GOING THROUGH THE 'ROOF': SPATIAL PRICE DIFFUSION AND THE RIPPLE EFFECT IN THE VANCOUVER HOUSING MARKET

by

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Abstract

The housing market in Vancouver is the most unaffordable in North America. Although extensive research has been done on price drivers and general trends, there is little understanding of how the price increases spread out through Metro Vancouver. To better understand the spatial spread effects in the local housing market, this study quantitatively examines spatio-temporal price diffusion by mapping price changes for detached houses over the last decade across the metropolitan area. Using median selling prices for single-family homes, additional measures of volatility and cycles of price peaks and troughs are constructed to identify spatial price diffusion patterns. Volatility and break-point analysis is supported by cross-correlation estimates of interconnectedness between non-central price dynamics and the price changes in the metropolitan center, where new price impulses arrive. Finally, multiple linear regressions for price changes in both central and non-central regions are estimated in several specifications: individual equations by municipality and a joint panel data equation for 15 non-central municipalities. Both specifications, as well as estimation methods (OLS and fixed effects), indicate the presence of a ripple effect from the highest-priced central regions (Vancouver West and West Vancouver) to the peripheral suburban regions up to Abbotsford and Mission in the Fraser Valley with the result being robust for both monthly and quarterly data. The ripple effect is observed across contiguous and non-contiguous areas making the entire Greater Vancouver area susceptible to price shocks that occur at the center.

Lay Summary

The Vancouver housing market is the least affordable in North America, with housing being a major land use issue. This study examines how house prices change across the metropolitan area. Analyzing 2006-2017 price trends, we compare how price changes in the City of Vancouver are different from the suburbs. We find the prices in Vancouver's west side neighborhoods and West Vancouver to be more volatile while suburbs like Langley and Surrey are more stable during economic crises. The graphs and maps also show the 'ripple effect' meaning that if the City of Vancouver experiences a shock (e.g. the 2008-2009 crisis) and its prices slow down, a similar slowdown can be observed in the suburbs in the following months. Statistical analysis confirms the presence of a ripple effect from the highest-priced regions (City of Vancouver, West Vancouver) to the suburbs making the entire Greater Vancouver area susceptible to external price shocks.

Preface

This thesis is original, unpublished, independent work by the author, Idaliya Grigoryeva.

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List of Abbreviations

BIP	– Business Immigration Program
CMA	– Census Metropolitan Area
CMHC	– Canada Mortgage and Housing Corporation
CREA	– Canadian Real Estate Association
FDI	– foreign direct investment
FV	– Fraser Valley
FVREB	– Fraser Valley Real Estate Board
GFC	– Global Financial crisis
GVA	– Greater Vancouver Area
HNWI	– High-net-worth individual
PR	– Permanent resident or permanent residence (in the Canadian context)
REBGV	– Real Estate Board of Greater Vancouver
S&P	– Standard & Poor's
SFH	– Single-family homes
UBS	– official name for the Union Bank of Switzerland after it merged with Swiss Bank Corporation. 'UBS report' refers to the UBS Global Real Estate Bubble Index reports.

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To my Mom, grandparents, and friends,

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Chapter 1. Introduction

> "At this point we're among a small number of cities that are seeing unprecedented increases in the value of our housing. We need strategies to address that so people who grow up and go to school here have a chance to stay and build a career in their home town."
>
> *Vancouver Mayor Gregor Robertson*
> (quoted in Mackrael & Chow, 2016)

Mr. Robertson rightfully acknowledges the state of Vancouver's housing market with its outstanding price increases and growing unaffordability as younger Vancouverites often cannot stay in the city because of both rental and ownership costs. His assessments are unequivocally supported by data. Vancouver is consistently ranked in the top-three most unaffordable cities in the English-speaking world along with Hong Kong and Sydney (Demographia Affordability Survey, 2016) and the most risky and prone to bubble bursting by UBS Global Real Estate Bubble Index in 2016 (up from 4th place in 2015) (UBS, 2015, 2016). The city's housing market dynamics are surely not sustainable in the long-run.

The housing market is an essential part of any city's economy and every resident's everyday life, so it is important to understand the dynamics and drivers of Vancouver house prices that stand out so strikingly from other major cities in the developed countries and specifically within North America. While a significant amount of research has been conducted on the factors contributing to such astounding price growth, including a few very recent studies (Gordon, 2016; Ley, 2017; Yan, 2017, to name a few), there is still only a limited understanding of the spatial patterns of house price diffusion in the Vancouver housing market. This constitutes the ***research topic*** that this thesis is focused on namely analyzing the patterns of price changes and transmission of responses to external shocks throughout the metropolitan area. The specific ***research question*** addressed in this study is identifying whether there is a ripple effect on the Vancouver housing market, implying that price shocks affecting the central areas are transmitted to other areas further away from the center and lead to changing housing market dynamics in the regions initially unaffected by the shock.

In this study, the housing market is conceptualized through the notions of a housing bubble and a ripple effect in order to analyze the market's long-term trends as well as the spatial price diffusion

throughout Metro Vancouver, an area that encompasses the City of Vancouver along with its many suburbs. The 'hot' housing market (Yan, 2017) in Vancouver provides a good setting for analyzing the effects of external factors on the market, connecting the spatial and temporal trends, which should contribute to a more comprehensive and well-informed understanding of the current state of Vancouver's housing market, evaluating its bubble-like trends, and determining whether there is a ripple effect or not.

More generally, studying the ripple effect can help predict regional housing market behavior, providing a better understanding of consumer behavior differences by region, the effects of price changes in consumer expenditures, and labor market consequences. The character of spatial price dynamics can also shed more light on how the housing market operates. If a ripple effect is present in the housing market, there are further implications for better informed consumer and investment decision making, especially during the periods when a shock is affecting the market.

As the changes in the housing market affect labor mobility and migration patterns, ripple effect analysis could benefit policy making by enabling a better understanding of the potential effects that a given policy could generate in different areas and different segments of the market, offer increasing efficiency in necessary supply provision, as well as more effectively correct housing market failures. It could also aid the construction of social housing and other interventions by the government. Changes in commuter shed activity, following pulses of price inflation, can also have consequences for infrastructure provision in the region.

Furthermore, identifying the origin of the ripple effect can enable an earlier response by the government to correct the inflationary or deflationary trends in other regions and prevent a housing shock from potentially rippling through the entire economy, as Balcilar et al. note in South Africa (2013). As the ripple effect transfers external shocks to local markets, it is especially important to understand it in the conditions of high volatility and high exposure to global economic dynamics experienced in a market like Vancouver. Understanding market shocks is important for consumers facing residential decisions and for the government designing appropriate interventions.

The next chapter (Chapter 2) introduces the theoretical overview of the two key concepts in this research, the housing bubble and the ripple effect, summarizing the existing research findings. In Chapter 3 we continue with an overview of Vancouver price trends and their explanations. Then, in Chapter 4, original analysis of the spatio-temporal price diffusion in Greater Vancouver is presented including maps, graphs and regression modeling. Chapter 5 offers a brief summary of research results and implications.

Chapter 2. Conceptualizing Housing Market Trends

In this chapter, the recent developments in the housing markets literature will be reviewed, with specific focus on housing bubbles and the ripple effect. First, we provide a rationale for studying these two concepts, their interconnectedness, and their relevance for the Vancouver case study. It will be followed by two separate reviews on the concepts of the 'housing bubble' and the 'ripple effect' with each subsection providing definitions of the respective term and ways to measure it, their status in the literature, and existing empirical findings from applied research, as well as newspaper articles. Each subsection will also introduce existing research on the Canadian housing market overall and the Vancouver case study specifically to demonstrate how this thesis fits into and complements the existing literature.

2.1 Housing Market Drivers

With the globalization of the economy and society in general, certain housing markets are exposed to and influenced by external (global) factors to a considerable extent. This is the case for major cities that are becoming more and more embedded into the global network of financial and trade flows. The role of the global economy for the urban community spans from providing additional jobs and filling store shelves with goods to changing the very nature of other urban markets that used to be driven primarily by local factors. One such market is the residential housing market.

With housing being exceptionally important for economic growth and people's well-being, we need to better understand how the housing market works and what its main drivers are. In earlier days, housing markets were determined only or primarily by local factors, referred to as 'market fundamentals' (e.g. Carter, 2012; Gordon, 2016; Hwang & Quigley, 2006; Shiller, 2015), that comprise the demand and supply by local people and businesses (see Table 2.1). Possible demand factors center around population and economic growth, interprovincial and international migration, changes in the proportion of home owners (homeownership rate), income growth, and unemployment (see Carter, 2012, for a detailed discussion of demand factors in the Canadian context). Supply is affected by the existing housing stock, new construction (housing starts and finished projects), the resale market dynamics, general availability of land for development and redevelopment, and density and zoning constraints. If affected by market fundamentals only, house prices are primarily based on the dwellings' "use value", determined by the interaction between local supply and demand with external shocks occurring sporadically and not having a consistent influence on the market.

In the 21st century, however, most of the major urban areas around the world are more exposed to global forces than ever before, with the housing markets there experiencing the ever-growing influence of international macroeconomic dynamics on the local markets (Gordon, 2016; Ley, 2017; Yan, 2016). Such influence could play out through changes in foreign investment flows that are drawn to 'safe havens' in select locations around the world for economic and personal reasons, to be withdrawn when the world economy experiences a downturn or when foreign exchange fluctuations make housing in some areas relatively cheaper as a given currency devalues against another (a summary of various factors is presented in Table 2.1)[1]. A growing influence of external factors would typically be observed in "hot markets" where housing is quite liquid and consistently growing in price over time, which makes it appealing for non-local buyers as an investment asset for its "exchange value" rather than "use value".

Table 2.1. Key Housing Market Drivers

LOCAL FACTORS (local fundamentals)		**EXTERNAL FACTORS (mostly international)**
• driven by local market forces (mostly) • housing primarily purchased for its **"use" value**		• more typical of speculative behavior • housing as an investments asset (for **"exchange" value**)
Demand (D)	**Supply (S)**	**Demand (D)**
• population growth (natural & migration) • economic growth (in employment and income) • financial incentives (mortgage rates, lending practices) • homeownership rate change	• new construction (housing starts) • unsold inventories • resale market • land & zoning (potential for sprawl, density, soil quality, rezoning practices)	*External, including:* • foreign investment • foreign exchange rates, local currency performance • global "attractiveness" of the location (safe haven country, immigration reasons, better environment, resort area, etc.)

Source: author's original classification based on discussions in Carter (2012), CMHC (2016), Gordon (2016), Shiller (2015).

[1] It is worth mentioning that 'local' supply factors can also be driven by external factors to the extent that the developers and other actors on the supply side determine their market behavior based on the expectation for both local and external demand. We do not identify any supply factors as external; however, since supply (housing itself) is inherently local as real estate is an immobile asset and new construction happens locally even if driven by expectations related to the external forces. Whereas the buyer doesn't necessarily need to be in a given location to make a purchase (external investors), a dwelling needs to be built in the area to be considered a part of the housing supply in the area.

As we see from the table, it is external factors that typically generate more speculative behavior, treating housing as an investment asset, and thus make the market more volatile and sensitive to global macroeconomic dynamics (Shiller, 2007). If a substantial part of residential real estate is driven by external dynamics, it may eventually lead to a decoupling of the housing market from the local economy. Depending on the price trends, the notion of a 'housing bubble' may be aroused in such a market as numerous speculative transactions make the market more liquid and generate upward price pressure, that in turn spikes further positive price expectations attracting even more investors to the area.

Highlighting the potential drivers of housing prices is important in order to understand more complex phenomena, such as longer-term price trends and potential housing bubbles, or the spatial dynamics of price change and a '*ripple effect*' that will be discussed in more detail later in the chapter. Studies of housing bubbles can provide important insights into the interplay between global and local forces in the housing market at different scales of analysis and sustainability of the current price dynamics. As Vancouver is one of the cities with a 'hot' housing market (Yan, 2016), experiencing significant influence from a variety of external factors, such as foreign investors (Ley, 2017), analyzing its housing market dynamics from the perspective of a potential housing bubble could be fruitful and meaningful. Besides, as the Global Financial Crisis (GFC) of 2007-2008, leading to an economic downturn in many countries around the world, originated in the housing market and specifically from a housing bubble bursting in the US, understanding the housing market dynamics and their relation to bubble-like trends could shed more light onto potential economic risks for Vancouver itself as well as implications for the national level if not beyond.

2.2 Global Housing Market Developments

The economic crisis of 2007-2008 has shown that Western societies have entered a new stage of housing market development, what Aalbers (2015) refers to as "the late neoliberal or emerging post-crisis period" (Aalbers, 2015, p. 43). There are at least three distinct features distinguishing this stage from former periods. First, this is the time of heightened interconnectedness between forces of global capital and local housing market conditions (Aalbers, 2015; Crump et al., 2008; Dymski, 2009; Martin, 2011; Smet, 2015; Walks, 2014) with globalization acting as a driver of housing market growth as "internationalized actors" gain access to "internationalized funding" (Aalbers, 2015). Smet (2015) believes that "the process of financialization established a link between global financial capital and local real estate markets" with the "process of globalization [serving] as key to understanding these uneven housing price developments" (Smet, 2015, p. 9).

The latter statement also introduces an important aspect of residential real estate, which is its complex spatial dynamics and specifically its unevenness across space on different levels. The complexity of urban housing dynamics in space is not limited to just unevenness across cities. Regional disparities in real estate development and especially in the residential housing market and related socio-economic outcomes exist within and between countries (Carter, 2012; Walker & Carter, 2010; Walks, 2013). Uneven development and significant differences in the housing conditions could be observed on a variety of levels, from national to the regional to the city level. While neighborhoods within a city do display a higher degree of similarity, a large city like Vancouver would always have a variety of housing characteristics and price ranges across its different neighborhoods.

The variety of spatial dynamics and factors affecting the housing market stands out when looking at the different city clusters within one country that share similar housing market conditions with each other, and yet are very different from other groups. For example, Smet (2015) and Martin (2011) classify US cities into groups based on the overall housing price trend. Smet (2015) clusters cities into groups based on visual data from an earlier study (Himmelberg, Mayer, & Sinai, 2005) and distinguishes a slow upward price trend, an N-shaped trend, an exponential trend, and other house price dynamics for particular US cities. Martin (2011), however, takes a slightly different approach and, in addition to identifying the general trend, accounts for other market factors, such as supply constraints, speculative behavior, based on Hubbard and Mayer's initial classification (Hubbard & Mayer, 2009). He clusters the US cities in his study into three groups: "cities that were characteristically supply-constrained and which traditionally have had '***cyclical markets***' – such as New York, Boston, Washington, Los Angeles and San Francisco; second, cities that because of slow economic growth and less constraints on new housing construction, had '***steady markets'***, and did not experience the bubble – such as Atlanta, Charlotte, Chicago, Denver and Detroit; and third, cities that were '***recent boomers'***, those which previously had stable markets but which experienced major waves of speculative house building and extraordinary increases in house prices – such as Las Vegas, Miami, Phoenix and Tampa" (Martin, 2011, p. 598, bold italics added).

