FUNDAMENTALS AFFECTING CANADIAN HOUSING MARKET

by

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Abstract

This paper studies the underlying long-term relationship between economic factors and house prices growth in Canada. Fundamentals used include, monthly real interest rate, mortgage rate, rental vacancy rate, rents and integrated Cost of Housing Capital. Monthly data for a time range of 10 years was used for the fitted regression and standard multi-factor regression model. Analysis that was conducted in this paper serve the purpose of examining the dynamics and correlations between fundamental variables and future growth rate of real estate prices.

On top of confirming results from previous studies on the strong responsiveness that house prices have to the movements of general economic conditions and the correlations with economic fundamentals, this paper goes further to compare these indicators with the objectives of finding out their predicting abilities. Results from the model specifically studies the correlation coefficients between growth rate of housing market with several economic fundamentals, such as the price to rent ratio, vacancy rate and the cost of housing capital.

Keywords: Real Estate market, house prices, macroeconomic variables, CMHC.

Dedication

We want to dedicate this research paper to our families for their unconditional love and support and to all our classmates and professors for an awesome chapter in our lives.

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1: Introduction

According to MLS Home Price Index, nominal house prices doubled from January 2005 to December 2016 in Canada with major metropolises such as Vancouver saw 2.37 times increase and Toronto 2.28 times. High volatility has shaken the traditional belief that houses are safe and long-term investments for people wanting to receive stable income. With real estate industry going through a rapid commercialization period in a worldwide scale, Canada, as major metropolitans started showing early signs, is predicted to experience fluctuations in house prices as demand continue to grow. Even though there are no consensus towards the causes of such volatility, macroeconomic condition and related factors should provide indication on some level of the pricing of houses in the long run.

Generally speaking, houses and properties, if treated as regular commodities should have prices that behave in a way like other commodity markets with multiple forces drive their movements. These drivers include macroeconomic factors include nominal interest rate, property tax rate, personal disposable income and employment condition, and local factors such as housing supply, property transfer tax rate, property depreciation rate, rental vacancy rate, etc. The common understanding is that favourable economy situation could simulate housing prices appreciation. However, the reality says otherwise sometimes with housing market in turn becomes the major driving force for the macro-economy or even when building up too much as to create a bubble.

Housing market with no doubt is one of the most important sector both in terms of its size and its significance in people's lives. Governments from countries all over the world

have been working on the supervision and regulations over real estate market. One example would be the recently issued additional property transfer tax for foreign buyers in metro Vancouver and the great Toronto area as a measure to control house prices. Nevertheless, one year after the implementation of the foreign buyer tax, the latest Housing Market Assessment still shows a red flag for Vancouver with particular concern given to "overvaluation and price acceleration". (Macleans, 2017) This reminds us that housing markets are influenced by a variety of factors that are constantly in flux and one or several indices with predicting ability on future house price movement could be of great use when measures and regulations are in need.

From the complex matrix of factors that influence real estate market, our analysis focus on macroeconomic variables that display propagation mechanism on the housing market such as national GDP, income growth, disposable income and mortgage rate. Rents and rental vacancy rate, given their role as an income source for owning properties also proved to have strong correlation with house price and its movement. Another indicator is the cost of housing capital which was constructed with nominal interest rate plus property tax rate after the effect of income tax and then combined with maintenance and depreciation rate.

House price dynamics have been attracting people's attention for a long time and for a lot of reasons. As the single largest component of household asset, owner-occupied homes comprise a major part of private-sector wealth. Its size and significant impact on social economy have urged monetary and regulatory policy makers to take into account emerging housing price fluctuations in their assessment to prevent 2008 subprime mortgage crisis from happening again. Therefore, it is for the benefit of the entire society that better understandings on the housing market and better indicators that can be used to forecast future movement of house prices be derived from historical data and empirical studies.

2: Review of Literature

Case and Shiller (1989, 1990) pioneered the analysis of housing price data. The S&P CoreLogic Case-Shiller Home Price Indices, as the leading measures of U.S. residential real estate prices, track changes in the value of residential real estate in 20 defined MSAs and three price tiers – low, middle and high. The indices is calculated using a three-month moving average algorithm, on which the repeat sales methodology is applied. The original analysis also tested the autocorrelation both in annual changes in real house prices and in estimated after-tax excessive returns. Evidence from their studies showed positive conclusions on the ability of macroeconomic variables in predicting house prices.

Previously, there are a number of empirical studies that have also given positive results on the correlation between house prices and economic fundamentals and scholars from all over the world have been refining different models using better indicators. However, only a limited number of papers deal directly with the question of how much economic indicators helps predict future changes. Clapp and Giaccotto (1994) in their research *The Influence of Economic Variables on Local House Price Dynamics* used two methods for measuring house price changes: the repeat sales method and the assessed value method and came to the conclusion that "these variables have considerable forecasting ability, contrary to the efficient market hytpothesis".

Similar conclusions were made by Englund and Loannides (1997), Malpezzi and Mayo(1997), and Kaparova and White (2001) to examine the dynamics between house prices and economic factors in an international perspective. Englund and Loannides in *House Price Dynamics: an International Empirical Perspective* compared the correlation relationship in

fifteen OECD countries. Malpezzi and Mayo worked on the basic urban indicators collected by the World Bank and the United Nation and put conditions in housing markets of one country in perspective relative to other countries. In *The Responsiveness of House Prices to Macroeconomic Forces: A Cross-Country Comparison*, Kasparova and White examined the situations in selected European Union countries and investigated the degree of correlation between the housing markets and the underlying demand and supply variables.

Another interesting idea that was brought up by Mankiw and Weil (1989) was that demographic changes can have major impact on the housing market and in *The Baby Boom, The Baby Bust, and The Housing Market*, they made assertive prediction that "If the historical relation between housing demand and housing prices continues into the future, real housing prices will fall substantially over the next two decades". This sociological perspective was also adopted by other scholars like Adams and Füss (2009) and Agnello and Schuknecht (2011). Adams and Füss in *Macroeconomic Determinants of International Housing Markets* discussed the lag effect of house prices in reaction to macroeconomic shocks and brought up the phenomena for house prices to exhibit strong downward price stickiness since homeowners tend to resist selling below a certain price during recessions.

With regard to specific relationship like house prices and rents, Meese and Wallace (1994) gave evidence on the co-integration between prices and rents using time-series data for Alameda and San Francisco counties. Transcending the previous studies on rents and prices, Gallin (2008) gave a well-structured model to examine how well the rent-price relationship can help predict future changes in real property prices, according to Gallin's findings in the article *The Long-Run Relationship Between House Prices and Rents.*

3: Data and Limitations

Scholars around the world in real estate research field have found that adequate housing market data are generally not available and usually of very low frequency. As a relatively young commodity that became one of the investment options for households just in the recent decade, new factors with the ability to influence property prices emerged and brought noise to the traditional model. Increasingly complicated market condition and urgent need for monetary and regulatory supervisions, especially after 2008, called for regular recording on property prices and systematic indices that could better reflect the real market condition.

3.1 House Prices

Due to the complexity that lies within the definition of house price and the difficulty in collecting actual data, researchers tend to use different methodologies when applying housing price data to their models. Recent developments in real estate indices have cast some light on the situation of housing market. In this article, MLS Home Price Index is the basic indicator used to gauge changes in home prices. This monthly index covers 11 major housing markets (see Appendix 1) separately and a composite HPI aggregated from different house types, using multivariate regression analysis. Therefore, the index is able to reflect contributions made by various quantitative and qualitative features toward the home price with the help of a hybrid modelling approach that merges the repeated-sales and hedonic price approaches.

By contrast, a similar index for the analysis of the U.S. housing market is the previously mentioned Case-Shiller Home Price Indices which use the repeated sales method

in the calculation. According to HPI methodology, MLS Home Price Index is superior to the repeated sales approach in that it overcame several disadvantages that repeated-sales approach has such as the neglect of sub-areas within a market, the considerable time lag due to data collection and the omit of useful information because only homes that have been sold at least twice are used.

MLS HPI takes into account available information and data that describes land, buildings, location, socio-demographic attributes (education level, average income) and additional geographical neighbourhood characteristics (nearby streets, hospitals and schools). Therefore, overall MLS Home Price Index is a good match for our researching needs and objectives. For details, please see Appendix 2.

3.2 Average Rents

Adequate information for rental market presents even more challenges, especially real data that could accurately reflect the entire market because of the level of freedom in the market and lack of direct regulation. Canada Mortgage and Housing Corporation (CMHC) conducts the Rental Market Survey (RMS) every year in April and October to estimate the relative strengths in the rental market. The survey targets only privately initiated structures with at least three rental units which have been on the market for at least three months. CMHC also conducts Secondary Rental Market Survey (SRMS) every summer and fall to estimate relative strengths in the market of dwellings not covered by the regular RMS. (Appendix 3)

Another technique for the source of rent data that was adopted by Gallin was the index for tenant's rent form the Consumer Price Index (CPI). Gallin argued that this measurement works better because it is closer to "housing dividends for owners" and it is

available for a much longer time series. Gallin also adjusted the published rent data by boosting the growth rate of the index 0.3 percentage point per year prior to 1988 and then increased the growth rate of the entire series an additional 0.2 percentage point for adequate adjustment purpose.

The rent data we used combined the two sources: by having the data from CMHC worked as the framework, we interpolate monthly data within the adjacent two actual rents from the Rental Market Survey with structured values that following the exact same increase rate as Consumer Product Index, thus creating a series of data that not only conform to the CPI growth rate, but also mirror actual level in the market. (Appendix 4)

3.3 Cost of Housing Capital

Effective user cost on home ownership has been a major concern while making house purchasing decisions which in turn makes it a well-related indicator on the pricing of houses. Diaz and Luengo-Prado (2008) pointed out different measurements for user cost and explained with the concept of shadow price of owning a house which "comprises current transactions costs, the forgone return to housing equity and the cost of mortgage payments plus future expected transaction costs, maintenance and property taxes, minus expected capital gains." They concluded that if households opt for renting, then the shadow price of housing services is the rental price of housing:

$$\frac{U_s(C_t, S_t)}{U_c(C_t, S_t)} = r_t^f$$

Additionally, the price of rental units and the shadow price of owner-occupied housing services could be amplified if the homeowner holds debt and is liquidity constrained.

