |
| *Per-household (in 2016 dollars)* | | | | | | |
| Low-growth | 17,183.52 | 17,178.72 | 17,333.48 | 17,356.10 | 17,463.52 | 17,530.31 |
| Medium-growth | 17,175.10 | 17,128.99 | 17,116.56 | 17,135.10 | 17,205.52 | 17,277.57 |
| High-growth | 17,157.21 | 17,049.75 | 16,919.40 | 16,834.12 | 16,866.86 | 16,950.93 |
| *Annualized growth (%)* | | | | | | |
| Low-growth | | -0.00698 | 0.18017 | 0.02610 | 0.12378 | 0.07649 |
| Medium-growth | | -0.06710 | -0.01452 | 0.02166 | 0.08219 | 0.08375 |
| High-growth | | -0.15659 | -0.15290 | -0.10081 | 0.03890 | 0.09969 |

Looking at the results in *Table 12* for per-household demand for housing services, the low-growth scenario results in the highest expected housing demand and the high-growth scenario results in the lowest. A low-growth scenario means that we have a larger share of those in older age groups, and thus a higher emphasis on older age groups when estimating willingness to pay per household. Given the shape of the curve in *Figure 4*, it makes sense that we would experience a higher predicted housing demand per household in the low-growth scenarios, as middle and older age groups exhibit higher willingness to pay than that of younger age groups. For the same reason, we would expect the high-growth scenario to result in a lower predicted housing demand per household – putting a greater emphasis on younger generations with lower willingness to pays. When looking at the aggregate results, we see that housing demand, in all growth scenarios, increases over time. The demand for housing

services is highest in the high-growth scenario and lowest in the low-growth scenario, with the high-growth being the only scenario to exhibit increased growth for each year. Both the low-growth and medium-growth scenario see positive growth in all years, but this growth declines in magnitude for each given year.

# 5 Conclusion

This analysis emphasizes different demand structures throughout the Canadian housing market. As high housing prices within Canadian markets can be partly explained by the high demand for housing in these areas, knowing where this demand comes from is increasingly important.

For the first stage we see that for Canada, Toronto, and Vancouver, the number of bedrooms derives the largest proportion of the home value – especially for 2016. This is the largest in Vancouver, who also sees the largest proportion being derived from single-family detached housing. In Canada, we see that apartments derive more value than single-family detached housing, opposite to both Toronto and Vancouver.

From the second stage we see that for Canada as a whole, high demand for housing services exists primarily in middle age groups. For Toronto, high demand for housing services exists primarily within younger age groups. These younger age groups are putting upward pressure on housing demand, making the value of a constant-quality house increase as the potential amount earned by renting is large. Additionally, renting results in the availability of purely owned rentals to decline. In Vancouver, we see the highest demand for housing in older age groups – showing that even though Vancouver has high housing prices, this

demand tends to come through older age groups rather than younger, like we see in Toronto. From the second stage regression, we see the most discrepancy within the age and cohort effects for different locations.

For our demand forecasts, we see that the per-household demand for housing services is highest in the low-growth scenario due to how this emphasizes middle-older age groups who have a higher willingness to pay relative to younger age groups. We see the lowest per-household demand for housing services in the high-growth scenario, as this puts emphasis on younger age groups who have a lower willingness to pay. For the results in aggregate, we see that the total demand for housing services in Canada is expected to increase in all years, with the high-growth scenario exhibiting increased growth in subsequent years. Both the low-growth and medium-growth scenarios see positive growth that declines in magnitude over the years.

It is clear that if we use blanket housing policies for all of Canada, they may be ineffective in certain areas. Different demand structures require different demand-related policies in order to be most effective, and thus this analysis has substantial value. Currently, this is the only study to extend the Rosen (1974) methodology to study and estimate future housing demand in Canada, and suggests significant potential for the research. Such research could include expanding the available data to include more housing characteristics and household attributes. The availability of population by age group within CMAs would also allow us to study projected housing demands throughout Canadian cities. Given we have studied housing demand by age group, this could be done for another control group other than age as well. A few potential options could be to look at housing demand by income, ethnic group, or racial group.

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