Both authors along with a variety of other studies highlight that the housing market trends are distributed unevenly in space across cities and on other levels, and whereas the national house price index might go one way or the other, the regional and individual city trends are much more multi-faceted and diverse in their nature. These trends need to be analyzed more in-depth to better understand the socio-economic implications related to housing market dynamics in a particular area and to evaluate, for example, whether a city is experiencing a housing bubble or not, or whether the ripple effect is observed or not.

Understanding this spatial unevenness and the patterns of spatial change on the housing market in the city level is more complicated that it might seem initially. While we have highlighted the key housing market drivers in Table 2.1 that would apply to given cities as a whole, the dynamics of local supply and demand as well as the impact of external factors differ significantly across neighborhoods. These differences occur not only at a given period, but could also change with time, which is why studying the socio-temporal dynamics of local housing markets is gaining more and more attention in the academic literature. How different areas in an urban region respond to change in external factors or market fundamentals can be partially explained by the concept of the ripple effect, which implies that price changes in a given area could directly and indirectly affect other nearby areas even though the market fundamentals in other areas have not changed. Liao et al (2015) specifically identify two aspects that occur with a ripple effect: first, there is a significant external shock affecting the market; second, it leads to a spatial "price-diffusion mechanism" from the (sub)market directly affected by the shock into other (sub)markets (Liao, Zhao, Lim, & Wong, 2015). On the city or metropolitan level, this ripple effect would typically diffuse from the downtown area outward changing the prices in further suburban areas where such a change would not be expected otherwise. The ripple effect will be discussed in more detail in consequent sections.

The notions of a housing bubble and of a ripple effect are intertwined as both of them are connected to the external factors affecting the housing market. Housing bubbles would typically occur with increased speculative behavior driven by positive price change expectations, with such behavior more prevalent in markets where external actors, namely profit-seeking investors, are abundant, and their participation often reinforces the price developments leading to the bubbles and contributes to the bubble eventually bursting. At the same time, the ripple effect occurs after the market has experienced an external shock, and the mechanisms of the spatial price diffusion across different submarkets in the region are also closely related to the behavior of investors on the market and their responses or adjustments to the changing external factors.

Therefore, both concepts of a 'housing bubble' and of a 'ripple effect' are closely tied with the external drivers of local housing market dynamics. Originating from an external driver, they also both involve decoupling of the local market or submarket from the local economy and the generation of spatial unevenness that usually deepens pre-existing regional inequalities. Furthermore, both typically reinforce an upward price trend with implications for deteriorating housing affordability and linked to that rising consumer debt, which is especially acute in the Canadian context (Bank of Canada, 2017; Blatchford, 2017; Walks, 2013).

The expansion of indebtedness is becoming an increasingly common phenomenon in the new age of housing around the world (Martin, 2011; Walks, 2013). Consumer debt is growing even among households under recent conditions of declining homeownership rates (Aalbers, 2015), for example, in the US after the GFC (Cheng, Raina, & Xiong, 2013). The decline in homeownership rates is most evident among younger households in most Western countries, the trend reinforced by the growing share of casual labor not capable of real estate purchases, yet at the same time the growing affordability issues might still act as a stimulus to purchase a dwelling rather than rent (Aalbers, 2015).

Housing is being commodified overall contributing to lack of affordability and speculative housing bubbles and driving households' debt burden even higher, which is why Aalbers argues that "a decommodified housing alternative is needed more than ever before" (2015, p. 57). Unaffordability is on the rise in many cities around the world, especially the markets that are most exposed to the global economy and experience a significant inflow of global capital. For example, in an annual international housing affordability survey by Demographia, in the last three years Hong Kong, Sydney and Vancouver have consistently been ranked as the top three least affordable cities in a sample of English-speaking countries (Demographia Affordability Survey, 2014, 2015, 2016, 2017).

According to Crouch (2009), debt now contributes to personal welfare within the model of the 'privatised Keynesianism', where economic growth relies on the expansion of individual consumer debt rather than government debt to finance people's expenses on housing and other goods and services. Unlike traditional Keynesianism that called on the state to step in and provide extensive welfare and safety nets for citizens, 'privatised Keynesianism' is "a system of markets alongside extensive housing and other debt among low- and medium-income people linked to unregulated derivatives markets" (Crouch, 2009, p. 382). This growth model relies on expansion of mortgage programs to enable and stimulate home ownership along with "an extraordinary growth in opportunities for bank loans and credit cards" (Crouch, 2009, p. 390) for other consumer needs. Watson (2010) further identifies 'house price Keynesianism' in relation to the UK economic growth model to emphasize the housing market and consumer mortgage debt as "the principal route through which personal debt fed the dynamics of growth in the UK" (Watson, 2010, p. 420).

Although not necessarily problematic at first glance, such a system is unreliable and unsustainable in the long run given real estate's inevitable price fluctuations, uncertainty, and possible abrupt corrections. And since most consumer debt is related to the housing market in the form of mortgage debt, it is extremely important to analyze the housing price dynamics, their drivers and fundamental causes. This question is not just of pure academic interest, but is directly relevant to

people's lives as housing is a basic necessity and defaulting on mortgages can have life-long consequences for individuals, as well as for the economy, if too many mortgage holders default in an economic downturn, which is what had happened during the 2007-2008 crisis, especially in the United States.

As mentioned before, there are two main concepts, housing bubbles and the ripple effect, that are considered in this study to analyze the dynamics of the housing prices and the interplay between the housing market and the local economy. This approach allows us to identify more generalized market trends and change patterns that are necessary to better understand residential real estate dynamics in a given area. Consequently, this chapter continues with a more detailed review of the two concepts, their theoretical interpretations, measurement, and empirical applications. Existing research findings from a variety of case studies will then be summarized in order to design a more comprehensive analysis of the Vancouver case study in the following chapters, and permit a comparison of the findings for other locales with those for Vancouver.

2.3 Housing Bubbles

In his 2011 paper, Martin wrote that "there is a new pressure to devise analytical frameworks that provide better insight into the origins and determinants of price and speculative bubbles, especially within housing, […] to explain why some countries seem far less prone to such bubbles than others" (Martin, 2011, p. 631). Building on this sentiment, this subsection elaborates on the theory of housing bubbles, different approaches to measuring them, and subsequently provides an overview of empirical findings about housing bubbles in different countries.

2.3.1 Defining and Measuring a Housing 'Bubble'

In both academic and non-academic writing related to economic trends, the term 'bubble' is most often used in relation to the real estate or the stock market. In the media, however, 'housing bubble' or 'market bubble' appear to be gaining ever-widening and oftentimes imprudent applications to attract more readers, so that the theoretical concept becomes diluted as it is being reduced to a shallow slogan, a 'click bait' in newspaper headlines, rather than a robust research framework. The word 'bubble' might sometimes be "used too carelessly" (Shiller, 2015) leading to unintended or unfounded conclusions. Still, in the academic literature, housing bubbles or market bubbles in general offer a more comprehensive framework that will be useful for our analysis. Henceforth, circumventing the common use of the 'bubble' in the media or by the general public, we will now look at the concept from an academic standpoint.

One of the widely accepted academic definitions was originally provided by Stiglitz (1990) who views bubbles as a price mismatch between speculative future price expectations and fundamental values of the asset as he writes: "if the reason that the price is high today is only because investors believe that the selling price will be high tomorrow — when 'fundamental' factors do not seem to justify such a price — then a bubble exists" (Stiglitz, 1990, p. 13). Shiller additionally emphasizes the psychological effects in forming future price expectations and, with respect to the US mortgage crisis that started in 2007, he explains that it was "the boom psychology [that] encouraged potential homeowners and encouraged lenders as well" to expand homeownership through lending "disproportionately to lower income borrowers, and to racial and ethnic minorities" eventually leading to a bust as the latter could not keep up with mortgage payments (Shiller, 2007, pp. 17–18). In a later book, Shiller also uses the combinations of "investor enthusiasm" and "psychological epidemic" (Shiller, 2015) to explain the bubble-inducing behavior by market actors.

Walks (2014) refers to housing bubbles as a 'Ponzi scheme' (Walks, 2014) and Macdonald (2010) also introduces the role of moral-hazard-type activities involved in generating the boom which eventually becomes a bubble, he calls them "wild card factors": "Bubbles are often accompanied by wild card factors such as subprime mortgage schemes in loosely regulated financial markets" (Macdonald, 2010, p. 4). He is quite specific about what housing prices should be compared to when he writes: "[A] housing bubble emerges when housing prices increase more rapidly than inflation, household incomes, and economic growth" listing here three key fundamentals.

One of the specific features of the term 'bubble' importantly relates to the assumption that house price increases are unsustainable and that the 'bubble' will burst at some point. In the UBS Global Real Estate Bubble Index report, a bubble is viewed as "a substantial and sustained mispricing of an asset" and goes even further stating that the bubbles' existence "cannot be proven conclusively unless they burst" (UBS, 2016, p. 16) while "recurring patterns of property market excesses" can be observed historically.

The UBS report uses the global real estate bubble index estimated for a number of select cities (18 major cities in the developed world in the 2016 report) based on the weighted average of five statistical indices: price-to-income and price-to-rent ratios, change in mortgage-to-GDP ratio and change in construction-to-GDP ratio (assessed at the country level) and relative price-city-to-country indicator (UBS, 2016, p. 16). The report sets the thresholds of a bubble bursting risk with overvalued markets in the top of the distribution identified as experiencing a bubble risk (those that score above 1.5 on their index), while markets with an index value of -0.5 to 0.5 and 0.5 to 1.5 are considered 'fair-

valued' and 'overvalued' respectively, and lower scores correspond to 'undervalued' and 'depressed' markets (UBS, 2016, p. 16). In 2016, the report identified 6 cities in risk of a bubble based on this measure: Vancouver, London, Stockholm, Sydney, Munich and Hong Kong, with their score ranging from 2.14 in Vancouver to 1.52 in Hong Kong (UBS, 2016). We consider the inclusion criterion of a 1.5 score to be somewhat arbitrary since it is not explained explicitly why Hong Kong is still at risk while the next city in line, San Francisco with a score of 1.27, is not considered a bubble anymore. Granted, there is no universally recognized measure for a market bubble, and the UBS report does offer an interesting methodology.

Despite the variety of interpretations and definitions, there are three features of a housing bubble that seem to be recurring across studies:

(1) Overpriced housing / decoupling between fundamental market factors and house prices

(2) Massive speculative activity of home buyers driven by (unsubstantiated) future price growth expectations

(3) Expectation of inevitable bursting

The first and second points above directly relate to the external factors' discussion in the earlier subsection of this chapter (see Table 2.1). The causes of the bubbles are specifically the speculative motives (psychological expectations about future price increases) behind housing price formation (Shiller, 2007) typical of 'hot' housing markets with high activity from external actors. The emergence of a bubble is connected then to the price diverging from the 'real' use value and the general price trend dissociated from the local economy dynamics.

There are several approaches to measuring a market bubble. One of the simpler ways, which is also the one most commonly used, is measuring the 'house price gap', i.e. the deviation of the current house price from the long term trend (Dokko et al., 2011; Dolphin & Griffith, 2011; International Monetary Fund, 2008; MacBeth, 2015; Smith & Smith, 2006). Another approach compares real estate prices to a particular index, for example inflation (Dolphin & Griffith, 2011) or looking at price-to-income or rents-to-income ratio dynamics (both accounted for in UBS, 2016; discussed in Walks, 2013).

A more complicated procedure which incorporates the changes in fundamentals over time is regression modelling designed to reconstruct the price trend based on the dynamics of market fundamentals (supply and demand factors), as well as the sales index. Consequently, the bubble is measured as the current housing price index deviation from the reconstructed trend (Case & Shiller,

2003). The authors view the bubble activity as "the expectations, the sense of opportunity and urgency, the excitement and amount of talk". Case & Shiller (2003) found no evidence for the housing bubble in the United States at the national level since the late 1980s as the price trend could almost fully be attributed to income growth. However, they identify the strong 'bubble sentiment' in three 'glamorous cities': Los Angeles, San Francisco and Boston, where expected annual price increases for residents in 2003 for the next 10 years were in the range of 13-15%, which is exceptionally high (Case & Shiller, 2003, p. 341).

Furthermore, there is another methodology which rejects analyzing current prices and bubble activity based on past values – as is the assumption in the trend or regression analysis – but rather looks at future cash flows as a way of measuring and comparing the 'real value' of a house to the current market price and thus evaluating if the market is in a bubble state (Smith & Smith, 2006). The method of calculating the net present value (NPV) is adopted from financial economics. The NPV of an investment is based on costs incurred during the acquisition and ownership of an asset and gains during ownership and from its sale at the end of the period. In the case of house prices, the following would be estimated: potential land and building value with depreciation, expected price at the point of sale, potential rental income, etc., compared to the costs of ownership, such as mortgage payments, renovation and maintenance expenses, taxes, opportunity cost of investing in housing, and other additional expenses associated with owning a dwelling in the long run. Hence, the 'real' value is viewed as the long-term benefit of owning the house. Future cash flows in this case would include necessary payments for and investments in the dwelling (mortgage, utilities, renovations), the opportunity cost of investment in housing comparing outward flows with possible rent income and resale price as inward flows (a similar approach to calculating user housing cost in Moos & Skaburskis, 2010).

The methodological choice in any given study of housing bubbles remains up to researchers since there is no universally recognized method, each has its advantages and disadvantages in accuracy and complexity, as well as constraints concerning the types of data necessary to conduct an evaluation. Moreover, most of the approaches are incapable of forecasting or even unambiguously identifying when the market boom turns into a bubble and bursts. Instead, they only enable researchers to raise concerns about the current unsustainable price growth or analyze past bubbles that have already burst.

2.3.2 Post-Crisis Geographies of Housing Bubbles

The majority of housing bubble studies are case studies of a particular national or city market, which sets the foundation for comparing spatial patterns of inflation dispersal. Several recent post-crisis cross-country comparative studies (Adams & Füss, 2010; Dokko et al., 2011; Milne, 2012) offer

some insight into global spatial housing market dynamics and possible bubbles in OECD countries mostly focusing on the US, EU, Canada and Australia. These studies show the different outcomes of the GFC on the national housing market and to a certain extent engage with globalization factors. Adams and Füss (2010) provide evidence to the significance of macroeconomic indicators in housing price formation and find that house price reactions are very country-specific and there is no single general trend across neighboring or otherwise similar countries. Dokko et al (2011) juxtapose monetary policy against mortgage expansion in OECD countries as determinants of the "global housing bubble" and assign "a greater role for macro-prudential regulation rather than monetary policy in managing asset price booms" as there is a direct link "between the marked loosening in terms and standards for mortgage credit and the most rapid increases in house prices" (Dokko et al., 2011, p. 240). Milne (2012) provides a more generic comparison of macroeconomic trends and outcomes of the GFC in Australia and Canada with less attention devoted specifically to the housing market. Still, Milne indicates that the Canadian and Australian banking systems have been more prudent in mortgage lending especially compared to the US. This accounts for a more stable market in Canada nationally, yet it leaves Vancouver and Toronto in "major condominium and housing bubbles that have drawn comments from the Bank of Canada and some senior Canadian private bank executives" (Milne, 2012, p. 9).