Gallin mentioned similar idea that linked user cost with rents that in a frictionless market if the rent should cover the user cost of housing, the relationship between house prices and rents could be expressed with the following equation:

$$R_t = P_t[(i_t + \tau_t^p)(1 - \tau_t^y) + \delta_t + \Lambda_t - E_t G_t + 1]$$

"where P_t is the house price, R_t is rent, i_t is the nominal interest rate, τ_t^p is the property tax rate, τ_t^y is the marginal income tax rate, δ_t is the combined maintenance and depreciation rate, Λ_t is the risk premium associated with housing and $E_t G_t$ is expected capital gains." (Gallin, 2008)

In the same article, Gallin used a simpler equation for the direct user cost of housing capital, denoted as C_t, which was adopted in this paper for the analysis of Canadian housing market:

$$C_t = (i_t + \tau_t^p)(1 - \tau_t^y) + \delta_t$$

This equation revealed the main factors that contribute to the cost of holding properties: interest rate, taxes and maintenance and depreciation rate. Based on this equation, our data is constructed by nominal interest rate which is calculated by putting 5 year fixed posted mortgage rate on top of inflation, annual property tax rate, marginal income tax rate and average rate of property maintenance and depreciation.

3.4 Rental Vacancy Rate

As well as the ability that rental vacancy rate has in indicating the availability in the general housing market, very few articles put major attention on the study of rental vacancy rate. One of the reasons could be the lack of sufficient data due to the difficulty in tracking

the exact units that are actually vacant. Canadian Mortgage and Housing Corporation (CMHC) conducts Rental Market Survey semi-annually to determine the vacancy rates for different types of houses and apartments with the purpose of better monitoring the housing market. However, the scope and type of data received have obvious limitations. An extreme low vacancy rate could indicate an over-heated housing market without an equilibrium in the overall supply and demand and furthermore, with ongoing demand for rental housing and limited increases in supply, average rents are expected to rise.

The data that CMHC provides is restricted to a certain time series length and very low frequency (semi-annual). To better understand rental market and the relationship between rents and rental availability which essentially is a matter of demand and supply, in this article, K-nearest interpolation method (Appendix 5) is used to fill the gap between April and October and obtain monthly data for the regression model.

3.5 Price-Rent Ratio

Rent-Price Ratio is a well-established economic principle used for real estate valuation in quite a lot of empirical studies. Even though it is not much of a benchmark for the overall property affordability, at the basic level, price-to-rent ratio effectively compares the economics of buying versus renting. An abnormally surging price-to-rent ratio could be a red flag to a housing bubble which was proved by the dramatic increase of the ratio that led up to the 2008-2009 housing market crash.

Scholars study price-rent from different perspectives. For example, Campbell, Davis, Gallin and Martin (2009) decomposed price-rent ratio into the present discounted value of real interest rate, housing return premium over risk-free rate, and expected rent growth. Kishor and Morley used similar decomposition method, combined with a latent variable

approach but focus on finding out the actual fractions of these factors in contributing to the variability of rent-price ratio.

In our research, we jumped directly to the fitting of regression of the real house prices growth and real rent growth rate with price-rent ratio respectively. Regression lines shows that when price-rent ratio is high, rents increase in subsequent years which conforms to the theory of Clark's (1995) that "price at least partially capitalize the present value of future rents". Therefore, high house prices signal the increase of future rents.

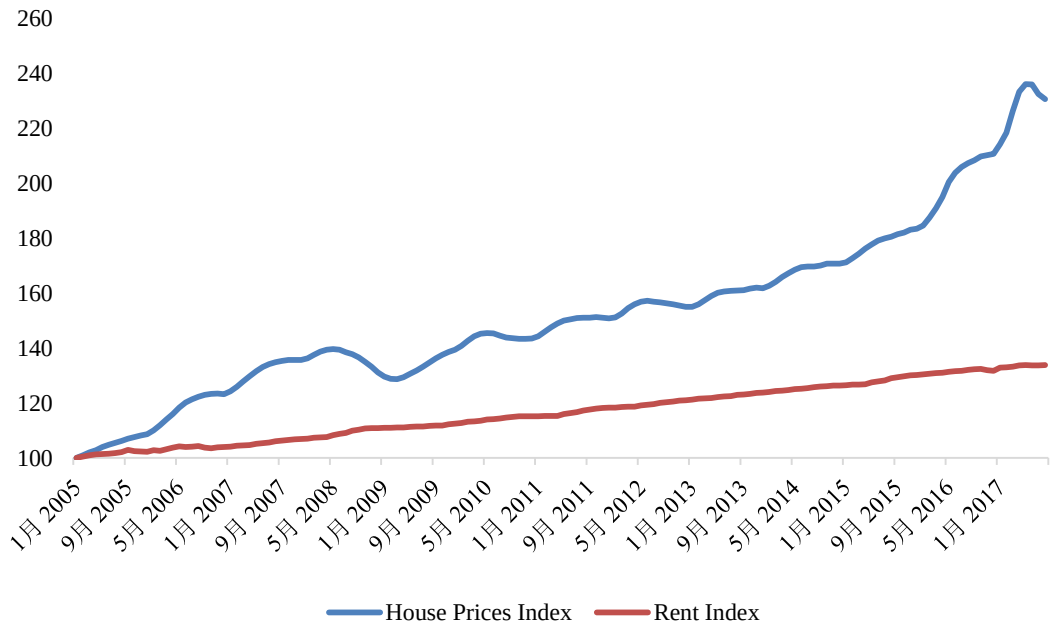
3.6 Limitations

Like previously mentioned, information on housing prices data is very limited in terms of time horizon and frequency. Many resort to panel co-integration analysis consisting multiple areas and then pooling the observations in order to test long-term relationships. One of the example would be the panel technique that used by Adam and Füss when examine international housing market where they collect 15 OECD countries and robust the estimation process by enlarging the sample population. This approach that proposed by Pedroni (2004) was also adopted by Kasporava and White in their combined error correction and panel model when analyzing cross-sectional data from various EU countries. However, even panel data present great limitations as the heterogeneity and noise of cross-sectional data sources could complicate the scope of analysis in empirical studies on housing. In addition, since co-integration techniques such as the Engle-Granger or the Johansen approach require a sufficiently long time period for testing long-term relationships, even with larger data population, it is still not adequate if the duration is short. These limitations could skew the evidence available on the macroeconomic effects and the determinants of house prices, especially on open-economy models.

4: Trends and Patterns of Nominal Data

This section presents the trends and patterns of the data that is used in this analysis of Canadian housing market in a comparative format to help with the construction of a more intuitive understanding on the historical situation.

Figure 1. Real House Prices and Average Rents (Jan 2005: July 2017)



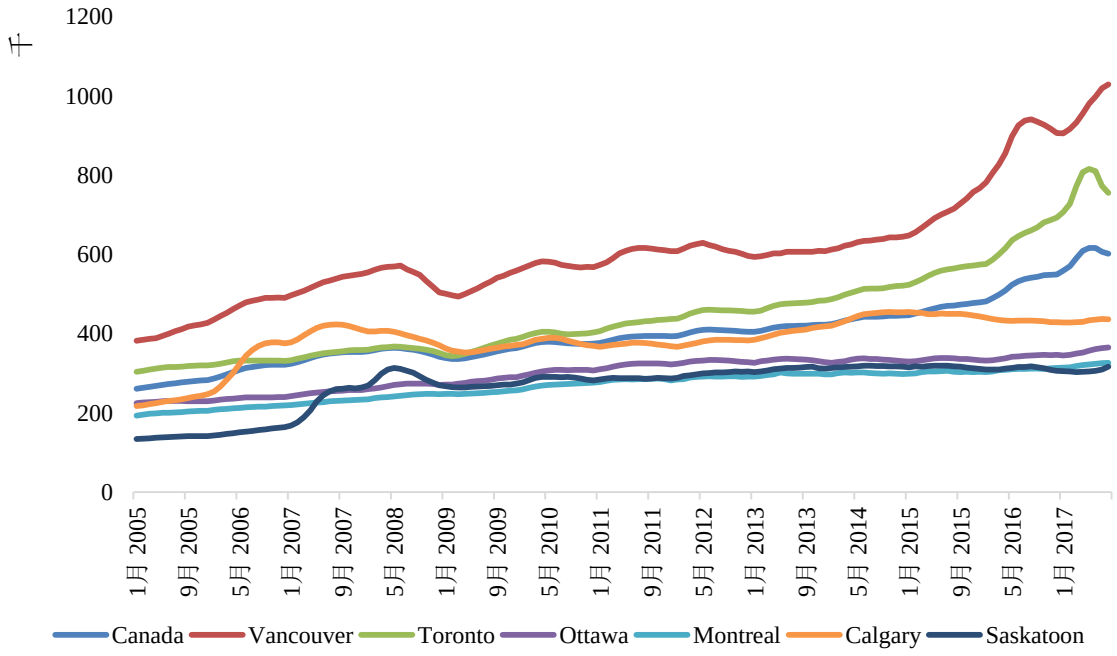
Source: MSL HPI., CMHC.

Nominal house prices were adjusted using the house price of October 2006 as the base amount of 100. As can be seen from the figure, in general, house prices in Canada has been going up fairly steadily with the single biggest decrease in 2008 affected by the sub-prime mortgage financial crisis in the United States. One of the sharpest slop appeared in 2016 boosted mainly by Vancouver and later Toronto, with a last similar level fluctuation

happened before and after 2008. In addition, an overall cyclical pattern was displayed from the graph with slight decreases happen at almost every year end which in line with the phenomena of generally lower sales of houses in winters.

Real rents, on the other hand, presented a much less volatile trend and smaller interval increases. Within the most recent 10 years, composite real rents in Canada has been rising with no obvious decline, revealing a relatively stable supporting economy. Small deviations could be caused by our method of calculating estimated rent with CPI increase rate, however, rent prices would always come back on the original track, returning to the trend-line.

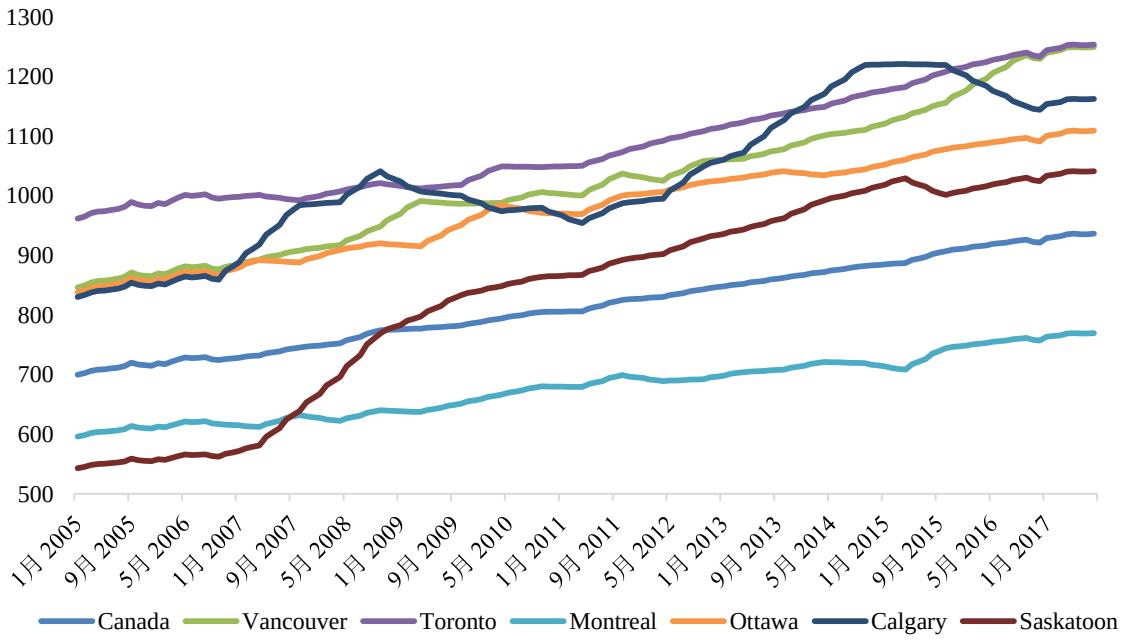
Figure 2. Nominal house prices of selected cities in Canada (Jan 2005: July 2017)



Source: MLS HPI, CMHC, Statistic Canada.

As can be seen from figure 2, among all the major metropolitans, Vancouver stood out as the city with the highest house prices tracing back to 2005 and continue to grow with the highest increase. Saskatoon and Calgary have seen some boost in real house prices before 2008 but then dropped back to the level before. Starting 2015, Toronto has joined Vancouver and began to show some level of surge in real estate market. Both of the distinct declines for these two cities relatively at the end of 2016 and the summer of 2017 coincided with the implementation of the additional property transfer tax for foreign buyers. But clearly, this policy has done nothing but to stall the shooting up of real estate prices in Vancouver. News and articles have been published to argue the effectiveness of this tax policy and urged further measurements from the government.

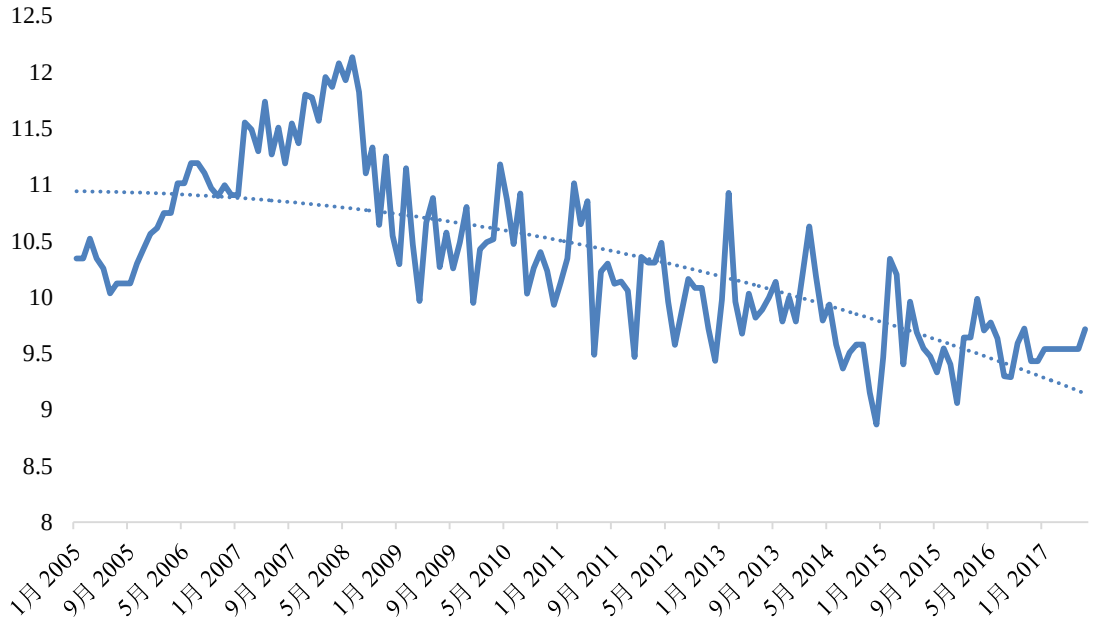
Figure 3. Nominal average rents of selected cities in Canada (Jan 2005: July 2017)



Source: MSL HPI., CMHC.

Major metropolitans in Canada established similar trends, with increase rate varies from city to city. With the dramatic increase of real house prices, Vancouver in recent years presented higher increase in rents compared with previous years due to higher demands. Although in terms of average nominal real rents, Calgary showed more and larger volatility than any other major cities and Saskatoon went through the biggest increase after 2008 which in line with the high house prices variabilities for these two cities. In general, average rents suffered smaller concussion from the sub-prime crisis then house prices, but rather fluctuated in their own patterns and caused by other reasons such as regulatory policies, new construction on apartments and demands caused by temporary residences.

Figure 4. Adjusted Cost of Housing Capital (Jan 2005: July 2017)

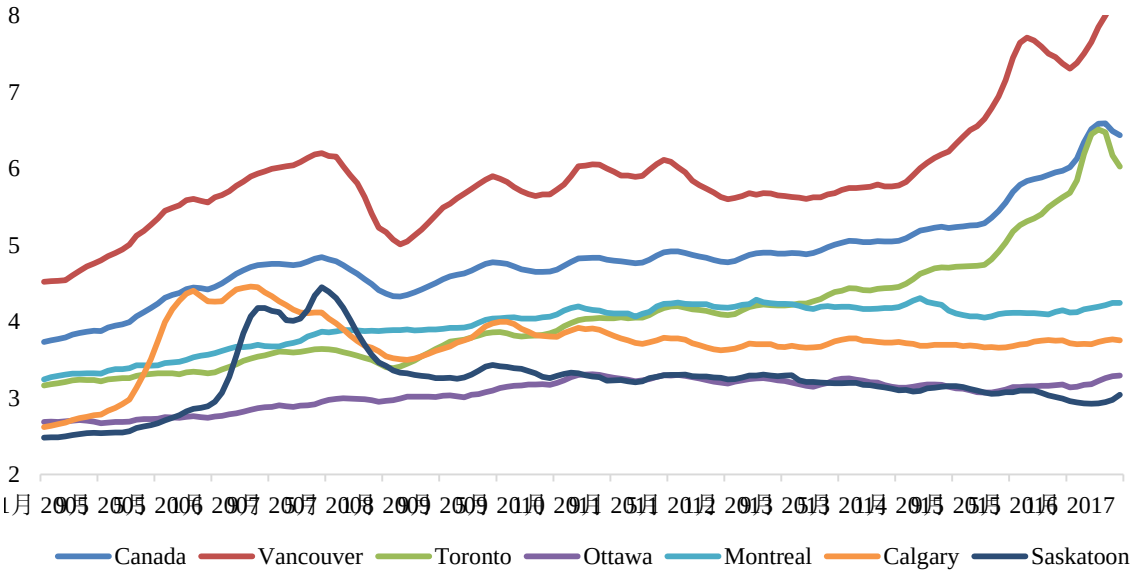


Source: Statistics Canada; CANSIM, CMHC.

With the polynomial trend line, we can see from figure 4 that cost of housing capital in general has been decreasing from 2005 to 2017. Mortgage market crisis in 2008 and other

reasons caused the highest cost of owning houses and since then with government's effort in increasing housing affordability, the overall cost has been declining. The calculation was the equation that previously mentioned: $C_t = \left(i_t + \tau_t^p\right)\left(1 - \tau_t^y\right) + \delta_t$, from which we can see the factors behind: mortgage rate, property tax rate, marginal income tax on capital gains and the depreciation cost. This particular variable reached its highest point in 2008 of more than 12% and the lowest point happened at the year end of 2014 with the value dropped below 9%.

Figure 5. Price-Rent Ratio (Jan 2015: July 2017)



Source: Statistics Canada; CANSIM, CMHC.