Further international comparisons can be found as introductory subsections of other country-specific studies (for example, see MacBeth, 2015; Martin, 2011). Whereas MacBeth (2015) focuses on the Canadian housing bubble and individual investment decisions, Martin (2011) highlights the uneven geographies of the US housing bubble across cities, and emphasizes the interaction between the global and the local scales in playing out the housing bubble activity. Both authors begin by situating their country of analysis within an international context.

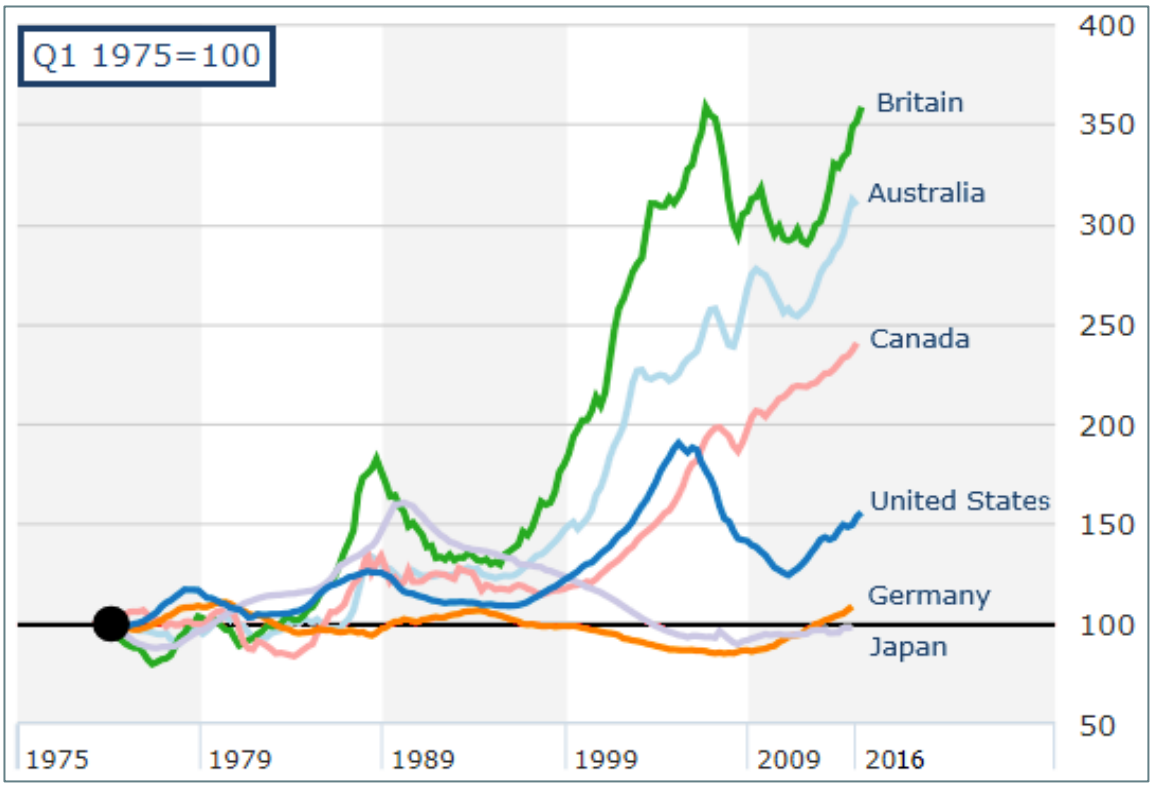
Essentially, their comparisons are based on providing an overview of the real housing prices across countries on select samples constrained by available data or justified for the sake of the argument they are making. MacBeth (2015) provides a reference to the *Economist* global house price dataset, which will be used here as well to demonstrate some of the global and regional trends in house prices. As can be seen from the first graph (see Figure 2.1), the selected six countries (Australia, Canada, the US, Japan, Germany, and the UK) experienced very different housing price dynamics.

It is remarkable how the US stands out from other countries on the graph as in 2016 national house prices were still lingering around 2002-2003 levels, markedly below the price peak in 2005-2006. Such volatility of prices within the last 10-15 years is a clear indication of the housing bubble bursting, which has of course been widely recognized in the academic and other research, for the bursting of the

US housing bubble in 2007, driven by excessive subprime mortgage expansion and consequent defaults, is considered to be the initial cause of the global economic crisis.

In contrast, Britain has recovered from the 2008-2012 decline, and for the first time since the financial crisis British real house prices in 2016 have exceeded the previous peak of 2007 Q4. Such an abrupt and extended price decline is also indicative of the housing bubble bursting (Bone & O'Reilly, 2010). Australia and Canada came out of the crisis almost unscathed with their respective house prices growing almost uninterruptedly in real terms. Australia did experience two short-term downturns in house prices (2008 and 2011-12), but the real house prices have already surpassed the previous peak of 2010 Q1 in late 2014 and kept on growing since then.

Figure 2.1. The *Economist* Real Quarterly House Price Index, 1975-2016 (select countries)



Sources: The *Economist*'s Global House Price dataset (layout slightly altered), based on Deutsche Bundesbank, OECD, ONS, Standard & Poor's (S&P), Teranet – National Bank.

Canada's slight dip in prices in the first and second quarters of 2009 had corrected itself by the end of that year and the national prices have been steadily growing ever since. Such a strong upward price trend is a prime reason leading some researchers to believe that the Canadian housing system is much more robust and not prone to a bubble (Carter, 2012). Others are more skeptical (Carlson, 2017; Walks, 2014), especially considering the house price dynamics in two major cities, Vancouver (e.g. Gordon, 2016) and Toronto (Business Insider, 2017), especially since bubble bursting in either or both

of them is expected to have serious negative consequences for the Canadian economy overall (The Globe and Mail, 2017; Young, 2017).

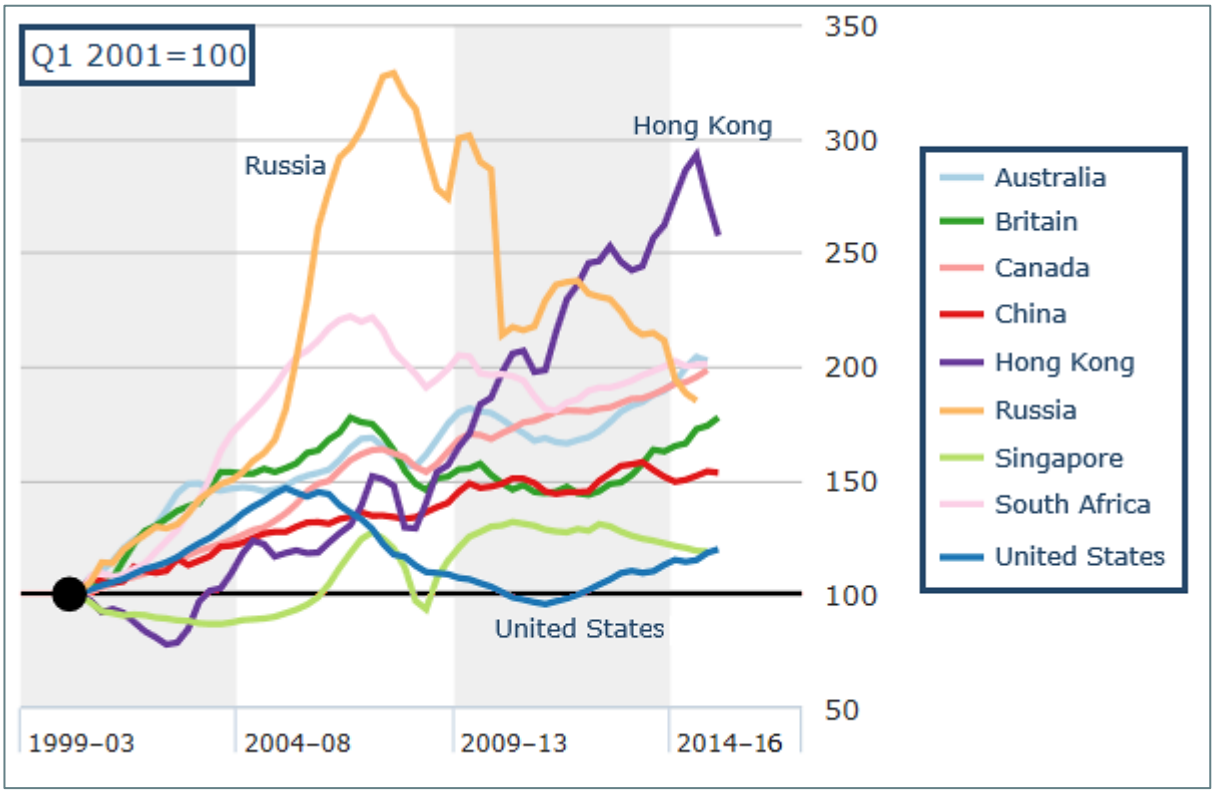
Still, not all countries on the graph experienced rising prices even before the GFC. Japan and Germany display a very different house price pattern from the others as Germany during the entire period displays no upward or downward trend and in Japan a steady decline in real house prices has been observed since the 1990s. Therefore, even such a small sample demonstrates how diverse housing price trends across countries can be, despite the impact of an external shock such as the GFC. It emphasizes the geographical diversity of the housing developments and the importance of paying close attention to regional differences of the global processes. At the same time, we also see that the countries who were hit by the bubble bursting (the US and the UK) also vary in the post-crisis recovery trend, which highlights the importance of studying housing bubbles on all levels, international, national and others.

Figure 2.2 and Figure 2.3 show that it is not only the Western countries that can experience volatile house prices and bubble-like activity in the housing market. Figure 2.2 displays real house price trends across select developed and developing countries since the beginning of the 21st century[2]. The first thing that catches the eye is the outstanding scale of house price growth and decline in Russia in the early 2000s that appears indicative of a bubble bursting and price trends not reversing at the national level in the last 10 years. In this case, the timeline follows the timeline of the GFC signaling that the Russian bubble also burst because of the global economic downturn.

Similarly, even though on a smaller scale, South African prices took a hit in 2008 reversing the trend from steep growth until the end of 2007 to slow decline until 2012. Since 2012, it appears that the prices started picking up, but they are still below the high point of 2007, a situation similar to the US. What one might also notice is the very different price dynamics in two of the Asian tigers on the graph, Singapore and Hong Kong, with exceptionally high growth in Hong Kong and a strongly curbed trend in Singapore. Both city states took a hit during the GFC, but Hong Kong exhibits staggering growth afterward whereas Singapore quickly recovered to the pre-crisis price levels and has remained around that level with slight stagnation in the last three years as a result of strong government 'cooling measures'.

[2] The sample and time period selection is determined by data available from the *Economist*'s Global House Price dataset.

Figure 2.2. The *Economist* Real Quarterly House Price Index, 2001-2016 (select countries)

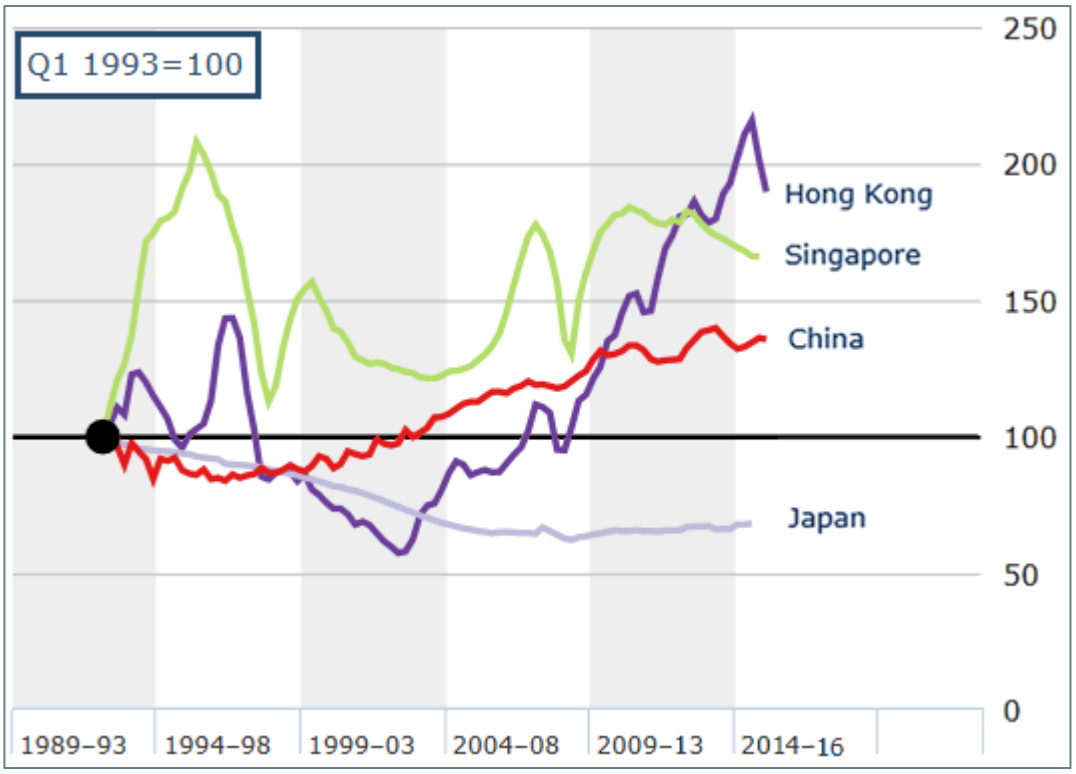


Sources: The *Economist*'s Global House Price dataset (layout slightly altered), based on ABSA Bank, Bank for International Settlements, Hong Kong Rating and Valuation Office, OECD, ONS, S&P, Teranet – National Bank, Thomson Reuters, Urban Land Authority.

Figure 2.3 provides more information on the Asian regional housing market trends. For these countries, the data were available going back to 1993, so longer term changes come to light. First, we see striking volatility for Singapore as the house prices there doubled in three years in 1993-1996 and then almost halved in the next two years, with further fluctuations in the subsequent period. Hong Kong is similar in the scale of price volatility, yet the prices in the last 10 years have been mostly on the rise with only small oscillations, whereas Singapore's more recent trend shows slight decline due to higher taxation and prudential mortgage policy.

Furthermore, it can be observed that other countries on the graph (Figure 2.3) display a very different pattern, with China enjoying a clear upward trend but with significantly slower growth than Hong Kong and not as volatile as either Singapore or Hong Kong. The latter is quite understandable given that the city-states would be expected to be more volatile as cities are in general in comparison to a national trend, especially for a country as big and densely populated as China. At the same time, Japan exhibits negative growth in prices.

Figure 2.3. The *Economist* Real Quarterly House Price Index, 1993-2016 (Select East Asian economies)



Sources: The *Economist* Global House Price dataset (layout slightly altered), Hong Kong Rating and Valuation Office, OECD, Thomson Reuters, Urban Land Authority.

As for the housing bubbles, Singaporean and Hong Kong price dynamics would seem indicative of potential bubbles, yet interestingly, the concept of a bubble is only used for the Hong Kong case (Yiu, Yu, & Jin, 2013), and for China, both nation-wide (Barth, Lea, & Li, 2012) and at the city level (Haila, 1999, on Shanghai; Hou, 2010; Hui et al., 2012 on Guangzhou and Shenzhen; Ramo, 1998 on Shanghai; Shen, Hui, & Liu, 2005, on both Beijing and Shanghai). Singapore, nonetheless, with strong state regulation of the land market and the prevalence of public housing escapes the typical housing market dynamics with excessive speculative investors' activities, and its housing market is not regarded as a 'bubble' (Haila, 2000; Phang, 2001).