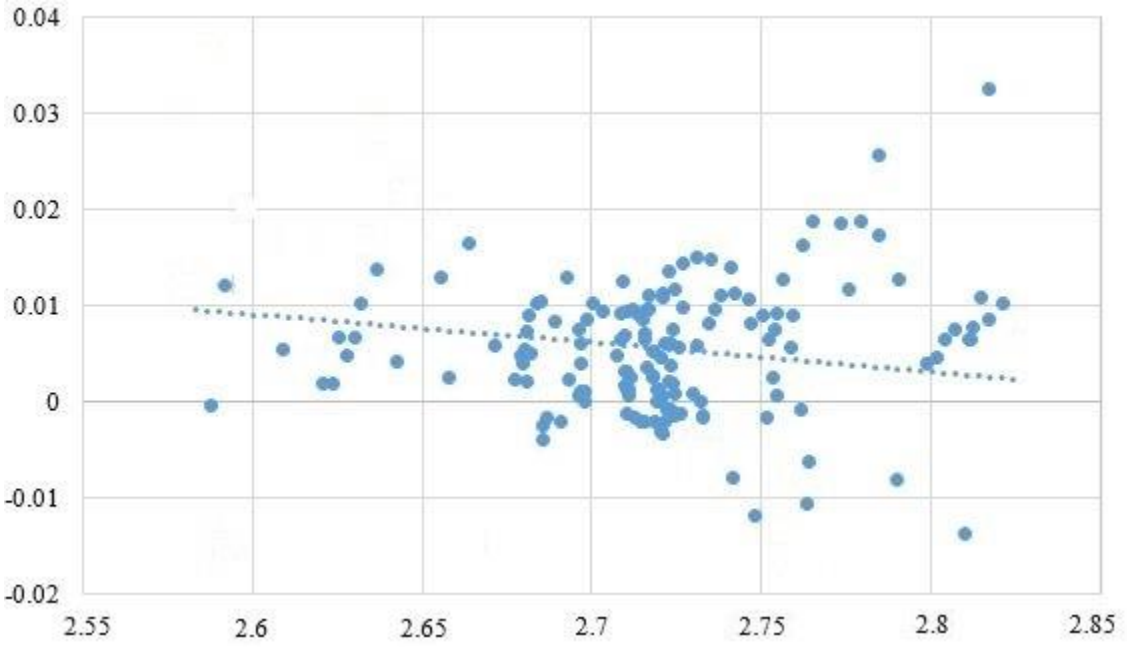
Absorbed the effects from both values: real house prices and average rents, Price to rent ratio showed higher volatility than either one of them with Canada in general has continuously rising price to rent ratio trend since 2009. Calgary and Saskatoon consistently showed higher fluctuation in the period of sub-prime mortgage crisis and Vancouver has the highest ratio among all the major cities. Price to rent ratio corresponds to the relative difference between property prices and rents which becomes a wildly used term for people to

compare the overall welfare in renting and buying. Stemming from this ratio, a recently developed term: Trulia Rent Vs. Buy Index compares the total cost of homeownership with the total cost of renting a similar property. (Appendix 6) We used Compbell and Shiller (1998)'s decomposition on this ratio as a reference and directly implement the conclusions. In general, rents are expected to go up in the cities with higher price to rent ratio and with the uncertainty of housing market in such cities like Vancouver and Toronto, the small fallback in the year 2017 is likely to stall the increase in rents.

5: Models and Regression Analysis

5.1 Fitted Regression of Real Growth Rate on Price to Rent Ratio.

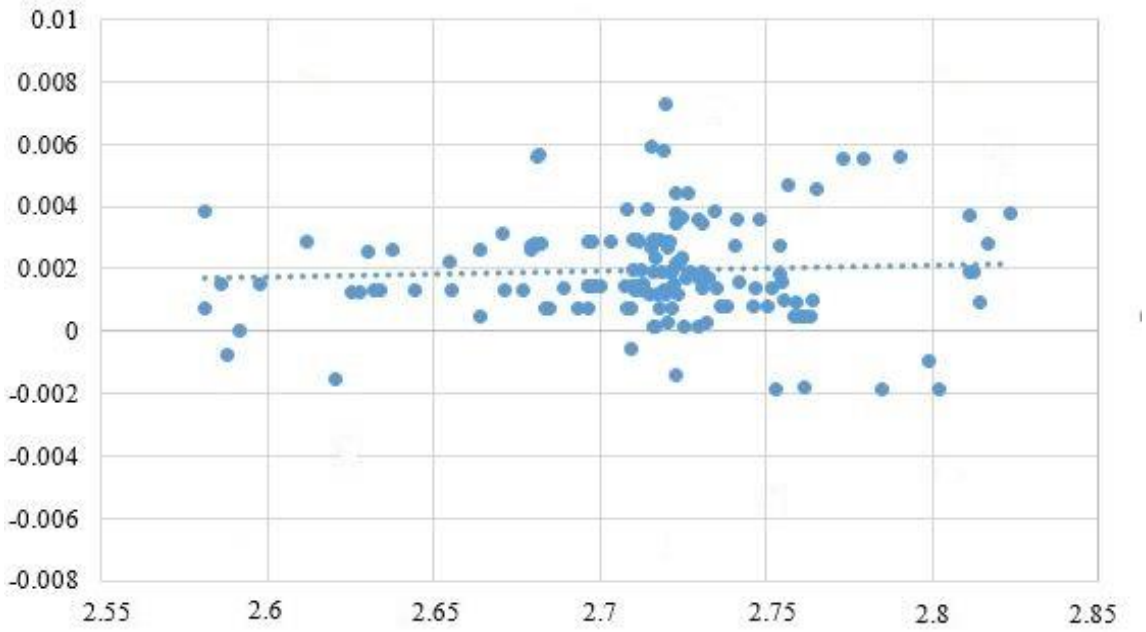
Figure 6. House Prices Growth over log Price to Rent Ratio.



With x-axis being log price to rent ratio and y-axis being the growth rate of house prices, the Scatterplot of the data, even though not perfectly fitted shows that when the house price is high relative to rent (high price-to-rent ratio), growth rate of houses tends to be low and that most of the data move around a central equilibrium, implying that in the long-term, house prices and rents should move within a certain range.

Figure 7 shows a similar scatterplot indicating growth of average rents would increase in a small scale if price to rent ratio is high, in other words, if house prices cost more for people relatively than rents, the higher demand will stimulate the increase of average rents.

Figure 7. Average Rents Growth over log Price to Rent Ratio



Gallin (2008) gave similar conclusion on the suggestive evidence of these scatterplot that there was clear trend of the two series moving towards each other when property prices are high relatively to average rents. However, in the long run it is proven that price to rent ratio cannot fully explain the movement of house prices because it does not take the cost of housing capital and expected future returns to housing assets into consideration.

5.2 Multi-factor Regression

In order to examine the correlation between observed house price growth and some of the chosen factors, we resorted to a multi-factor regression model. As was described above, a variety of models have been developed to address the relationship. However, due to data limitation, long-term predicting ability for some of the factors may be biased and imprecise.

To exam which factor has the highest correlation with the growth rate of property prices, we used the following factors: log Price-to-Rent Ratio, Vacancy Rate and Direct Cost

of Housing Capital which include macroeconomic fundamentals such as mortgage rate and tax effects.

The basic idea of this regression model is:

$$\Delta P\mathrm{t} = \alpha + \beta_1\left(\frac{p\mathrm{t}}{r\mathrm{t}}\right) + \beta_2 VR\mathrm{t} + \beta_3\left[\left(i\mathrm{t} + \tau_t^p\right)\left(1 - \tau_t^y\right) + \delta\mathrm{t}\right] + \beta_4 \Delta P\mathrm{t}_{-1}$$

Where, $\Delta P\mathrm{t}$ denotes the growth rate of real house prices, $\Delta P\mathrm{t}_{-1}$ is used to address the potential concern that changes in house prices are highly persistent. $\left(\frac{p\mathrm{t}}{r\mathrm{t}}\right)$ is the price-rent ratio calculated from nominal values and the lower case denotes the log value, housing vacancy rate used to examine the basic demand and supply effect on housing market and finally as was mentioned before, $\left(i\mathrm{t} + \tau_t^p\right)\left(1 - \tau_t^y\right) + \delta\mathrm{t}$ represents direct user cost of housing capital.

Table 1. Multifactor Regression Results of Canada

Regression Statistic	
Multiple R	0.88750
R Square	0.78766
Adjusted R Square	0.78021
Standard Error	0.32311
Observation	119

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	44.14928	11.03732	105.71848	0.00000
Residual	114	11.90194	0.10440		
Total	118	56.05122			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.85635	1.05170	-2.71594	0.00764	-4.93975	-0.77294
Δ P(t-1)	0.86284	0.05221	16.52563	0.00000	0.75941	0.96627
Rent-Price Ratio	14.29820	3.40031	3.91088	0.00016	6.56221	20.03419
Vacancy Ratio	0.09786	0.14439	2.75553	0.00682	0.11183	0.68389
Cost of Housing Capital	-0.09458	0.05168	-1.82996	0.06987	-0.19696	0.00781

Overall correlation coefficient of these factors with house prices in Canada has indicated moderate influences from these variables. In this multiple linear regression model, the size of the effect that each independent variable has on dependent variable: growth rate of house prices shows that average rents and housing vacancy rate has relatively higher effect than the cost of owning houses and among the three factors, Price-to-rent ratio has the highest coefficients which implies higher predicting ability due to the direct relationship between this particular factor with the dependent variable.

5.3 City-Specific Analysis

This section focus on city-specific analysis in Canadian Housing Market. We picked cities that can best represent different geographic areas in Canada and compare their responses to the regression model. As can be seen from the regression analysis on the aggregate Canadian housing market, a certain level of deviation exists and by applying the same model on specific cities, it is possible to extract the particular cases.