These graphs and studies provide an insight into how complex and spatially diverse house price dynamics are across and within countries. A geographical perspective is essential to understanding, for example, the origins of the GFC (French, Leyshon, & Thrift, 2009), as well as the uneven spatial distribution of its outcomes (Carter, 2012; Martin, 2011; Walks, 2013). The relevance of geography to housing analysis stems from differences across countries in banking structures, different mortgage finance systems (Aalbers, 2009b), and different regulatory regimes (Martin, 2011). At the same time, the spatial diversity does not stop at the national level as in any country, different cities would

experience housing bubbles to a different extent (Carter, 2012; Himmelberg et al., 2005; Hou, 2010; Hubbard & Mayer, 2009; Hui et al., 2012; Hui & Yue, 2006; Martin, 2011; Smet, 2015; Walks, 2013).

As real estate is an inherently local, spatially-fixed asset (Aalbers, 2009a), even with the overreaching influence of macro-level conditions, "local outcomes may differ considerably, depending on such factors as the pre-existing nature of the local housing stock, the buoyancy of the local economy and labour market, local incomes, the scope for new local house building, social and ethnic composition, and so on" (Martin, 2011, p. 597). The housing market is geographically differentiated with varying house price dynamics and indebtedness observed on the regional, city or neighborhood level (Martin, 2011).

Many recent studies on housing markets and specifically real estate bubbles incorporate spatial analysis. In the case of the US, for example, there are examples of studies that bring out the spatiality of housing bubbles conducted by economists (Mikhed & Zemčík, 2009), urban planners (Y. Li, 2011), and geographers (Martin, 2011). Whereas Martin (2011) and Mikhed & Zemčík (2009) highlight regional and city differences, Li (2011) goes further to explore housing price changes and lending practice patterns on the neighborhood level. Further works on bubbles include advanced quantitative analysis and modelling and use spatial units in their analysis (Brueckner, Calem, & Nakamura, 2012; Glaeser, Gyourko, & Saiz, 2008; Mayer, 2011), but do not focus on the spatial dimension of residential real estate developments and bubbles, advancing theoretical abstraction more than local empirical differences.

Analyzing the upward housing price dynamics of a particular place with the lens of the housing bubble concept can highlight important factors and patterns that might go unnoticed otherwise. Spatial analysis specifically can enhance the understanding of the housing markets and bubbles as "spatialities not only have implications for the search for causes of house price bubbles, but also may have a bearing on the form of policy interventions intended to stem them" (Martin, 2011, p. 614). There is plenty of room to expand the spatial dimension of housing price trends as few papers conducting comprehensive spatial analysis of housing markets were found, especially in the Canadian context.

2.4 The Ripple Effect

2.4.1 Defining 'Ripple Effect'

The notion of a "ripple effect" has been widely applied both in academic and non-academic (mostly media) sources. Similar to a "housing bubble" concept, the ripple effect became a frequent term for a headline in the media, a "clickbait", that has been widely used appealing more often to

emotions than specific definitions. In the academic literature, borrowing from natural science vocabulary, spatial price dynamics could also be described in terms of 'contagion' (e.g. Guo, Chen, & Huang, 2011). Financial contagion typically refers to the effects that price shocks in one market, e.g. the stock market, have on other sectors, such as housing, energy, banking, etc. With the negative connotations coming with the term itself, most recent studies on contagion focus on consequences of a financial crash for other sectors of the economy. The housing-specific studies, however, primarily use the terms 'ripple effect' and 'diffusion', with their usage being stretched in different dimensions across academic and non-academic sources.

Even in the academic literature, the definitions vary and the authors might use the "ripple effect" in a very generic form or specified to their particular case study. For example Cook & Watson (2016) refer to the ripple effect as "a relationship whereby changes in house prices in the UK are noted first in London and the South East of England before being observed in other regions" (Cook & Watson, 2016, p. 3).

More generally, however, the ripple effect implies consequences of price changes in one area for other areas. Liao et al (2015) specifically identify two sufficient and necessary components for a ripple effect to take place: "a pronounced *shock* entering a market (submarket) that is significant in the regional (city) economy" and "a *price-diffusion mechanism* exists, allowing price movements, which are a result of the shock, […] to affect prices of other markets (submarkets)" (Liao et al., 2015, italics added). Balcilar et al (2013) further add that such price shocks could lead to either temporary or permanent changes in price dynamics in other areas, both cases would be considered to display a ripple effect.

Alongside the 'ripple effect', other terms and concepts could be used as well carrying identical or at least a similar meaning. While 'ripple effect' is the term applied almost always to the UK housing market in the relevant literature (Cook, 2005; Cook & Watson, 2016; Tsai, 2014), other country or city case studies present a wider range of vocabulary. The corresponding concepts include but are not limited to 'spatial price diffusion' (on the UK: Holly, Pesaran, & Yamagata, 2011; or other countries: Oikarinen, 2004; Roehner, 1995, Loesch 1940 reproduced in 1999; Stevenson, 2004), 'spillover effects' in Australia (Costello, Fraser, & Groenewold, 2011), also used in reference to the UK market (Meen, 1999), 'knock-on effect' referring to the US market in Stevenson (2004) and 'domino effects' on the HK housing market as described by Ho et al (2008). Furthermore, in earlier research the term 'positive feedback effect' was often applied to spatial dependence of housing prices meaning that changes in one

areas would affect another area, or ‘feed back’ into it (Clapp & Tirtiroglu, 1994; Dolde & Tirtiroglu, 1997).

Whereas these concepts seem and indeed are similar in their interpretations, there might still be difference as evidenced by Luo et al (2007) who refer to the house price diffusion in Australia as “display[ing] a ripple effect”, which implies that there could be a different diffusion pattern without a ripple effect. The authors do not elaborate on terminology, though, so we could only speculate whether the authors intended this implication.

Since ripple effect is still the term used most widely (Balcilar, Beyene, Gupta, & Seleteng, 2013; Berg, 2002; Cook, 2005a; Cook & Watson, 2016; Costello et al., 2011; Gupta & Miller, 2012; Huang, Zhou, & Li, 2010; Huang, Zhou, et al., 2010; Liao et al., 2015; Luo, Liu, & Picken, 2007; Tsai, 2014), in this study it will also be the primary concept. Under “ripple effect” we hereby understand a lagged co-movement of prices in peripheral areas depending on the price changes in the center.

2.4.2 Behavioral Factors behind the Ripple Effect

Before testing any potential market for the presence of a ripple effect, it is important to understand why it might occur to evaluate whether it would be a valid explanation for a case study. This subsection will address the drivers of a ripple effect and what identifies the ‘shocks’ that cause spillovers, the characteristics of an area where it is expected to originate, and the extent of potential spatial dependence of prices by distance and contiguousness.

First, Meen (1999) provides a systematic review of the incentives for the ripple effect to occur. His explanations display the convergence expectation in a regional housing market, meaning that a shock in the central area (in Meen’s case, South-East England) is transmitted to other areas with a lag, but eventually the periphery catches up and the equilibrium is restored. Therefore, Meen’s explanations imply drivers forcing convergence, of which he mentions four:

1. Local migration: mobile people move to cheaper areas after the shock in the central area leading to balancing of the new supply and demand across different areas
2. Equity transfer: owners from more expensive central regions enjoy rising purchasing power that they can exercise to advantage in cheaper areas as well

   even though are random and there is no consistent connection among different areas
3. Different reaction speeds to shocks across the studied area (not only in housing specifically, but economic shocks in general)

4. Spatial arbitrage: a difference in prices and price changes leading to a potential profitable opportunity (arbitrage) could exist across regions at a point in time despite the idea of efficient markets, notably the market efficiency hypothesis that implies that regional prices at any given moment already reflect the dynamics in other regions, thus ruling out potential regional differences. Spatial arbitrage (spatial difference in prices) explains why there might be a delayed response to a price shock in 'non-central' areas, which is necessary for the ripple effect to occur, due to the presence of search costs and the information asymmetry on the housing market among consumers and between consumers and realtors or owners. As the migration and equity transfer often take a longer time period to pan out because of the aforementioned search costs and information asymmetry, there is room for spatial arbitrage to exist in a given time period. (Pollakowski & Ray, 1997 in Meen 1999)

Price shocks

In general, there are two key groups of factors that usually explain most house price changes: market fundamentals and external (global) macroeconomic drivers. This division stems from the classical view on housing as being primarily driven by local market needs and dynamics ('fundamentals'), which has been standard in the past, and is still the case for some of the smaller and less economically integrated places nowadays. Recently, however, the role of global factors, such as foreign investment, started to be emphasized more in housing market research, especially in the aftermath of the global financial crisis (GFC) of 2007-2008 that started in the US housing market, but was felt around the world with the negative economic ripple effects felt in most countries shortly after the market crash in the US (Martin, 2011). The global factors become more important not only with long-range migration, but also with the growing commodification of real estate and property markets of the world's major cities, which become the target of global investors seeking better returns and portfolio diversification (Bardhan & Kroll, 2007; Fernandez & Aalbers, 2016; Ley, 2017).

With the "repercussions [of the financial crisis] felt globally" (Martin, 2011, p. 587), a better spatial understanding of those effects is necessary across countries as well as within countries. Martin (2011) engages in a discussion of both levels, and his findings on the national level for the US are most relevant to this study. While the subprime mortgage market was a national problem, it hasn't affected all US states or major cities in the same way making the housing bubble not a nation-wide phenomenon, but represented in "a number of local bubbles" (Martin, 2011, p. 598) that most notably affected the north-eastern (NY, RI, DC, MA) and some southern and western states (CA, NV, FL), as well as the

cities with major waves of speculative housing construction (e.g. Las Vegas, Miami, Phoenix, Tampa) (Martin, 2011). These areas saw highest price increases before the crisis, but also took the largest hit during it, sending ripples across the country and the whole world.

In relation to the ripple effect, the global factors in general and specifically foreign investment in residential real estate enter the picture as one of the potential sources of shocks that lead to ripple effects, which is the case Martin (2011) describes. As central districts in a city or the capital city region in the country typically enjoy a more significant share of foreign buying in the property market (Ley, 2017; Ley & Tutchener, 2001), these areas would be first to experience a negative or a positive shock caused by macroeconomic dynamics. A few articles on ripple effects investigate the issue of foreign capital or global trends as a factor of the spatial price diffusion on the local housing market. For example, Roehner (1999) mentions the connection of the top-priced city districts in Paris to global markets and, hence, their leading role in the price changes on the city level.

Furthermore, Liao et al (2015) present Singapore as a case in point and specifically analyze the impact of external shocks on the local housing market distinguishing between central and suburban areas. They find that "the growth of suburban housing prices is still significantly affected by foreign buyers through the 'ripple effect' [as] an influx of foreign liquidity to the central region's housing submarket can trigger an upsurge of property prices in that region, and the effect of the upsurge can ripple out to the non-central region" (Liao et al., 2015, p. 139). They also present detailed data proving that foreign buyers are much more present in the central property markets in comparison to the suburbs.

Scaling up to the national scale and tracing ripple effects across the country's regions in the UK (Holly et al., 2011) or cities in South Africa (Balcilar et al., 2013), there is a way to account for foreign investment as a factor as well. In South Africa, Balcilar et al (2013) find that Cape Town is a driver of regional price change in one of the market segments and note its peculiarity in being a hub for foreigners and foreign money suggesting it has played a role in forming the established regional price dynamics. As for the UK, the authors do not merely suggest the impact of global macroeconomic dynamics, but they actually include New York's housing price index as a factor of local shocks on the UK housing market and identify "an independent role for shocks to London coming from developments in house prices in New York. These proxy the effect of global financial developments on house prices in London" (Holly et al., 2011, p. 20).

Apart from global external factors that create internal housing market shocks, the source of ripple effects could also be shifts in macroeconomic dynamics and/or government policies, that a given country or city do not necessarily have control over. For instance, in the western US states

unemployment shocks in one state are found to have a significant effect on housing prices in neighboring states (Kuethe & Pede, 2011), which serves as an example of a macroeconomic shock. Liao et al (2015) factor political changes into their analysis as the Singaporean real estate market is affected by foreign capital under consistent government policies that change depending on the current state of the market with the government "easing rules and regulations on foreign investment when the market is dull and tightening them when the market overheats" (Liao et al., 2015, p. 139).

To be considered a shock to the market, government policies do not necessarily have to deal with foreign investment, there are shocks to the housing market that could be intentional and targeting a specific local issue through policy change by the local or national government. For example, in the heavily regulated housing market in Hong Kong, Ho et al (2007) mention the shocks causing ripple effects for different property types stemming from the government changing demand factors through punitive taxation and macro-prudential policy, specifically creating a wealth shock on the rental market. Similarly, in London increases to stamp duty (the local property transfer tax) were introduced to cool the prime central market in 2013, which eventually led to cooling effects spreading to more peripheral markets in the metropolitan area.

Therefore, the shocks that stimulate a ripple effect could stem from a number of factors:

- global macroeconomic dynamics that affect the destination country in general via global interconnectedness of economies and societies, such as the GFC of 2008 (for instance, see Tsai, 2014) or the more region-specific Asian crisis of 1997 (Ho, Ma, & Haurin, 2008)
- foreign investment shocks caused either by the previous reason or by a change in government policies regarding investment inflows in general or real estate specifically (Liao et al., 2015)
- local shocks including changes in government policies (Balcilar et al., 2013; Ho et al., 2008) or national and regional macroeconomic dynamics (Kuethe & Pede, 2011; Stevenson, 2004)

2.4.3 Measuring a Ripple Effect

Now that we have seen that various studies have found evidence of a ripple effect, we move on to questions of method and measurement. As is clear by now, the 'ripple effect' is a complex phenomenon in the housing market and its representation in hard data might not be evident. This section addresses the measurement issues raised in the literature.

Scales

First, the existence of a ripple effect could be estimated at different geographical scales: across a country's regions, across cities, or across neighborhoods within a city. The former is most widespread in the research on the UK that focused on regions without specific reference to individual cities (Alexander & Barrow, 1994; Cook, 2005; Cook & Watson, 2016; Tsai, 2014). In this case, the South-East acts as a proxy for the London region. Region-level research has also been done in other countries, for instance, in Finland (Oikarinen, 2004), Australia (Costello et al., 2011), Taiwan (Chien, 2010), and the USA (Barros, Gil-Alana, & Payne, 2012; Kuethe & Pede, 2011).

Another level of analysis prominent in the academic literature appears to be across cities, which has been conducted in different parts of the world at different times: Australian state capitals (Luo et al., 2007), Irish main urban centers (Stevenson, 2004), South African cities (Balcilar et al., 2013), select USA cities (Chiang & Tsai, 2016; Clapp & Tirtiroglu, 1994; Dolde & Tirtiroglu, 1997; Gupta & Miller, 2012), China (Hong, Xi, & Gao, 2007; Huang, Li, & Li, 2010; Huang, Zhou, et al., 2010; J. Li, Sun, & Li, 2010).

Finally, and this is the scale most relevant to this research project, the ripple effect could be observed and measured within a metropolitan area. This has been achieved for Paris (Roehner, 1999), Singapore (Liao et al., 2015), partially for Dublin, Ireland (Stevenson, 2004) and Helsinki, Finland (Oikarinen, 2004). The latter two cases do not constitute studies specifically focusing on the metropolitan level; however, they do feature some of the center-suburbs dynamics for the respective capitals. These studies will be discussed in more detail later in this chapter.

Price Data & Statistical Tests

As the ripple effect refers to the dynamics in housing prices, the primary data points are house or apartment price data depending on the case study. Since finding homogenous housing-type data is challenging whether it be across different neighborhoods of the city or across cities and/or regions in a country, researchers often employ hedonic price models to adjust the prices using the dwelling or neighborhood characteristics to make the data comparable.

Prices could be used in modelling the ripple effect in a number of ways. Some studies look at price indices (for example, Balcilar et al., 2013; Liao et al., 2015; Stevenson, 2004), others employ absolute prices, city averages (Cook & Watson, 2016) or a per square meter metric for apartments in a city (Roehner, 1999). Depending on their choice of statistical tests to run, a number of studies look at the regional price dynamics relative to the national level (for instance, Balcilar et al., 2013; Cook, 2005). Very few studies so far have looked at price changes as the main variable in analysis measuring the ripple effects from the first difference in prices (Cook & Watson, 2016). This project will potentially

expand on this aspect. Oftentimes, any given study would include a combination of several data sources to test sensitivity and different indices.

Finally, once the data at the selected level is collected, the statistical modelling begins. There is a variety of methods to estimate the ripple effect, the direction of spatial changes, the extent of interdependence, etc. The methods include analyzing descriptive statistics including variance, auto-correlation, and volatility measures (Oikarinen, 2004), to autocorrelation analysis and vector error correction tests, to more advanced unit root and tests evaluating stationarity of data within the convergence hypothesis (see Luo et al., 2007 for a review) and vector autoregression models with co-integration tests that enable assessing whether regional prices are converging with the national level and identify the potential primary drivers of price changes across the region of study. Some studies also emphasize break-point or structural break analysis, specifically looking at the spatial impact of the positive and/or negative price shocks on the local market (Balcilar et al., 2013; Chien, 2010; J. Li et al., 2010; Liao et al., 2015), with a variety of dating techniques applied for determining the periods of price peaks and troughs (see Cook & Watson, 2016 for classification suggestions).

The wide range of methods accounts for the lack of a unified framework for evaluating the ripple effect, with varying interpretations of the effect and how it plays out on the market. Data used include mostly absolute prices and price indices, less often price changes. Some of these techniques, primarily co-integration tests, are based on comparing area price dynamics to national or regional averages to evaluate convergence or divergence in the long-term trend. This model works best when the national average is determined beyond the data sample. Structural vector autoregression models typically utilize data beyond just the housing market statistics, but also include region-specific economic indicators. The latter presents a challenge for analysis on the intra-metropolitan level especially since most of the macroeconomic indicators are only available at the city level, but not in more detail on the district / neighborhood level. Overall, the choice of methods depends on available data (type and time period), local context and specific research questions. The methods most promising for the Vancouver case study that will be used later include cross-correlations, volatility analysis, structural breaks and auto-regression modelling.

2.4.4 Empirical Results Overview

Now the empirical results of existing research will be covered in more detail. Table 2.2 provides these details in a tabular form sorted by the country / city of the case study and contains information on each study: the observation scale and size, the time period, whether a diffusion center was identified, and whether or not the ripple effect was supported by evidence. The selection is by no means complete,

but the most cited works were selected. Apart from the UK, most of the other cases are represented by one article, so as not to overwhelm the visual representation. There are multiple UK references to reflect the literature bias with an overwhelming coverage of the UK in particular. The sample includes 19 articles and covers regional price analysis on multiple continents and under different political and economic systems: Europe (UK, Finland, Paris, Ireland, Sweden), USA, Australia, South Africa, Asia (Singapore, Hong Kong, Mainland China, and Taiwan).

Probably, the most striking result is the overwhelming empirical evidence in support of the ripple effect, most of the 19 articles in the table find some support for the ripple effect, with the only exception of one study of US state-level data (Barros et al., 2012). Four of the articles (Alexander & Barrow, 1994; Lee & Chien, 2011; Oikarinen, 2004; Tsai, 2014) show somewhat ambiguous results. Oikarinen (2004) found an expected result for the Helsinki area being a driver of the Finnish housing market, although at the metropolitan scale itself the suburbs seem to be driving downtown price growth, which goes against one's expectations and other research results, primarily for the UK. The ambiguity of Alexander & Barrow (1994) is concerned with the fact that the direction of the ripple effect was somewhat unexpected, i.e. the ripple effect does exist, but it is not London transmitting price shocks throughout the country, but the aggregate South-Eastern region, whereas Greater London was found to have independent price development. Still, the other 12 studies in Table 2.2 are straightforward examples of a ripple effect from the expected central region outwards to the periphery.

Both Lee & Chien (2011) and Tsai (2014) still find evidence for the ripple effect, even though it is weak. Lee & Chien (2011) find a weaker spatial dependence across Taiwan's regions overall, yet not weak enough to disprove the presence of the ripple effect. Only contiguous regions are directly affected by the ripple effect, namely Taipei's price changes ripple into its southern neighboring regions, which in turn affect the further periphery. The weakness of the ripple effect present in Tsai (2014) is concerned with the fact that some of the UK regions displayed inconsistency with the general trend, so the ripple effect in this study is not pervasive across all regions.

Table 2.2. Ripple Effect Main Research Results Summary

Case study	Reference	Time	Data intervals	Spatial unit, N#	# of obs's	Identified Center	Ripple Effect	Ripple Effect direction
Australia	**Luo et al 2007**	1989-2005	Quarterly	Cities	8 state capitals	Sydney => Melbourne	**Y (yes)**	From major cities to secondary cities: Sydney => Melbourne (both 1st tier cities) => Adelaide & Perth (2nd tier) => 4 cities in the 4th tier
China – Mainland	**Huang, Li, Li 2008**	2008-2010	Monthly	Cities	19 cities	Guangzhou. Shenzhen	**Y**	Guangzhou. Shenzhen => Beijing, Shanghai, Hangzhou, Nanjing and Xiamen => non-major 12 cities
Finland	**Oikarinen 2004**	1987-2004	Quarterly	National regions & City areas	4 regions	Helsinki	**Y // N (No)**	*Country:* Helsinki => regional centers => periphery / *Intraurban (within Helsinki)*: suburbs => city center
Hong Kong	**Ho et al 2007**	1987-2004	Quarterly	Property class	4 classes by size	X	**Y**	From lower to higher quality tiers (allegedly through changes in wealth)
Ireland	**Stevenson 2004**	1978-2002	Quarterly	Urban centers	5 centers + N Ireland	Dublin	**Y**	Dublin => out
Paris, France	**Roehner 1999**	1984-1993	Quarterly	City districts	20 districts	S-W districts	**Y**	S-W districts => North => East => cheapest districts
Singapore	**Liao et al 2015**	1996-2011	Quarterly	City neighborhoods	25 consolidated areas	Center	**Y**	Center => periphery
South Africa	**Balcilar et al 2013**	1966-2010	Quarterly	Cities	5 provincial capitals	Cape Town & Durban	**Y**	CT & Durban outward + feedback effect
Sweden	**Berg 2002**	1981-1997	Monthly	Urban areas	7 economic / city regions	Stockholm	**Y**	Stockholm => the rest
Taiwan	**Lee & Chien 2011**	1993-2009	Quarterly	Urban regions	6 regions	Taipei	**Y *(weak)***	Taipei => neighbors (=> their neighbors)
UK	**Alexander & Barrow 1994**	1968-1993	Quarterly	National regions	13 regions	London	**Y/N**	London – independent From S-E northwards
UK	**Cook & Watson 2016**	1973-2013	Quarterly	National regions	13 regions	London	**Y**	London => neighbors => rest of the country

Case study	Reference	Time	Data intervals	Spatial unit, N#	# of obs's	Identified Center	Ripple Effect	Ripple Effect direction
UK	**Holly et al 2011**	1973-2008	Quarterly	Regions & cities	12 regions	London (+ NY proxy)	**Y**	(NYC) => London => rest of UK
UK	**Tsai 2014**	1995-2012	Monthly	National regions	10 regions	South East; Yorks & Humber	**Y *(with limits)***	From South East, and Yorks and Humber region to other 8 regions
USA	**Barros et al (2012)**	1975-2010	Quarterly	States	50 states	–	**N**	– (no ripple effect; relatively independence of states' housing prices)
USA (Hartford, CT)	**Clapp & Tiroglu 1994**	1981-1988	Quarterly	Towns	19 towns	No center identified	**Y**	Feedback effects significant for **neighboring** towns **only**; no considerations of size or centrality are identified
USA	**Chiang & Tsai 2016**	1988-2012	Monthly	Cities	8 cities (major regional centers)	LA (West), NYC (East), Miami (South)	**Y**	LA; NYC; Miami => other cities in their respective regions
USA (West)	**Kuethe & Puede 2010**	1988-2007	Quarterly	States	11 states in the West Region	–	**Y**	Ripple effect works in all directions, it affects neighboring states of a state experiencing a macroeconomic shock with varying magnitudes

Source: respective articles, author's layout.

The ripple effect is largely estimated using quarterly data, with only four studies using monthly statistics (Berg, 2002; Chiang & Tsai, 2016; Huang, Li, et al., 2010; Tsai, 2014). The scale also differs varying from country regions to major urban centers to districts of one city. Despite this diversity of scales and time intervals, the ripple effect was found to be significant in all of those different cases (the ambiguous results mentioned in the previous paragraph do not account for differences in scales or time periods). Therefore, the ripple effect appears to be a prevalent phenomenon and its estimations are robust under different country conditions.

All but two studies (Alexander & Barrow, 1994; Oikarinen, 2004) support the idea that the origin of the ripple effects belongs in the major metropolitan areas, largest by size, economic impact and/or attractiveness for foreign buyers, or in the most expensive city neighborhoods that are again subject to higher foreign investment. Hence, it would be a reasonable expectation for the Vancouver case study that the city of Vancouver would be the leader of the ripple effect.

Another important factor in the ripple effect analysis is proximity and/or contiguity, i.e. whether the ripple effect mainly operates through neighboring regions or whether it can reach further areas directly by other linkages. For example, some studies find that proximity matters with the spatial price diffusion happening very differently for contiguous and non-contiguous areas (Chien, 2010; Cook & Watson, 2016; Kuethe & Pede, 2011; Lee & Chien, 2011; Stevenson, 2004). More specifically, Clapp & Tirtiroglu (1994), Dolde & Tirtiroglu (1997), and Lee & Chien (2011) all find no evidence for a direct ripple effect across non-contiguous areas. Nevertheless, in other papers it is argued that there is no consistent pattern or difference between neighboring and non-contiguous regions (Luo et al., 2007; Pollakowski & Ray, 1997).

Still, hierarchical diffusion studies, e.g. studies of a number of cities across the country, display the linkage between the largest centers regardless of their proximity through economic linkages and consumer behavioral motivations (Balcilar et al., 2013; Chiang & Tsai, 2016; Huang, Li, et al., 2010; Luo et al., 2007; Meen, 1999; Pollakowski & Ray, 1997). It is not clear, however, how hierarchical diffusion would play out within a single metropolitan area across neighborhoods or municipalities. The issue of contagious spread, hierarchical diffusion, or some other ripple mechanism has not received a clear consensus in the literature.

2.4.4.1 Canadian Studies

As mentioned before, academic studies on the ripple effect and price diffusion patterns in Canada are lacking and so far non-existent to the best of our knowledge. No official reports were published on the topic until the May 2017 short report by the CMHC Market Analysis team came out almost entirely focused on the housing price spillovers in British Columbia (Batch, 2017). More specifically, it analyzes the diffusion of price changes from the City of Vancouver throughout the metropolitan area and beyond to other cities and towns in the interior of British Columbia.

This report is based on the methodology of the earlier academic paper on the national house price diffusion and ripple effect in the UK (Holly et al., 2011), and adopts the price correction model from the paper adjusting it to the Greater Vancouver context (see more details about Holly et al (2011) Table 2.2). Essentially, the approach estimates two regressions separately for the price changes in the analytically identified ‘central area’ (in our case, the City of Vancouver) and a separate equation for the price changes in other areas accounting for spatial effects and including lagged variable for prices in the center. This study will be discussed in more detail in the next chapter as the design of the model for our study builds on the CMHC report’s approach.

The report provides sufficient evidence for the significant interrelation between the prices in the City of Vancouver, and its suburbs and other cities quantifying the spillover effect in percent changes and time period between municipalities and cities, as well as linking the price diffusion dynamics with commuter patterns. Specifically, it establishes a spill-over effect from the City of Vancouver to other municipalities that can be observed over a few quarters and may take up to a few years to fully affect further municipalities. Furthermore, the report makes a clear link between commuting patterns and distance and the housing price ripple effect, exemplifying some of Meen's (1999) justifications and rationalizations of the ripple effect. Still, the cities and towns more distant in the interior of the province still observed the spill-over effects from the city that span beyond the commuter regions of Metro Vancouver.

Other than this CMHC report (2017), however, there are no other academic or institutional studies on the ripple effect either in Vancouver or in Canada overall. This is one of the main literature gaps that the present study addresses as we are using a somewhat different methodology and will be looking specifically at the Metro Vancouver area without including municipalities and cities located further away.

Still, outside the academic literature, the terms 'ripple effect' or 'spill-overs' do come up in media articles on the housing market quite often, and especially after the publication of the CMHC report, the term "spill-over" started to be referenced more in the media. However, just like housing bubbles, the concept of the ripple effect in the media gets diluted and is sometimes applied too broadly without generating identifying useful implications. A few examples will be provided to demonstrate how the 'ripple effect' framework is used in the Canadian context in the media and what the key findings of journalists' research are. The concept comes up mostly in relation to the City of Vancouver as the origin of the ripple effect with other areas in Metro Vancouver or BC or even elsewhere in Canada feeling the effects. An alternative is to make Toronto the center of the ripple effect, but significantly fewer articles came up from this perspective.

Vancouver, the city with most expensive housing in Canada (Statistics Canada) and least affordable dwellings in all of North America (Demographia Affordability Survey, 2017), receives a lot of media attention in terms of housing market dynamics. A few articles use 'ripple effect' to indicate people leaving Vancouver for good as a reaction to rising house prices especially in the West Side neighborhoods (the Western part of the City of Vancouver, also referred to as Vancouver West). For example, one *Globe & Mail* article suggests that home buyers leaving the West Side and 'going East' meaning East Vancouver and nearby suburbs to buy cheaper houses is "a clear-cut example of the

ripple effect" (The Globe and Mail, 2016). Another article suggests that buyers leave the city all together for more distant cheaper areas including Vancouver Island (Seale, 2016) and the commuting options are explored to analyze which living options on the Island are feasible for commuting to Vancouver.