Table 2. Regression Results of Ottawa

Regression Statistic	
Multiple R	0.70651
R Square	0.49915
Adjusted R Square	0.48158
Standard Error	0.39760
Observation	119

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	17.96105	4.49026	28.40339	0.00000
Residual	114	18.02214	0.15809		
Total	118	35.98319			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.67038	0.85187	-1.96084	0.05234	-3.35794	0.01717
Δ P(t-1)	0.66832	0.07538	8.86573	0.00000	0.51898	0.81765
Rent-Price Ratio	9.26738	3.21002	2.88702	0.00465	2.90836	15.62639
Vacancy Ratio	-0.06050	0.07258	-0.83348	0.40632	-0.20428	0.08329
Cost of Housing Capital	-0.10274	0.08211	-1.25136	0.21337	-0.26539	0.05991

Table 3. Regression Results of Montréal

Regression Statistic	
Multiple R	0.50348
R Square	0.25349
Adjusted R Square	0.22730
Standard Error	0.40156
Observation	119

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	6.24215	1.56054	9.67791	0.00000
Residual	114	18.38220	0.16125		
Total	118	24.62435			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.82538	0.87051	-2.09692	0.03821	-3.54985	-0.10092
Δ P(t-1)	0.38476	0.09437	4.07731	0.00008	0.19782	0.57170
Rent-Price Ratio	8.36843	4.58860	1.82374	0.07081	-0.72155	17.45842
Vacancy Ratio	-0.13874	0.09229	-0.41974	0.67546	-0.22157	0.14409
Cost of Housing Capital	-0.10410	0.09010	0.04550	0.96379	-0.17438	0.18258

Ottawa and Montreal share the similarity on the test results through the coefficients and the conclusion should be close to the case of Canada. They both reveal low correlation between housing vacancy rate and the growth rate of house prices. Negative relationships from cost of housing capital and relatively larger influence from the rent to price ratio.

Table 4. Regression Results of Saskatoon

Regression Statistic	
Multiple R	0.90618
R Square	0.82116
Adjusted R Square	0.81488
Standard Error	0.85194
Observation	119

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	379.90684	94.97671	130.85628	0.00000
Residual	114	82.74226	0.72581		
Total	118	462.64910			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-14.37946	2.88500	-4.98422	0.00000	-20.09462	-8.66431
Δ P(t-1)	0.86541	0.04399	19.67128	0.00000	0.77826	0.95256
Rent-Price Ratio	27.33152	4.68360	5.83558	0.00000	18.05334	36.60969
Vacancy Ratio	-0.08154	0.05606	-1.45444	0.14857	-0.19260	0.02952
Cost of Housing Capital	-0.62867	0.17647	3.56252	0.00054	0.27909	0.97825

Saskatoon, not surprisingly displayed higher coefficient between price-to-rent ratio and the growth rate of property prices which can also be seen from the nominal graphs that with a relatively closed market without much outside disturbances, the market receives higher influence from internal factors. In addition, the high volatility of house prices in response to 2008 sub-prime mortgage also proved that the high coefficients might imply high variability in future movement of real house prices.

Table 5. Regression Results of Vancouver

Regression Statistic	
Multiple R	0.85964
R Square	0.23899
Adjusted R Square	0.22983
Standard Error	0.60064
Observation	119

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	116.43898	29.10975	80.68927	0.00000
Residual	114	41.12704	0.36076		
Total	118	157.56602			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.18563	1.05170	-1.12735	0.26196	-3.26904	0.89778
Δ P(t-1)	0.91404	0.05371	17.01864	0.00000	0.80765	1.02044
Rent-Price Ratio	0.26107	5.52386	3.48689	0.00069	8.31835	30.20378
Vacancy Ratio	-0.17972	0.09809	-1.83221	0.06953	-0.37404	0.01459
Cost of Housing Capital	0.17163	0.07837	-2.18999	0.03056	-0.32689	-0.01638

Vancouver, on the other hand, is a special case in this analysis. With an abnormally low correlation coefficients (adjusted R Square) which should represent the fraction of the variation in the dependent variable (growth rate of house prices) that is accounted for the independent variables (price-to-rent ratio, vacancy rate and cost of housing capital), we can basically conclude that other factors have much larger effect on the housing market than macroeconomic fundamentals. It is unsure which period in history exactly, but the overall behaviour of the house prices in Vancouver as well as the growth rate would be very hard to predict using available economic indicators.

Foreign investment has already caused a lot of variation in the market. The effect was further amplified by the additional property transfer tax on foreign buyers, creating a sharp hill in the house prices. However, one year after, the trend of increasing got picked up and started shooting for a higher point with faster rate since the beginning of 2017. It is clear that procrastinating the growth of house prices is not the solution. Further measurements such as expanding the supply for both independent houses and rental apartments or developing suburban areas might create better results in improving the overall affordability in Vancouver.

6: Conclusion

We begin by inspecting the coefficient estimates using multi-factor regression model. Evidences show that cost of housing capital that incorporates interest rates and tax effects actually does not significantly affect the growth rate of house prices as anticipated, however it does have certain negative correlation with the growth rate of house prices which is logically accurate. This further proves that the direct user cost of housing capital is embedded in the total economic value of houses and this negatively related relationship is the evidence of the link between macro-economy and the overall performance of the housing market. Even though cost of housing capital seems to dampen the growth rate for house prices in a small degree, the coefficient relationship comes more from the economy side than the subsequent low demand that caused by the high cost.

Including the user-cost term does not significantly affect the correlation between the price to rent ratio and subsequent changes in the growth rate of house prices. As was concluded, the higher house prices are relative to average rents, the slower the growth rates will be. In the long run, this relationship is not hard to be interpreted as a long-term equilibrium between house prices and rents. Many research studies have also came to the conclusion that whenever real house prices deviate from its range that allowed by the macroeconomic fundamentals, an error correction mechanism will be triggered automatically even though there is a time lag for rents and house prices to respond to economic shocks.

As much as we would love to study from statistics the fundamental idea that was brought up in the beginning of this paper about housing market being a special form of traditional commodity market and should be influenced by the basic demand and supply

equation, we are constrained from limited available data. Thus, we want to clarify that the vacancy rate that was used in the model is not a perfect representative of the supply situation in the entire housing market, data for constructions and available units of houses in the future are updated in a very low frequency and often have a very obvious time lag.

Government's role in this market should not be taken lightly and other unpredictable uncertainties such as foreign buyers or even as contingent as Amazon's second headquarter decision could have huge influences in the local housing market.

The important goal for doing research on housing market and continuously trying new models to test and to examine factors with predicting abilities is to prevent any possibilities of future crash which without doubt brings severe consequences on the stability of the economy and the entire society,

Appendices

Appendix 1. Real House Prices for Selected Cities in Canada (2005-2017)

Table 6. Real House Prices for Selected Cities in Canada (2005-2017)

Date	Canada	Victoria	Vancouver	Regina	Calgary	Saskatoon	Toronto	Ottawa	Montreal
Jan 2005	261100	303100	382500	107900	217300	134700	304000	225000	193400
Feb 2005	263400	309100	384800	109500	219500	135400	306700	226200	195700
Mar 2005	266100	315500	387100	111100	222500	136200	309700	227300	198000
Apr 2005	268400	321900	389000	113600	224900	137300	312200	228400	199400
May 2005	271300	328500	394700	115600	228100	138400	314600	229500	200300
Jun 2005	273400	335200	400500	116700	230500	139400	316100	230700	200900
Jul 2005	275200	339700	406200	116600	232500	140300	316400	230400	201300
Aug 2005	277000	344600	411200	116300	234900	141100	317300	230200	202100
Sep 2005	279100	349100	418100	115800	237700	141900	318300	230000	203600
Oct 2005	280900	350600	420800	115500	240800	141600	319500	230000	205000
Nov 2005	282200	351900	423800	116600	243600	141500	319800	230000	205800
Dec 2005	283300	353400	427300	113400	247500	141300	320100	229800	205800
Jan 2006	286900	360300	435300	117000	254000	143200	321900	231600	207500
Feb 2006	291900	367300	444500	118800	266800	145100	324300	233400	209400
Mar 2006	297400	374600	452500	121200	283600	147100	327700	235200	210600
Apr 2006	302900	378200	462100	122100	301600	149000	330400	236500	211600
May 2006	308600	381600	471600	123300	323800	151000	332500	237900	212700
Jun 2006	313600	384900	479300	124600	344400	152900	332200	239400	214300
Jul 2006	316400	385800	483100	125600	359200	154900	332200	239400	215000
Aug 2006	318800	386400	486900	125100	369800	157000	331900	239200	215800
Sep 2006	320900	387300	490400	124900	375500	159000	332500	239200	216200
Oct 2006	321700	386700	490700	125200	378300	160700	332500	239400	217900
Nov 2006	321900	386100	491100	127000	378300	162600	332500	239900	218700
Dec 2006	321400	385500	490400	125200	375700	164500	331300	240100	219300
Jan 2007	324000	392200	497300	128100	378500	168500	332800	242600	220300
Feb 2007	328500	399100	502600	132400	385200	176800	337100	245100	221800
Mar 2007	333400	406100	508000	141100	396100	189600	340700	247800	223200
Apr 2007	338400	410700	515600	150900	405700	206400	344400	249800	224500
May 2007	343300	415200	522900	163600	415000	228900	348000	251400	226100
Jun 2007	347300	419700	529800	174500	420000	245100	350800	253400	227600
Jul 2007	349900	424000	534400	186300	423100	254800	352600	255000	229700
Aug 2007	352000	428200	539300	194100	423900	260700	353800	255900	230700
Sep 2007	353300	432200	543500	196300	422800	261400	355600	256300	231300
Oct 2007	354000	434900	546200	198100	419600	263300	357800	257900	232100
Nov 2007	354300	437300	548900	199800	415000	262300	358700	258100	233000
Dec 2007	354000	439800	550800	201000	409600	264600	358700	258300	233600
Jan 2008	355600	443400	555400	211900	406100	269500	359900	260400	234800
Feb 2008	359000	450100	561500	234300	405700	282900	363200	262400	237500
Mar 2008	362100	454300	566500	251600	407000	299000	365400	264400	239000
Apr 2008	364000	457900	568800	266500	407400	309500	366600	268000	240600
May 2008	364500	458500	569900	267600	404600	313500	367500	271200	241700
Jun 2008	364000	457600	571800	263400	400900	311600	366900	272700	243300
Jul 2008	361400	456100	562300	258800	395900	306200	365100	273900	245200
Aug 2008	359500	452200	555800	248600	392400	301900	364100	274300	247000
Sep 2008	356700	447900	548500	240600	387600	292500	362300	274300	247700
Oct 2008	352500	441600	533600	233900	383500	284100	359900	274300	247900
Nov 2008	347800	433100	518700	228200	377600	276600	356200	273000	248100

Date	Canada	Victoria	Vancouver	Regina	Calgary	Saskatoon	Toronto	Ottawa	Montreal
Dec 2008	342000	422500	504100	219600	371300	270000	351400	270700	247500
Jan 2009	338400	415800	501100	222100	363100	267600	345900	271800	247900
Feb 2009	336300	414000	497300	225200	357200	265300	343800	272100	247900
Mar 2009	336000	415500	493800	231500	354600	264200	345600	273900	247700
Apr 2009	337900	420100	500300	231800	352200	264700	349000	276100	248100
May 2009	341000	424900	507200	235500	353300	266000	353800	278800	248700
Jun 2009	344100	429400	514500	234500	356100	266500	359300	280200	249700
Jul 2009	347800	434000	523300	237300	359000	267300	364500	281500	251000
Aug 2009	351700	437000	532100	237100	362200	268500	369900	283800	252200
Sep 2009	355600	441600	541600	239000	364800	270000	375100	286700	253500
Oct 2009	359000	445200	546200	239100	367600	272000	380300	288500	255100
Nov 2009	361900	447900	553500	241600	369800	271900	384800	289900	256400
Dec 2009	364000	451600	559600	243800	371600	273900	387300	290100	257400
Jan 2010	367600	457600	565700	247200	373700	277700	391800	294400	259500
Feb 2010	372600	462800	572200	255100	378900	283300	397300	297700	263800
Mar 2010	376800	465200	578300	259000	385000	288700	401800	301600	267100
Apr 2010	379100	466400	582900	262500	387200	291100	404600	305200	269000
May 2010	379900	466700	582200	263200	389800	290900	404900	307400	270700
Jun 2010	379400	464300	579500	264100	390000	291000	403100	308500	271900
Jul 2010	377300	459400	574100	263600	387400	290200	400000	308800	272900
Aug 2010	375500	454900	571100	259900	382200	290900	398800	308100	273300
Sep 2010	374900	450700	568800	259800	378500	289100	399400	308800	273800
Oct 2010	374400	449400	567600	257700	374600	287200	400000	308500	274600
Nov 2010	374400	448200	568800	258600	371100	283500	401200	308500	275600
Dec 2010	374700	444900	568400	258200	369200	281900	403400	307600	276200
Jan 2011	376800	446100	574100	258800	367400	284500	406700	310100	278100
Feb 2011	380900	449100	579900	265100	369800	287000	413100	313000	281400
Mar 2011	385100	453400	590600	269300	371800	288700	417600	317100	283700
Apr 2011	388800	456400	603200	271400	373500	288200	421900	320000	284900
May 2011	391600	456400	609300	274400	375200	288000	425900	322900	285200
Jun 2011	393000	456700	613900	275400	377600	287600	427400	324500	284900
Jul 2011	394000	452200	616200	276100	377600	287800	429500	325000	285400
Aug 2011	394500	448200	616600	274400	376600	285900	431600	325400	285600
Sep 2011	394500	444300	615100	272000	374800	287200	432500	325200	286000
Oct 2011	394800	441600	612800	273400	372900	288700	435000	325200	287000
Nov 2011	394500	440400	610900	274400	371300	288000	435600	324500	285800
Dec 2011	393700	440400	608200	278100	368300	287100	437400	322300	282500
Jan 2012	394800	440100	608600	283000	367400	288700	438300	324100	284500
Feb 2012	398400	437300	615100	289800	370300	293200	444100	326300	285400
Mar 2012	403400	437300	621900	295800	373300	295200	450800	329500	289700
Apr 2012	407100	439800	626500	300600	376800	297600	456200	331700	291400
May 2012	409700	441000	629200	303900	380900	299900	460200	332600	292000
Jun 2012	410400	442200	624200	308500	383500	301000	461100	334000	293000
Jul 2012	409700	437900	619700	309900	384400	302500	459900	333700	292000
Aug 2012	408900	435800	613100	308800	384600	302600	459300	333100	292200
Sep 2012	408100	432200	609700	309000	384800	303300	459000	331900	292400
Oct 2012	407300	431300	607000	307400	383900	304600	458400	330600	292400
Nov 2012	406000	426700	602100	306100	383700	304400	457200	329000	291400
Dec 2012	404700	424300	596300	307100	383300	304800	455900	328300	291600
Jan 2013	404700	420400	593600	307700	385000	303500	455600	327000	291800
Feb 2013	407300	419700	595900	306700	388700	304900	458400	330400	293800
Mar 2013	411200	422500	598600	308200	392600	307400	464800	332200	296300
Apr 2013	415100	424900	603200	307400	397800	310400	470200	334600	297400

Date	Canada	Victoria	Vancouver	Regina	Calgary	Saskatoon	Toronto	Ottawa	Montreal
May 2013	418000	425800	603200	305200	402200	312300	474200	336200	302100
Jun 2013	419300	424300	606600	304800	404800	314100	476300	336900	299900
Jul 2013	419800	424000	607000	305200	407000	313500	476600	336200	299200
Aug 2013	420100	420700	606600	305300	408700	314600	477500	335500	299200
Sep 2013	420600	419400	607000	305400	410700	315900	478400	334900	299200
Oct 2013	421900	421300	606600	305400	414800	317100	480000	333100	299200
Nov 2013	423000	416700	609300	304100	417000	313200	483000	330600	299000
Dec 2013	422500	414300	608900	302900	418300	312300	483900	328100	297600
Jan 2014	424500	414900	612800	300000	420700	313600	487600	326500	297400
Feb 2014	428500	417300	615800	298800	425900	315000	492100	328800	300900
Mar 2014	432900	424300	621900	300400	431700	315800	498500	331000	302100
Apr 2014	436600	424900	625400	301100	438000	316600	503700	334400	301900
May 2014	439900	427000	631100	300900	444800	318000	508200	337100	302100
Jun 2014	442600	428500	634600	299000	449100	319000	513100	337800	302100
Jul 2014	443100	429400	635000	297700	451300	319600	514000	336400	300900
Aug 2014	443100	426100	637200	295900	452600	318500	513700	336200	299700
Sep 2014	443600	426400	639200	294200	454100	318500	514600	334400	299400
Oct 2014	445400	425500	643000	292800	455200	317800	518000	334000	299700
Nov 2014	445700	425800	643400	291200	454300	317800	520100	331900	299200
Dec 2014	446000	424900	644900	289300	454100	317300	521600	330400	298400
Jan 2015	447000	429700	648000	285600	455200	315700	523400	329500	298800
Feb 2015	450700	429100	656400	283800	453700	317700	530100	330800	300300
Mar 2015	455400	436100	667800	287000	452800	316700	537700	332800	303200
Apr 2015	460100	441300	679700	288300	449600	318200	546500	335300	305000
May 2015	464200	447300	691600	290000	449300	319600	553500	338000	305000
Jun 2015	467600	448200	700700	289400	450900	319200	559300	338900	305500
Jul 2015	470000	450400	707600	288300	450600	319400	562600	339100	306100
Aug 2015	471000	449800	715700	285900	450400	318100	565100	338000	304400
Sep 2015	473600	452800	729000	283200	450400	317100	568400	336400	303600
Oct 2015	475500	455500	741700	281300	448500	314500	570200	336400	303800
Nov 2015	477800	455800	758100	278900	446300	313000	572400	334900	303600
Dec 2015	478900	459100	767300	279900	443500	311500	574200	332800	304000
Jan 2016	481700	461600	782200	283100	440200	309700	576600	332400	303000
Feb 2016	489600	470700	805200	283100	437600	309300	587000	333100	305200
Mar 2016	498400	484300	827000	288400	434600	310000	600300	335500	307900
Apr 2016	509100	495500	856000	293900	433500	312200	615500	338200	309200
May 2016	523500	507900	898500	299600	432600	313400	635600	342300	310400
Jun 2016	532400	517600	925700	299900	433300	316200	646800	343000	311000
Jul 2016	537900	527600	937900	296200	433000	316500	654400	344100	311000
Aug 2016	541500	533700	941000	296300	433000	317600	661100	345000	311900
Sep 2016	544100	537900	935200	297200	432800	315400	669000	346100	311700
Oct 2016	547800	542800	927600	293800	432000	312600	681500	346600	311500
Nov 2016	548800	545200	918000	294400	429600	309200	687000	346300	312900
Dec 2016	549900	547900	906500	294600	429100	306500	693600	346600	313900
Jan 2017	559000	554000	905800	293600	428500	305800	706700	345400	314300
Feb 2017	570200	564300	916900	292800	428000	304500	728300	346600	315200
Mar 2017	591100	574600	933300	293400	429100	303400	772400	349900	318500
Apr 2017	609400	586700	955500	294700	430200	304400	807900	352600	321000
May 2017	616700	602800	981100	294700	433700	304900	816400	357100	322400
Jun 2017	616500	611300	998700	297800	435900	306500	810700	361000	323900
Jul 2017	607100	621600	1019400	306800	437600	309600	773000	363900	326200
Aug 2017	602400	620700	1029700	313000	436500	316700	755400	365200	326400

Appendix 2. Average Rents for Selected Cities in Canada

Table 7. Average Rents for Selected Cities in Canada (2005-2017)