Others focused on how effects from the foreign buyers' tax introduced in Greater Vancouver in the summer of 2016[3] rippled to neighboring areas (Bula, 2016; Mitham, 2017). Bula (2016) shares the perspective of city mayors in Metro Vancouver and other BC regions on the tax and their pessimistic view that their respective regions would be negatively affected by the tax, yet they are not getting any of the benefits. Mitham (2017), interestingly, only mentions 'ripple effect' in the title of the article, a true 'clickbait', and then goes on to analyze migration patterns across the Lower Mainland finding that there was a "single biggest increase in net arrivals has been in the Fraser Valley Regional District", which is "more than double the average in the previous decade" (Mitham, 2017).

Further studies extend the potential area affected by the foreign buyers' tax beyond BC as Calgary and Toronto might expect "mild ripples" (Jang, 2016) as foreign buyers switch to other markets from Vancouver, and the author also provides data on increased sales numbers in both cities. Spill-overs to Toronto have attracted more attention highlighting the stronger economy and population growth in the area (Finance & Estate, 2016) with double the sales number of the previous year in the 3rd quarter of 2016 in Toronto coinciding with introduction of the foreign tax in Vancouver (Marr, 2016).

Finally, the concept of the ripple effect is also applied to Toronto as the central city impacts its suburbs: "communities outside the city are starting to feel the effects as Toronto buyers look farther afield for affordable housing" (Karpenchuk, 2017). The effect is extended to the rest of the country in the case of a Toronto housing market crash that would send ripples across Canada (Young, 2017).

2.4.4.2 Intra-metropolitan Studies

As mentioned above, the studies of the ripple effect on the intra-metropolitan scale are significantly scarcer, potentially due to data limitations. The more pertinent studies directly addressing the ripple effect at this level are Roehner's (1999) study of Paris and a Singapore case study by Liao et al (2015). In some studies (Oikarinen, 2004; Stevenson, 2004) the intra-metropolitan scale is brought up almost as a side project while the main question addresses the national or regional scale. Oikarinen (2004) finds evidence of a counter-intuitive dynamic of the ripple effect spreading from the suburbs to

[3] The tax policy will be discussed in more detail in the next chapter.

the center whereas Stevenson (2004) confirms the more wide-spread notion of the price shocks affecting city center and then moving outwards.

Liao et al (2015) focus their study on the impacts of foreign investors on the Singaporean housing market in different parts of the city with the shocks being policy changes to real estate ownership by foreigners as well as looking at the global financial crisis. The authors use a structural vector autoregression model with structural breaks including data on housing prices, price index, housing supply and a number of macroeconomic indicators. They find that foreign-liquidity shocks in the central region with the highest share of foreign buyers "greatly impact housing price growth in *not only the central region* but also the *non-central region* where foreign buyers are inactive" (Liao et al., 2015, p. 138, emphasis added). Furthermore, these shocks can even "reach the public-housing market, where foreigners' participation is prohibited" (Liao et al., 2015, p. 138). Thus, external shocks through changes to foreign investment regulation in this case cause changes throughout the city through the ripple effect reaching areas the shock might not influence directly.

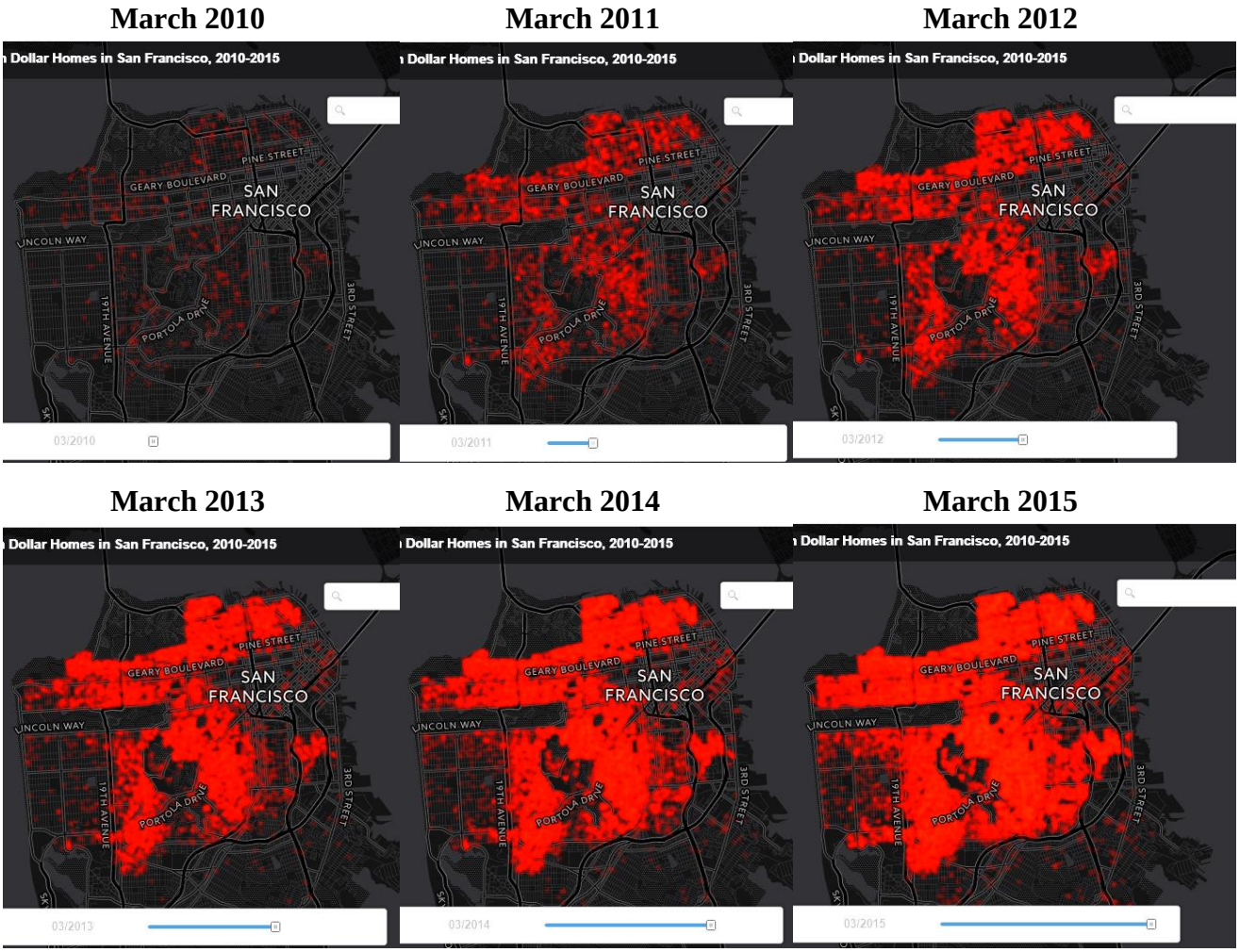
The Paris study (Roehner, 1999) is exploring apartments' per sq. meter price dynamics across the city's official districts in a non-linear partial equilibrium model, which estimates the impact of inelasticity, speculative activity and delay on the prices. 'Delay' is the indicator for the ripple effect. The shock under consideration is the 'bubble'-like state of the Paris housing market in late 1980s-early 1990s. Roehner finds that "the bubble originated in the wealthy districts of the South-West, then swept northwards and eastwards to medium-priced districts and finally reached the cheapest districts" (Roehner, 1999, pp. 85–86). South-Western districts are identified as the most expensive and the most speculative ones, also prone to foreign investment even though the scale and context were different at that time than in the more recent study in Singapore.

Both intra-metropolitan studies described here find a strong connection of Singapore's and Paris's housing prices to the global markets, that play a role in creating the ripple effect and reaching the regions that are not directly affected by external market shocks. It is quite interesting that the focus on global factors and foreign investors' activity on the housing markets comes out most prominently through the intra-metropolitan studies while this contribution wasn't as prominent in the regional and multi-city studies. This lays a good foundation for analyzing Vancouver ripple effect as well, as foreign investment plays an important role in this city's housing market as well (Ley, 2017).

Apart from the graphs and diagrams in the academic papers, there are price heat maps published by university research units, consultancies and real estate companies that help visualize the ripple effect. Animated maps can be found in the original sources, and here screenshots are presented to exemplify

the phenomenon. A common theme is visualizing intra-metropolitan price diffusion is mapping one-million-dollar houses. For example, an interactive heat map has been published for the City of San Francisco and the entire Bay Area from 2010 to 2015 and Los Angeles from 2012 to 2016 (McLaughlin, 2015) based on sales above USD $1 million. The changes that took place in San Francisco can be seen on select screenshots of the map presented in Figure 2.4.

Figure 2.4. Million Dollar Homes in San Francisco, USA, 2010-2015

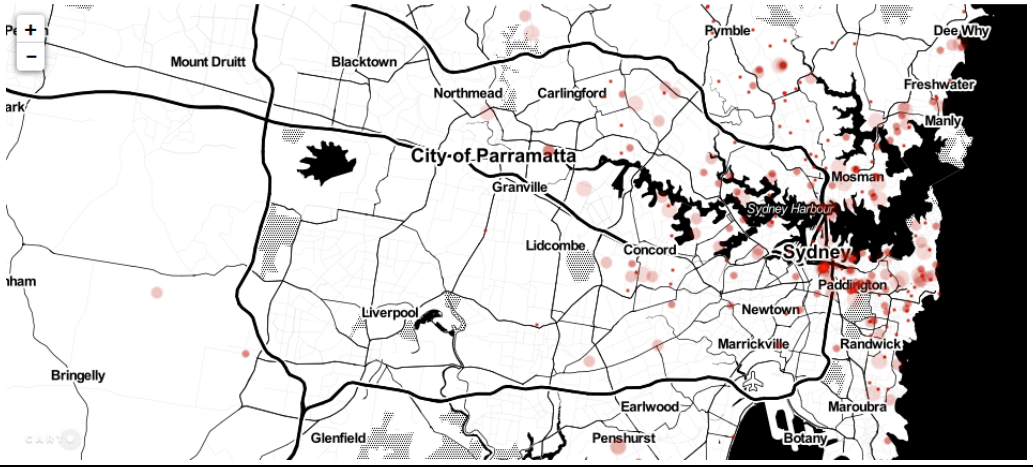


Source: Trulia's blog 2016. Reprinted with permission.

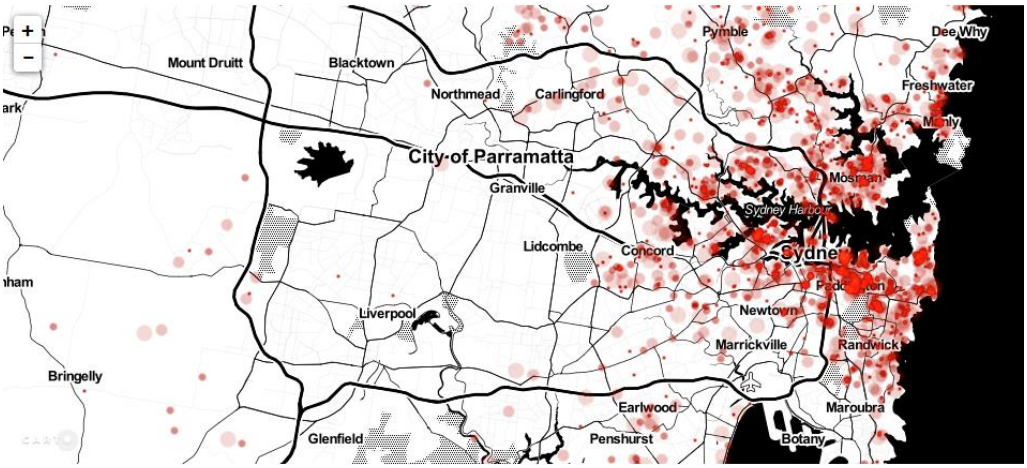
In another instance, for Sydney a map animation has been published by City Futures Research Centre at the University of New South Wales (UNSW) ("Sydney's Million Dollar Sales," 2015). A few screenshots from the original map are reproduced below (Figure 2.4).

Figure 2.5. Heat Maps of Over $1 Million Sales in Sydney, Australia, 2009-2015 (select years)

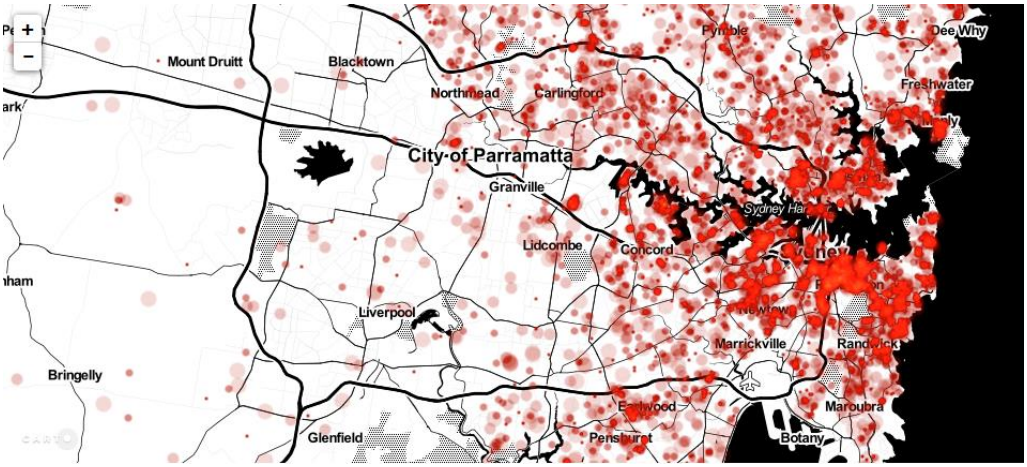
May 2009



May 2012



May 2015



Source: UNSW City Futures Research Center on the Open Street Map. Reprinted with permission.

In the case of Vancouver, urban planner Andy Yan has been publishing City of Vancouver maps displaying property assessment values by dwelling and tracking the one-million-dollar homes line since 2006, which he has recently updated with 2016 data ("Homes Under $1 Million in Vancouver Are Virtually Extinct," 2017). The most recent map has thus concluded the project as 99.7% of single-family homes in the city are now assessed above CAD 1 million with the million-dollar line moving beyond the city limits (see the maps in Chapter 3).

One of the most striking findings from all these maps is the fact that in the displayed period these four cities virtually went from the majority of areas selling (being assessed) under one million dollars in respective currencies to most neighborhoods being priced over a million dollars. All four cities covered in the visualizations (San Francisco, Los Angeles, Sydney and Vancouver) are prominent examples of lack of affordability as all four make the top-10 of the least affordable cities (Demographia Affordability Survey, 2017).