Date	Canada	Vancouver	Toronto	Montreal	Ottawa	Calgary	Saskatoon
Jan 2005	699	846	961	596	838	830	543
Feb 2005	702	849	965	598	841	833	545
Mar 2005	706	854	970	602	846	838	548
Apr 2005	708	857	973	603	848	840	550
May 2005	709	858	974	604	849	841	550
Jun 2005	710	859	976	605	850	842	551
Jul 2005	711	861	978	606	852	844	552
Aug 2005	714	864	981	609	855	847	554
Sep 2005	720	871	990	614	862	854	559
Oct 2005	717	867	985	611	858	850	556
Nov 2005	715	866	983	610	857	849	555
Dec 2005	715	865	982	609	856	848	555
Jan 2006	719	870	988	612	861	853	558
Feb 2006	717	868	986	611	859	851	557
Mar 2006	721	873	991	615	864	856	560
Apr 2006	725	878	997	618	869	861	563
May 2006	729	882	1001	621	873	865	566
Jun 2006	727	880	1000	620	871	863	565
Jul 2006	728	881	1000	620	872	864	565
Aug 2006	729	882	1002	622	873	865	566
Sep 2006	725	878	997	618	869	861	563
Oct 2006	724	876	995	617	867	859	562
Nov 2006	726	880	997	616	873	874	567
Dec 2006	727	882	997	615	876	881	569
Jan 2007	728	885	998	615	880	889	572
Feb 2007	730	889	1000	613	886	903	576
Mar 2007	731	891	1000	613	889	911	579
Apr 2007	732	893	1001	612	892	918	581
May 2007	735	897	999	617	891	935	596
Jun 2007	737	899	998	620	891	943	603
Jul 2007	739	901	997	622	890	951	610
Aug 2007	742	904	994	627	889	968	625
Sep 2007	743	906	993	630	889	976	632
Oct 2007	745	908	992	632	888	984	639
Nov 2007	747	910	996	630	893	985	653
Dec 2007	748	911	998	628	896	986	660
Jan 2008	749	913	1000	627	899	987	668
Feb 2008	750	915	1003	625	904	988	682
Mar 2008	751	916	1005	623	906	988	689
Apr 2008	752	917	1007	622	909	989	696
May 2008	758	925	1011	627	912	1002	714
Jun 2008	760	929	1012	629	913	1009	723
Jul 2008	763	933	1014	631	915	1015	733
Aug 2008	769	940	1018	636	917	1028	751
Sep 2008	771	944	1019	638	919	1035	760
Oct 2008	774	948	1021	640	920	1041	769

Date	Canada	Vancouver	Toronto	Montreal	Ottawa	Calgary	Saskatoon
Nov 2008	775	959	1019	639	919	1033	776
Dec 2008	775	964	1018	639	918	1028	780
Jan 2009	776	970	1017	639	918	1024	783
Feb 2009	776	980	1014	638	916	1016	790
Mar 2009	777	986	1013	637	916	1011	794
Apr 2009	777	991	1012	637	915	1007	797
May 2009	778	990	1014	641	924	1005	806
Jun 2009	779	989	1014	642	929	1004	811
Jul 2009	780	989	1015	644	933	1004	815
Aug 2009	781	987	1017	648	942	1002	824
Sep 2009	781	987	1017	649	947	1001	829
Oct 2009	782	986	1018	651	951	1000	833
Nov 2009	785	987	1026	655	960	994	837
Dec 2009	787	987	1030	657	964	990	839
Jan 2010	788	987	1034	659	968	987	841
Feb 2010	791	988	1041	662	977	981	844
Mar 2010	793	988	1045	664	981	977	846
Apr 2010	794	988	1049	666	985	974	848
May 2010	797	993	1049	670	982	976	852
Jun 2010	798	995	1049	671	980	976	854
Jul 2010	800	997	1049	673	978	977	856
Aug 2010	802	1002	1048	677	975	979	860
Sep 2010	804	1004	1048	678	973	979	862
Oct 2010	805	1006	1048	680	971	980	864
Nov 2010	805	1005	1049	680	971	974	865
Dec 2010	805	1004	1049	680	970	970	865
Jan 2011	806	1003	1049	680	970	967	866
Feb 2011	806	1002	1050	679	970	961	866
Mar 2011	806	1001	1050	679	969	957	867
Apr 2011	806	1000	1050	679	969	954	867
May 2011	811	1009	1056	684	977	962	873
Jun 2011	813	1014	1059	687	981	966	876
Jul 2011	816	1019	1062	689	985	971	880
Aug 2011	820	1028	1067	694	992	979	886
Sep 2011	823	1032	1070	697	996	983	889
Oct 2011	825	1037	1073	699	1000	987	892
Nov 2011	826	1034	1078	697	1002	989	895
Dec 2011	827	1033	1080	695	1002	990	896
Jan 2012	828	1031	1083	694	1003	991	897
Feb 2012	829	1028	1087	692	1005	993	900
Mar 2012	829	1027	1090	690	1005	994	901
Apr 2012	830	1025	1092	689	1006	995	902
May 2012	833	1033	1096	690	1010	1009	909
Jun 2012	835	1037	1098	690	1012	1015	912
Jul 2012	837	1042	1100	691	1014	1022	915
Aug 2012	840	1050	1104	691	1018	1036	922
Sep 2012	841	1054	1106	692	1020	1042	925
Oct 2012	843	1058	1108	692	1022	1049	928
Nov 2012	845	1059	1112	695	1024	1055	932
Dec 2012	846	1060	1114	697	1025	1058	934
Jan 2013	848	1060	1116	698	1026	1061	936
Feb 2013	850	1061	1119	701	1028	1066	939
Mar 2013	851	1062	1121	703	1029	1069	941
Apr 2013	852	1062	1123	704	1030	1072	943
May 2013	855	1066	1127	705	1033	1086	948
Jun 2013	856	1068	1129	706	1034	1093	950

Date	Canada	Vancouver	Toronto	Montreal	Ottawa	Calgary	Saskatoon
Jul 2013	857	1070	1131	706	1036	1100	953
Aug 2013	860	1074	1134	707	1038	1113	957
Sep 2013	861	1076	1136	708	1040	1120	960
Oct 2013	862	1078	1138	708	1041	1127	962
Nov 2013	865	1084	1141	711	1039	1138	970
Dec 2013	866	1087	1142	713	1038	1144	973
Jan 2014	867	1090	1144	715	1038	1149	977
Feb 2014	870	1095	1146	718	1036	1160	985
Mar 2014	871	1098	1148	719	1035	1166	988
Apr 2014	872	1101	1149	721	1034	1171	992
May 2014	875	1103	1154	721	1037	1183	996
Jun 2014	876	1104	1157	720	1038	1189	998
Jul 2014	877	1106	1160	720	1039	1195	1000
Aug 2014	880	1108	1165	720	1042	1207	1004
Sep 2014	881	1109	1167	719	1043	1213	1006
Oct 2014	882	1110	1170	719	1044	1219	1008
Nov 2014	883	1116	1173	716	1048	1220	1013
Dec 2014	884	1118	1175	715	1050	1220	1016
Jan 2015	885	1121	1176	714	1052	1220	1019
Feb 2015	886	1127	1179	711	1056	1221	1024
Mar 2015	886	1129	1181	709	1058	1221	1026
Apr 2015	887	1132	1182	708	1060	1221	1029
May 2015	892	1138	1189	717	1065	1221	1022
Jun 2015	895	1141	1192	722	1067	1220	1019
Jul 2015	897	1144	1195	726	1069	1220	1015
Aug 2015	902	1150	1202	735	1074	1220	1008
Sep 2015	905	1153	1205	740	1076	1219	1005
Oct 2015	907	1156	1208	744	1078	1219	1001
Nov 2015	909	1166	1212	746	1080	1210	1005
Dec 2015	911	1171	1214	747	1082	1206	1006
Jan 2016	912	1176	1216	748	1083	1202	1008
Feb 2016	914	1186	1220	750	1085	1193	1012
Mar 2016	915	1191	1222	751	1086	1189	1014
Apr 2016	917	1196	1224	753	1088	1185	1016
May 2016	919	1206	1228	755	1090	1176	1019
Jun 2016	920	1211	1230	756	1091	1172	1021
Jul 2016	921	1216	1232	757	1092	1167	1023
Aug 2016	924	1226	1236	759	1095	1159	1026
Sep 2016	925	1231	1238	760	1096	1154	1028
Oct 2016	926	1236	1240	761	1097	1150	1030
Nov 2016	922	1231	1235	758	1093	1146	1026
Dec 2016	921	1229	1233	757	1091	1144	1024
Jan 2017	929	1240	1244	763	1100	1154	1033
Feb 2017	930	1242	1246	765	1102	1155	1035
Mar 2017	932	1244	1248	766	1104	1157	1036
Apr 2017	935	1248	1252	769	1108	1162	1040
May 2017	936	1249	1253	769	1109	1162	1041
Jun 2017	935	1248	1252	769	1108	1162	1040
Jul 2017	935	1248	1252	769	1108	1162	1040

Appendix 3. Methodology of MLS HPI (Excerpt)

Modeling Approach The MLS® HPI is based on a hybrid model that merges Repeat-Sales and Hedonic Price approaches. Using multivariate regression analysis, a commonly used statistical technique, the MLS® HPI model reflects the contribution that various housing features make toward the home price, and includes a dummy variable in the hedonic model specification to distinguish single and repeat sales.

The MLS® HPI is conceptually similar to the Consumer Price Index (CPI), which measures the value of a "basket" of common goods and services. Similarly, the HPI measures the contribution toward a home's prices that each attribute or feature makes as part of a "basket" of housing features.

The approach used to construct the MLS® HPI is superior to the Repeat-Sales approach that has gained media attention over the past few years in Canada and the United States:

- The Repeat-Sales approach omits useful information and sample size is reduced because only homes that have been sold at least twice are used.
- The Repeat-Sales approach may be incapable of reliably tracking home prices for sub-areas within a market.
- Price indices calculated using the Repeat-Sales approach may be produced with a considerable time lag due to data collection and availability.
- The Repeat-Sales approach assumes that qualitative and quantitative attributes of homes remain constant; however, the significance of Canadian home renovation expenditure each year makes this assumption unrealistic.

Appendix 4. Methodology for Rental Market Survey (Excerpt)

"Canada Mortgage and Housing Corporation (CMHC) conducts the Rental Market Survey (RMS) every year in October to estimate the relative strengths in the rental market. The survey is conducted on a sample basis in all urban areas with populations of 10,000 and more. The survey targets only privately initiated structures with at least three rental units, which have been on the market for at least three months. The survey collects market rent levels, availability, turnover and vacancy unit data for all sampled structures.