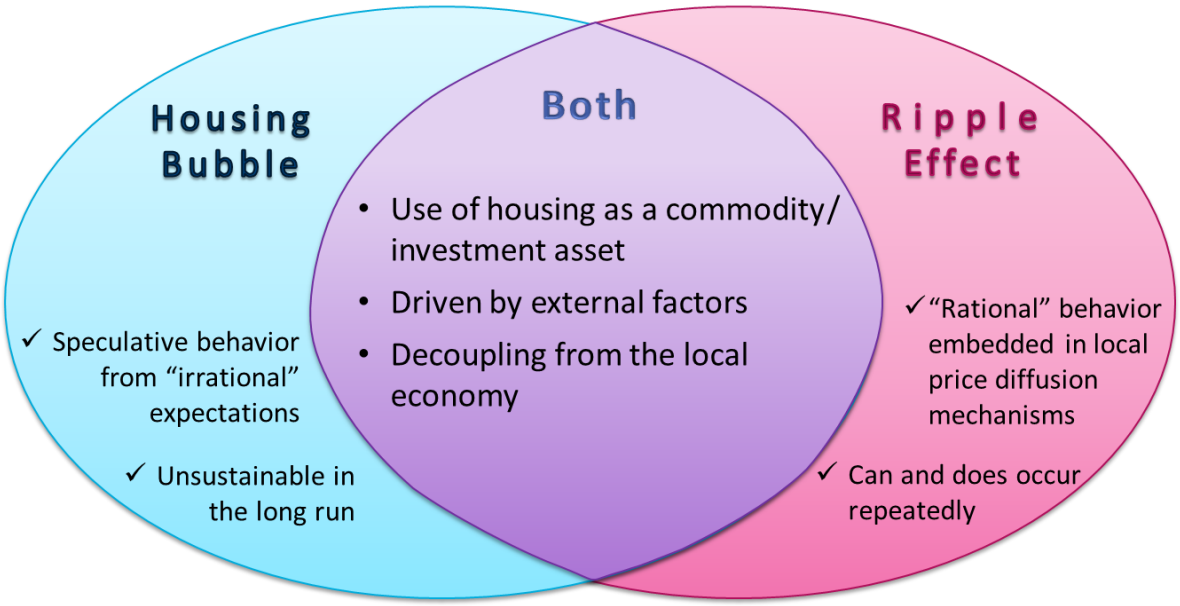
Lack of affordability is typically intertwined with decoupling from the local economy, as by definition "unaffordable" means that house price to local income ratio is astoundingly high, which entails house price developments responding to external factors beyond the local fundamentals. Especially for the cities among the top-3 least affordable in the world featured on the maps above, there are strong sentiments abound bubble activity on the housing market for Sydney (Hatzvi & Otto, 2008; Hendershott, 2000) and general decoupling from market fundamentals and unsustainable price growth in Vancouver (Gordon, 2016; Ley, 2017; Moos & Skaburskis, 2010). This again draws the connection between the key housing market drivers, the housing bubble approach and the ripple effect, and social outcomes of different housing price dynamics, in this case lack of affordability and out-migration from more central areas to the suburbs (specifically mentioned for Vancouver).

2.5 Bubble and Ripple Effects – Implications from the Theory

The present chapter provided an overview of the main housing market drivers and recent market developments tying them with the concepts of a 'housing bubble' and a 'ripple effect' that present useful frameworks to identify more general patterns of 'hot' housing markets, such as that of Vancouver. Both concepts are interconnected and relate to the outcomes of speculative housing market activity by external actors (see Table 2.1). Both concepts typically lead to more unaffordability as they mostly relate to the upward price dynamics, although the ripple effect can also be observed for a negative market shock that would lead to price decreases in the area, rather than increases. Nevertheless, ripple

effect studies are more often associated with the upward trend and shocks inflating prices. In the case of upward price movement, both phenomena also coincide with increasing consumer debt in light of decreasing affordability.

Figure 2.6. Housing Bubble & Ripple Effect Diagram



Source: author's original design.

While both phenomena rely on the impact of external factors, and both are often associated with a lack of housing affordability and significant spatial disparities, there are a number of differences in their characteristics, namely the motivations behind consumers' activity in the bubble market can be referred to as "irrational" (Shiller, 2015) and are considered unsustainable in the long run (bubbles burst). At the same time, the ripple effect phenomenon is rooted in local price diffusion mechanisms and 'rational' behavior of the actors in the market. Furthermore, ripple effects can occur repeatedly in response to a variety of external shocks and it can be a more permanent characteristic of a given market than bubble tendencies.

Nonetheless, both can occur at the same time in the same market, they can co-exist and even reinforce each other. Before bursting, housing bubbles drive the prices upwards and attract further short-term investment by non-local actors which could reinforce the ripple effect by the sheer size of speculative activity as it is more liquid and less attached to a particular area. The investors can more easily switch to a different region or area if the housing purchase is just considered an investment with no strings attached to workplace, commuter zones, etc. Hence, they would be sensitive to market signals through the ripple effect switching their investments to areas more promising in the current state of the market.

This review of the recent post-crisis literature on housing market developments and specifically real estate bubbles demonstrates that we have entered a new age of the housing market development in the West characterized by the interplay of housing commodification, high household indebtedness and the increasing influence of globalization forces. The existing economic system created conditions to drive real estate prices upward creating a bubble in the US that burst during the GFC with ripple effects for the economy in general and beyond affecting the lives of millions of people. Multiple research studies have been published since then analyzing the effects of the housing bubble and its dispersion at different geographic scales.

Housing bubbles are prominent world-wide and are analyzed at different scales. They can be observed in the developed and developing world, across countries, across cities (nationally and internationally), or for one specific city or place. The bubble-like market activity implies the prevalence of speculative behavior by home buyers driven by unsubstantiated future price growth expectations, which leads to housing being significantly overpriced and the housing prices being decoupled from fundamental market factors of the local economy.

As the concept of a housing bubble gains prominence in academic literature and the media, its forecasting limitations surface in Canadian research (on Vancouver in particular) with different explanations for the still-rising housing prices and ambiguity around sustaining such a trend. Even if not good in its predictive power, the concept of the housing bubble is still useful in analyzing past and current housing market development, as we will see in the following chapters.

As for the ripple effect, academic sources are quite consistent in acknowledging the existence of the effect at different levels and scales, which is supported by empirical evidence. In most papers, there is a rather homogenous understanding of the ripple effect which is the transmission of the external price shocks from the central area throughout the given region when the other area or municipalities are not necessarily directly affected by the shock. The price shocks could be exogenous or endogenous. An example of an exogenous shock would be a slowdown in price growth and/or reversal of the upward trend, for example, in Mainland China, Singapore, or Hong Kong due to the Asian crisis in 1997, that did not originate in those countries, but has affected the region as a whole causing stagnation and property price decline in a number of East and South-East Asian countries. On the other hand, a change in the government policy about foreign investment in specific activities (e.g. real estate) in a particular area would be an internal shock created within the system. Another example of a local (endogenous) shock would be a spike in the economic growth in the area under consideration, which consequently leads to increasing prices through increased purchasing power of the locals and potential migrant inflow

to a relatively more prosperous area. Overall, such shocks, whether endogenous or exogenous, positive or negative, are rippling into the peripheral regions after first having affected the central area.

To identify the central region, the researchers usually use local knowledge about the study area typically assigning the role of the leading region to the highest-priced areas that are usually the economic and/or political center. At the national level, the center would usually be the capital region as is the case in the studies on the UK, Ireland, Sweden, and Finland. It can also be a major city by economic power, such as in Australia it is Sydney, which is the economic center even though it is not the official political capital, just as in South Africa where the source of the national ripple effects was found to be Cape Town, the most expensive city and economic center with a higher proportion of foreigners. On the city level, the origin of the ripple effect is typically attributed to the most expensive neighborhoods in the central city with the higher proportion of foreign buyers who have higher liquidity and flexibility that results in higher volatility and faster reaction of the central areas to external and internal shocks.

Most studies attempt to model the ripple effect and derive theoretical implications more so than interpret the housing price dynamics specific to a given area that is used as a case study. This could probably explain the persistent lack of more elaborate interpretations of the model and the identified ripple effect and its dynamics. This study will attempt to improve on this aspect and provide more specific interpretations and potential policy recommendations regarding what can be learned from the Vancouver housing market.

So far, we could only find one study by Canada Mortgage and Housing Corporation evaluating housing price diffusion patterns and the ripple effect hypothesis in the Canadian markets (Batch, 2017) at the regional level – in the province of British Columbia with the center being the city of Vancouver. No other studies were found at either national or city level. This study will, therefore, expand the ripple effect literature in the Canadian context also contributing to furthering the intra-metropolitan scale studies as we focus to a larger extent on Metro Vancouver using a different and more comprehensive approach than in the CMHC study (Batch, 2017) confined to the metropolitan area.

Based on the existing research findings for other cities and countries and consistent with Batch (2017), we expect an outward ripple effect movement from the center to the peripheral regions of Vancouver with the center being the highest-priced and most exposed to foreign investment. There has been some discussion about the ripple effect in British Columbia and Metro Vancouver in the media, that generally implies a similar pattern of rising unaffordability in the City of Vancouver or specifically on the West Side (Vancouver West) driving people eastward to the suburbs or even out of Metro

Vancouver overall down to Fraser Valley regions or across to Vancouver Island. Those media studies are using descriptive statistics at best, so the present study still has a lot to add in mapping and graphic analysis along with an econometric model.

The next chapter will provide an overview of the Vancouver housing market, the main drivers of price growth, recent and historical price dynamics, spatial price diffusion patterns, and relevant policies, with the following chapter presenting the original analysis of the ripple effect in the Vancouver housing market.

Chapter 3. Vancouver Housing Market Dynamics

This chapter will introduce the dynamics of change in the Vancouver housing market in more detail. We will examine the market in the overall Canadian context, and then discuss past and present trends, the local and global drivers of the housing market, as well as new housing policies and possible outcomes.

3.1 The Canadian Context

3.1.1 International Comparisons

Before discussing the particularity of the Vancouver case study, the housing market dynamics in Canada overall will be presented in comparison to other countries. In international comparative studies of (mostly) developed countries (Adams & Füss, 2010; Dokko et al., 2011; Milne, 2012), Canada evidently stands out as an example of remarkable housing price growth during and after the global financial crisis (GFC) with minimal fluctuations even in the crisis years (see Figure 2.1 in the previous chapter)

Canada and Australia enjoyed similar price dynamics as they both sustained an upward trend in house prices, especially striking when set against the remarkable plunge in prices in the US. Milne (2012) points out the higher prudency of the Canadian (as well as Australian) banking system in mortgage lending practices particularly when compared to the US, which arguably accounts for a more stable market in Canada nationally, yet it leaves Vancouver and Toronto in "major condominium and housing bubbles that have drawn comments from the Bank of Canada and some senior Canadian private bank executives" (Milne, 2012, p. 9). This trend is quite different to the plummeting of house prices in the UK and the US after the GFC (Figure 2.1) with the UK just recovering to the pre-crisis levels in 2016 while US prices hover around 2003-2004 levels, significantly below the pre-crisis peak. At the same time, Germany and Japan display a completely different housing market development overall, with real house prices lingering without significant changes in Germany.

While the continuous real house price growth and seeming resistance to external shocks are indeed outstanding in Canada, there is no consensus in the academic literature as to whether Canada represents a successful model of housing regulation that is robust to crises and enables continuous house price growth or whether Canada and especially its major metropolitan areas, such as Toronto

and Vancouver, are on the verge of a housing bubble bursting which might generate "ripple effects" across the national economy and beyond (Carter, 2012; The Globe and Mail, 2017).

On the one hand, such a strong upward trend leads some researchers to believe that the Canadian housing system is much more robust and not prone to a bubble like other countries. They consider the Canadian housing market to be stable and real estate not to be significantly overvalued (Carter, 2012; Elliott, 2009; Head & Lloyd-Ellis, 2014; Londerville, 2010; Lynch, 2010; Tsounta, 2009). An economist at the *Dominion Lending Centres* believes that "the growth in housing values in British Columbia and Ontario is based on fundamentals" and that "the likelihood of a price collapse any time in the foreseeable future is remote" dubbing Toronto and Vancouver housing as "one of the pillars of the Canadian economy" (Sherry Cooper, 2016) sending a message against imposing restrictions on the housing market. Among academic sources, Carter (2012), for example, concludes that "there has been no collapse nor does it appear a collapse is imminent", and that "the evidence in the Canadian situation" supports the basic assertion that there is "No bubble! No meltdown!" on the housing market in Canada (Carter, 2012, p. 532). At the same time, Carter (2012) along with Macdonald (2010) and Milne (2012) do acknowledge that there is "center specific housing stress" referring to Toronto and Vancouver housing markets, which are arguably the most problematic areas in their lack of affordability and high consumer indebtedness.

On the other hand, there is an array of studies taking the opposite position of pronounced skepticism about the current price dynamics (Carlson, 2017; Ley, 2017; MacBeth, 2015; Moos & Skaburskis, 2010; Walks, 2013, 2014; Walks & Clifford, 2015) deeming them unsustainable in the long-run and raising a major concern for the government and the general public. Walks (2014) disputes the robustness of the Canadian housing market as "already by early 2008 lending standards in Canada had declined substantially and a particularly Canadian form of 'subprime' mortgages had grown strongly within the residential mortgage market" (Walks, 2014, p. 257). He compares the housing market in Canada to a Ponzi scheme, with "Canadian real estate values being out of line with fundamentals, in other words, in a 'bubble'". As such, Walks challenges the common notion of Canadian exceptionalism that "both Canada's real estate markets and financial institutions were sound, prudent and solvent, due to Canada's unique regulatory apparatus, and in turn the myth that they did not require nor accept any 'bailout' in response to the GFC" (ibid, p. 277). MacBeth (2015) is also skeptical of Canada's housing boom, an investment consultant, he considers the current investors' interest in real estate as an asset to be erroneous. In 2016, CMHC has also (finally) 'red flagged' Canada's housing market due to "strong overall evidence of problematic market conditions" (Marr, 2017).

In the realm of financial markets, the housing market dynamics have affected Canada's own banks as Moody's in their most recent credit rating in 2017 has downgraded Canada's Big Six banks, with ongoing concerns about the "continued growth in Canadian consumer debt and elevated housing prices" leaving the banks more vulnerable to a potential downturn in the Canadian economy (CBC News, 2017a).

The skepticism regarding longer-term house price fortunes is especially prominent among researchers and journalists when analyzing the price dynamics in two major cities – Vancouver (e.g. Gordon, 2016; Todd, 2017) and Toronto (Business Insider, 2017; Young, 2017), especially since bubbles bursting in either or both of them is expected to have serious negative consequences for the Canadian economy overall (Armstrong, 2017; The Globe and Mail, 2017; Young, 2017).

Walks (2014) draws attention to a number of flawed financial practices in Canada, most prominently, the enormous indebtedness of Canadian households in general and those living in major cities in particular (Walks, 2014) with Vancouver displaying the highest debt-to-disposable income ratio of 266.2% (Walks, 2013, p. 166). Over-indebtedness appears to be the most likely potential cause of the housing market crash in Canada as it has reached levels even above those in the US and it keeps growing partially due to the massive lack of affordable housing in a few of the major cities (Walks, 2013). The governor of the Bank of Canada Stephen Poloz has also acknowledged this problem during a news conference in Ottawa in 2016 commenting that there is a "threat from housing" with "high debts still growing" in Canada as the debt burden outpaces disposable income growth in most of the monthly data points in the last 5 years since 2013 (Parkinson, 2017). Whereas consumer credit growth (excluding mortgages and home equity lines of credit) has been more in line with the changes in disposable income, the size of total residential mortgage credit and home equity line of credit has been growing by around 1% faster on average than disposable income (Bank of Canada, Financial System Review 2017 reported in Parkinson, 2017).