The survey is conducted by a combination of telephone interviews and site visits, and information is obtained from the owner, manager, or building superintendent. The survey is conducted during the first two weeks of October, and the results reflect market conditions at that time."

"CMHC's Rental Market Survey provides a snapshot of vacancy, availability, and turnover rates and average rents in both new and existing structures. There also exists a measure for the change in rent that is calculated based on existing structures only. The estimate is based on structures that were common to the survey sample for both the previous and the current Rental Market Surveys. The estimate of percent change in rent is available in all Canada and Provincial Highlights publications, and also in the CMA reports."

Methodology for Secondary Rental Market Survey

"Canada Mortgage and Housing Corporation (CMHC) conducts a survey of the Secondary Rental Market (SRMS) in late summer and early fall to estimate the relative strengths in the secondary rental market which is defined as those dwellings not covered by the regular RMS – rented single-detached homes, semi-detached (double) homes, rented freehold row/townhomes, rented duplex apartments (i.e., one-above-other), rented accessory apartments (separate dwelling units that are located within the structure of another dwelling

type), rented condominiums (can be any dwelling type but are primarily apartments), and one or two apartments which are part of a commercial or other type of structure. The SRMS has two components which are conducted in selected CMAs:

A Household Rent Survey of all households to collect information about rents in the following CMAs: Abbotsford-Mission, Barrie, Calgary, Edmonton, Halifax, Hamilton, Kelowna, Montréal, Ottawa, Québec, Regina, Saskatoon, St. Catharines-Niagara, St. John's, Toronto, Vancouver, Victoria, Windsor and Winnipeg.

A Condominium Apartment Survey to collect vacancy and rent information in the following CMAs: Calgary, Edmonton, Gatineau, Halifax, Hamilton, Kelowna, Kitchener-Cambridge-Waterloo, London, Montréal, Ottawa, Québec, Regina, Saskatoon, Toronto, Vancouver, Victoria and Winnipeg.

Both these surveys are conducted by telephone interviews. For the Condominium Apartment Survey, information is obtained from the property management company or condominium (strata) board, or building superintendent and can be supplemented by site visits if no telephone contact is made. For the Household Rent Survey, information is collected from an adult living in the household. Both surveys are conducted in late summer and early fall, and the results reflect market conditions at that time. CMHC publishes the number of units rented and vacancy rates from the Condominium Apartment Survey. For the Household Rent Survey, the average rent is published. A letter code representing the statistical reliability (i.e., the coefficient of variation (CV)) for each estimate is provided to indicate the data reliability. Every year CMHC reviews the method of estimation for Household Rent Survey, which may result in some changes to previously published estimates. All statistics in this report are reflective of the new method of estimation."

Appendix 5. Vacancy Rate

Interpolation is the process of predicting a missing or unknown value of a function or a sample point using the known points around it. Different techniques can be applied as interpolators: Polynomial interpolation, Multivariate interpolation, Bilinear interpolation, Bi-cubic spline interpolation, K-Nearest-neighbor interpolation, quadratic interpolation, B-spline interpolation among other techniques. In our effort for obtaining sufficient vacancy rate data, K-Nearest neighbor method was used to structure our data for missing values.

K-Nearest neighbor method is a statistical test that is used to determine the significance of a point's nearest neighbor in order to calculate the deviation from the general trend. The contiguity of K-Nearest neighbor method can be estimated using what is called the weight function, which is defined as a function that measures the effect of each one of the neighbor points on the required one. In other words the estimated value of the missing or required point is the weighted average of its neighbors. We use the simplest weight function can be described as the ratio of the distance between each point of the neighborhood to the total sum of distances. The following are the formulations about K-Nearest neighbor method.

$$w_i=\frac{d_i}{\sum d_i} \quad ;d_i=\|\hat{y}-y_i\|$$

$$\hat{y}_l = \sum w_i y_i$$

Where d is the distance function, wi is the proper weight for each one of the neighbor points yi to the interpolated point.

Appendix 6. Trulia Rent vs. Buy Index

The following is the excerpt from Trulia Rent vs. Buy Calculator Methodology:

"Our rent vs. buy calculator methodology compares the total cost of renting with the total cost of buying by looking at much more than a rent check or mortgage payment.

To calculate the cost of renting, we start with the monthly rent and add renter's insurance and a refundable security deposit.

To calculate the cost of buying, we start with the purchase price and calculate the initial down payment and buyer closing costs; the monthly mortgage payment and other recurring costs like maintenance, property taxes, and insurance; income tax deductions for mortgage interest and property taxes; and the final mortgage payment, sales proceeds, and seller closing costs. These costs depend on numerous assumptions, like your mortgage rate, your income tax rate, how long you stay in a home, and local home price appreciation: we provide baseline assumptions that we encourage you to tailor to your personal situation.

Finally, we use a net present value (NPV) calculation to compare the total costs over time of renting versus buying, and to account for opportunity cost of money."

Appendix 7. Basic Statistics Analysis

Table 8. Statistical Analysis on Nominal Data.

Log house prices	Minimum Value	Maxmum Value	Mean	Standard Deviation	Standard Error
Canada	5.42	5.79	5.59	0.09	0.007786743
Ottawa	5.35	5.56	5.47	0.06	0.005685661
Montreal	5.29	5.51	5.43	0.06	0.005786045
Saskatoon	5.13	5.50	5.42	0.12	0.010801314
Vancouver	5.58	6.01	5.78	0.10	0.008720476

This table shows the basic statistical characteristics of our nominal data (log) which returns the results of the minimum value, maximum value, mean, standard deviation and standard error. We use the results to make statistical comparisons among difference cities in Canada.

Bibliography

Adams, Z. and Füss, R. (2010). *Macroeconomic Determinants of International Housing Markets.* Journal of Housing Economics, 19, pp. 38-50.

Agnello, L. and Schuknecht, L. (2011). *Booms and Busts in Housing Markets: Determinants and Implications*. Journal of Housing Economics, 20, pp. 171-190.

Campell, S.D., Davis, M.A., Gallin, J. and Martin, R.F. (2009). *What Moves Housing Markets: A Variance Decomposition of the Rent-Price Ratio.* Journal of Urban Economics. 66: pp. 90-102.

Case, K.E. and Shiller, R.J. (1990). *Forecasting Prices and Excess Returns in the Housing Market.* AREUEA Journal 18: pp. 252-273

Case, K.E. and Shiller, R.J. (1989). *The Efficiency of the Market for Single-Family Homes*. The American Economic Review. Vol. 79, No.1, pp. 125-137.

Clapp, J. and Giaccotto, C. (1992). *The Influence of Economic Variables on Local House Price Dynamics.* Journal of Urban Economics 36, pp. 161-183.

Diaz, A. and Luengo-Prado, M. J. (2011). *The User Cost, Home Ownership and Housing Prices: Theory and Evidence from the US.* International Encyclopedia of Housing and Home by Elsevier.

Dipasquale, D. and Wheaton, W. (1992). *The Markets for Real Estate Assets and Space: A conceptual Framework.* Journal of the American Real Estate and Urban Economics Association, V20, 1: pp. 181-197.

Dugan, B. (2017). Why the foreign buyers tax isn't making Vancouver more affordable. Retrieved from: http://www.macleans.ca/opinion/why-the-foreign-buyers-tax-isnt-making-vancouver-more-affordable.

Englund, P. and Ioannides, Y. (1995). *House Price Dynamics: An International Empirical Perspective.* Journal of Housing Economics, 6: pp.119-136.

Gallin, J. (2008). *The Long-Run Relationship Between House Prices and Rents*. Real Estate Economics V36, 4:pp.635-658

Granziera,E. and Kozicki, S. (2012). *House Price Dynamics: Fundamentals and Expectations*. Bank of Canada, working paper 2012-12.

Kan, K., Kwong, S., Leung, C. (2004). *The Dynamics and Volatility of Commercial and Residential Property Prices: Theory and Evidence.* Journal of Regional Science, Vol.44, No.1, 2004, pp. 95-123.

Kasparova, D. and White, M. (2001). *The Responsiveness of House Prices to Macroeconomic Forces: A Cross-Country Comparison.* International Journal of Housing Policy, 1:3, pp. 385-416.

Kishor, N. K. and Morley, J. (2010). *What Moves the Price-Rent Ratio: A Latent Variable Approach.* University of Wisconsin-Milwaukee, MEG conference.

Mack, A., Martinez-Garcia, E., Grossman, V. (2011). *A Cross-Country Quarterly Database of Real House Prices: A methodological Note.* Federal Reserve Bank of Dallas Globalization and Monetary Policy Institute No.99

Malpezzi, S. and Mayo, S. (1997). *Housing and Urban Development Indicators: A Good Idea Whose Time Has Returned.* Real Estate Economics, B25, 1: pp.1-11.

Mankiw, N. and Weil, D. (1989). *The Baby Boom, The Baby Bust, and The Housing Market.* North-Holland: Regional Science and Urban Economics 19, pp. 235-258.

Meese, R. and Wallace, N. (1992). *Testing the Present Value Relation for Housing Prices: Should I Leave My House in San Francisco?* Journal of Urban Economics 35, pp. 245-266.

Nagaraja, C.H., Brown, L.D. and Wachter, S.M. (2010). *House Price Index Methodology.* Wharton Statistics Department.

Pedroni,P.(2004). *Panel Cointegration: Asymptotic and finite sample properties of pooled time series tests, with an application to the PPP hypothesis*. Econometric Theory 20(3), pp. 597-625.

Sommer, K., Sullivan, P. and Verbrugge, R. (2011). *Run-Up the House Price-Rent Ratio: How Much Can Be Explained by Fundamentals?* U.S. Bureau of Labor Statistics, working paper 441.

S&P Dow Jones Indices. (2017). *S&P CoreLogic Case-Shiller Home Price Indices Methodology.* S&P Global.

The Canadian Real Estate Association (CREA). *MLS Home Price Index Methodology.*

Wong, J. (2003). *An Error Correction Model of Vancouver Housing Prices*. Simon Fraser University.