3.1.2 Inter-Metropolitan Dynamics across Canadian Cities

Another important background aspect for a city-level analysis of Vancouver is understanding how it fares against other cities in the country. Vancouver, being the third biggest Canadian city by population after Toronto and Montreal (Statistics Canada 2016[4]), is often put into comparison among top-10 or top-15 census metropolitan areas (CMAs) nationally (for example, see City of Vancouver,

[4] Source: Statistics Canada, CANSIM, table 051-0056, Population of census metropolitan areas.

2014, for top-15; Yan, 2016, for top-10). The City of Vancouver Report on Social Indicators and Trends provides information on income and labor profiles relevant to housing trends across large CMAs (City of Vancouver, 2014). However, it fails to engage with the topic of housing per se only mentioning it in a recommendation for the city government (itself) to "facilitate[e] affordable housing to reduce costs for individuals and families"(City of Vancouver, 2014, p. 19). This report, however, highlights some important comparative points, such as the fact that Vancouver among top-10 CMAs has the highest economic growth rate and average unemployment for top-10 CMAs, which is also lower than provincial and national averages, while Vancouver residents receive the lowest median personal income from the sample cities and register the second highest share of people with low income (after Toronto). Additionally, Yan's report with *BTA Works* highlights that the median income is also lowest for university degree holders in Vancouver compared to other CMAs in the top-10 (Yan, 2016).

Table 3.1 presents comparative statistics across Canadian CMAs specifically on housing. As well as data on income, housing prices complete the rather bleak picture of Vancouver as the city with lowest median income among residents, but the highest housing price. This is consistent with the previously mentioned housing affordability index that rates Vancouver as the third least affordable city in the English-speaking countries after Sydney and Hong Kong, which makes it the least affordable in North America (Demographia Affordability Survey, 2017). The table contains the February 2016 statistics, corresponding to the period of consistent price growth a few months before the foreign buyers' tax was introduced in July 2016. House prices in Vancouver are easily the highest among selected regions.

The housing market in Vancouver has displayed the highest increase compared to others in the last year, last 3 years and second highest in the last 5 years after Greater Toronto (Table 3.1). Interestingly, the dynamics have changed as in the last half year as Vancouver's price growth has been outpaced by the Fraser Valley and Lower Mainland. Potentially, this corresponds to consumer behavior in an extremely expensive housing market that drives more and more people out of the city and older suburbs into a more widespread commuter shed, driving up the demand there (Batch, 2017; Bula, 2016; Mitham, 2017; Seale, 2016).

Table 3.1. Housing Price Index (HPI) and Average Home Prices in Select Regions in Canada[5]

Composite HPI	Feb. 2016	% Change					
		1 month ago	3 months ago	6 months ago	12 months ago	3 years ago	5 years ago
1. Greater Vancouver	$795,500	2.61	5.58	12.06	22.18	34.50	38.16
2. Lower Mainland	$700,700	2.81	5.95	12.08	21.38	31.30	35.53
3. Greater Toronto	$589,000	1.85	2.82	4.27	11.30	28.84	42.23
4. Fraser Valley	$522,400	3.43	6.97	12.40	19.39	23.60	29.17
5. Victoria	$468,900	2.33	3.43	4.62	9.84	11.43	4.62
6. Calgary	$440,900	-0.69	-2.13	-3.12	-3.45	12.37	17.82
7. Ottawa	$328,800	0.14	-0.34	-1.41	0.82	0.75	6.20
8. Vancouver Island	$319,100	0.13	0.51	0.71	5.72	9.25	4.39
9. Greater Montreal	$304,100	0.70	0.44	0.32	1.67	4.08	8.57
10. Saskatoon	$301,600	-0.48	-1.18	-3.33	-2.96	0.76	7.72
11. Regina	$281,700	0.04	1.66	-0.79	0.11	-7.33	7.22
12. Greater Moncton	$158,500	-0.89	0.38	3.49	6.97	6.97	8.18
Aggregate	**$519,900**	**1.41**	**2.30**	**3.78**	**8.49**	**19.62**	**27.20**

Source: Original layout based on Canadian Real Estate Association's (CREA) data ("National Average Price Map – CREA," 2016).

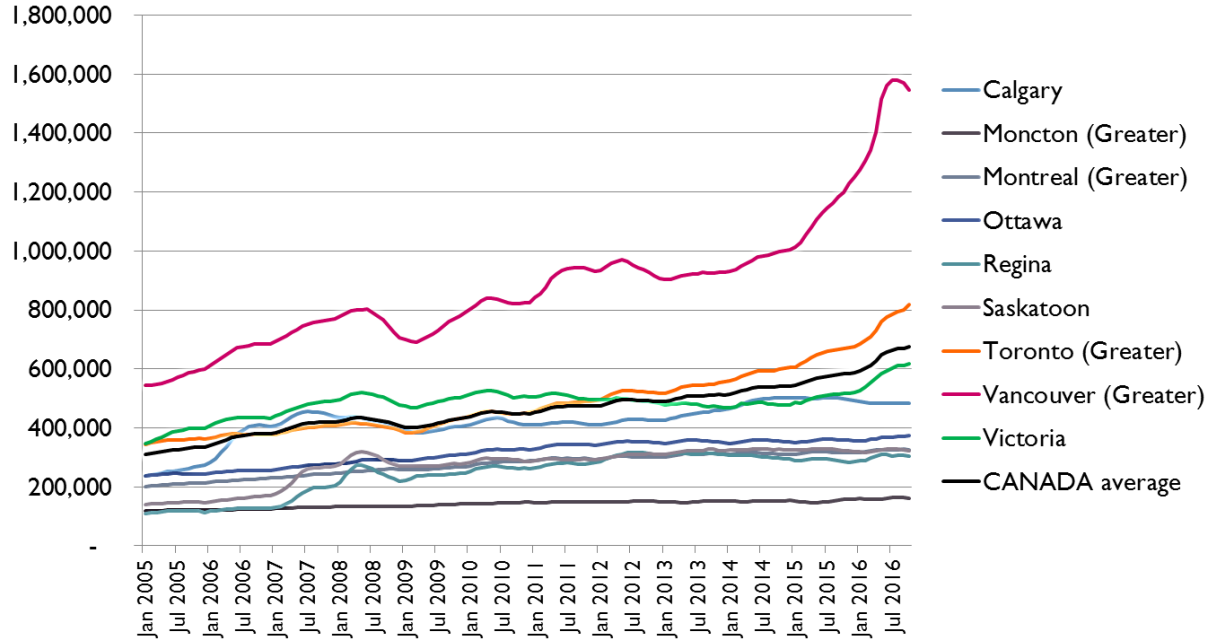
Regional difference and deepening regional divergence becomes even more pronounced when looking at the price graph across Canadian CMAs in the last decade (Figure 3.1). Benchmark house prices, representing a price of a typical dwelling in a given area, demonstrate that Vancouver is around twice more expensive than the second highest-priced CMA which is Toronto. Furthermore, the gap between them appears to have increased as it used to be around a 50% difference in early 2005. There is only limited volatility in Greater Vancouver prices in recent times with the only significant, yet temporary, decline observed in 2008-2009 during the Global Financial Crisis.

In an earlier period during the 1970s-1990s, Vancouver did not yet exhibit such striking price growth (Figure 3.2) as until the early 1990s its trends were in line with the other CMAs. Between 1971 and 1991, Toronto ranked highest most frequently, though both Vancouver and Calgary had spells as most expensive city. But since 1991 Vancouver has consistently displayed a faster growth rate

[5] Sorted by price. Regional sample determined by the original dataset.

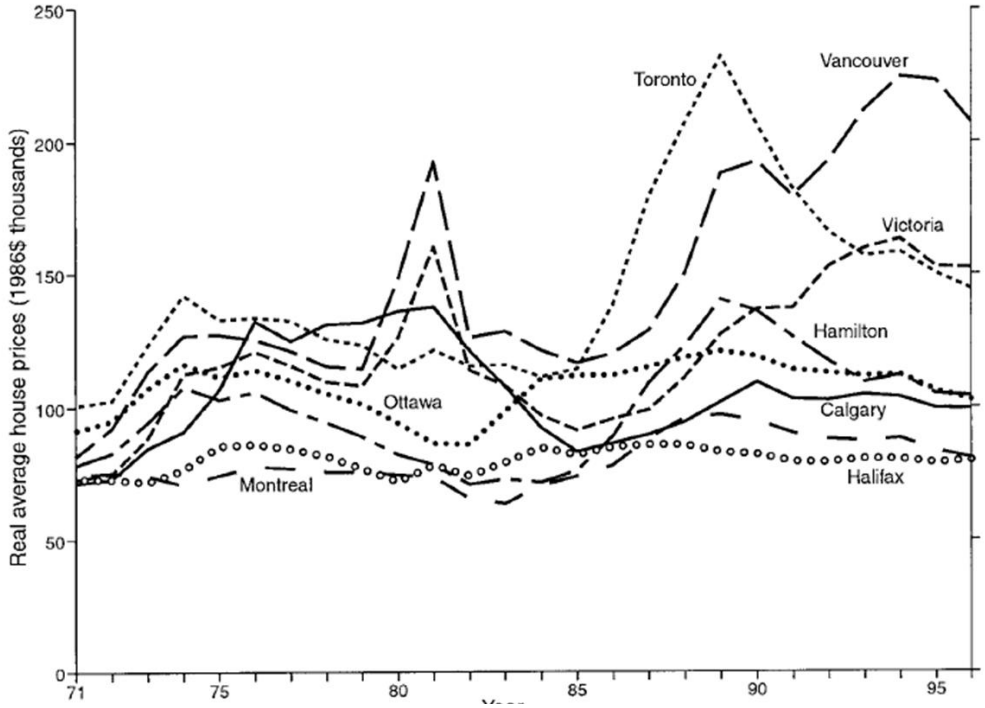
compared to other areas, with the result that the Vancouver housing market is the least affordable in all of North America and the most expensive in Canada.

Figure 3.1. Nominal Single-Family Home Benchmark Prices across Select CMAs, 2005-2016



Source: original layout based on Statistics Canada, CANSIM table 111-0009.

Figure 3.2. Real Average House Price Index across Select Canadian CMAs, 1971-1995



Source: Ley & Tutchener (2001). Reprinted by permission.

3.2 'Hot' Housing in Vancouver

Switching to a city-level analysis, one can observe similar contradictions in opinions about the existence of a housing bubble in Vancouver. While some researchers have been pointing out for over a decade now that the housing market in Vancouver approximates a bubble (Ley, 2017; Ley & Tutchener, 2001; Moos & Skaburskis, 2010; UBS, 2015, 2016; Walks, 2014), the government did not share this opinion. A 2015 report from the Canada Mortgage and Housing Corporation still referred to Vancouver's housing market as stable with 'weak evidence of problematic conditions' (CMHC, 2015, p. 3). In 2016, CMHC did change its official position on the Vancouver housing market raising the assessment of problematic conditions from 'moderate' to 'strong' signifying 'strong signs of problems' (CBC News, 2016a). Still, some economic analysts consider the Vancouver and Toronto markets to be driven by 'fundamentals' such as lower unemployment and population growth mostly from migration (Sherry Cooper, 2016).

For local and provincial politicians, taking a stand on one side of the debate or the other is often even more complicated as their interests and policies are intertwined with the real estate and construction sectors driving the local economy, yet they are still required to address the aggravated lack of housing affordability that has become very obvious for most. Housing policies were also an important issue for the most recent 2017 provincial elections (Tomlinson, 2016) as the former majority party, the BC Liberals, had pledged and introduced some of the new policies on the Vancouver housing market, such as the foreign buyers' tax in July 2016 and permitted the City of Vancouver to initiate an empty homes tax in January 2017, in order to increase public support.

However, housing policy initiatives were still limited – too little and too late – given that major Liberal Party donors were from the real estate and construction sectors who are not interested in reversing the house price trend as it would be detrimental for their business. Therefore, "the impasse […] has occurred in public policy with governments and their allies in the property sector in denial that the deregulated space of flows accompanying the globalisation […] could be a primary cause in the creation of a property asset bubble" (Ley, 2017, p. 3). In response to their weak performance on housing affordability (along with dissatisfaction with other policies), enough voters in Vancouver CMA withdrew their support that the Liberals narrowly lost the May 2017 election.

In a nutshell, the Vancouver housing market is usually described as 'hot' alluding to the consistent and fast price growth and high liquidity on the market. During 2016, the benchmark price for detached SFH rose to $1,483,500 in Dec. 2016 constituting a 19% increase from Dec. 2015 (REBGV stats). The total sales in 2016 were above the 10 year average (CMHC, 2016) and the first

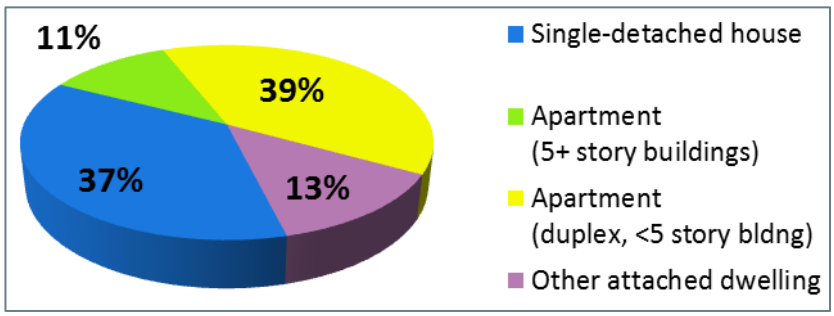
signs of recovery from the foreign buyers' tax are already present with the detached SFH benchmark sales price in the first half of 2017 displaying a trend reversal and climbing almost to the pre-tax peak (see Figure 3.4).

Homeownership is expensive in Vancouver, and so is renting. The rental market is tight and close to fully occupied with a vacancy rate of less than 1% in 2016 (CMHC Rental Market Survey). Average rent for a two-bedroom apartment was estimated at CAD $1,450 in Oct. 2016 constituting a 6% increase from Oct. 2015. The two-bedroom rent of just under $1,500 in Vancouver is 9% higher than in Toronto, 21% higher than in Ottawa and a striking 83% higher than in Montreal.

Both house prices and rents are on an upward trend long term and not showing significant signs of trend reversal or slow down at this point in time. The new policies in 2016-2017 (especially the 15% foreign buyers' tax) have had an impact on the market to an extent leading to slight price declines for a few months following the announcement and the tax coming into effect. Nevertheless, in summer 2017 there are already signs of recovery as the housing market has bounced back to its pre-tax state.

In Metro Vancouver, housing density is comparable to other major Canadian metropolitan areas with 37% living in SFH (Figure 3.3) comparable to 47% in Toronto CMA and 40% in Montreal CMA (Statistics Canada – Census 2016). At the same time, 11% of the Greater Vancouver population lives in high-rise apartments (over 5 stories) while this number is double in Toronto with 22%, yet just 6% in Montreal.

Figure 3.3. Metro Vancouver Population by Dwelling Type, 2016

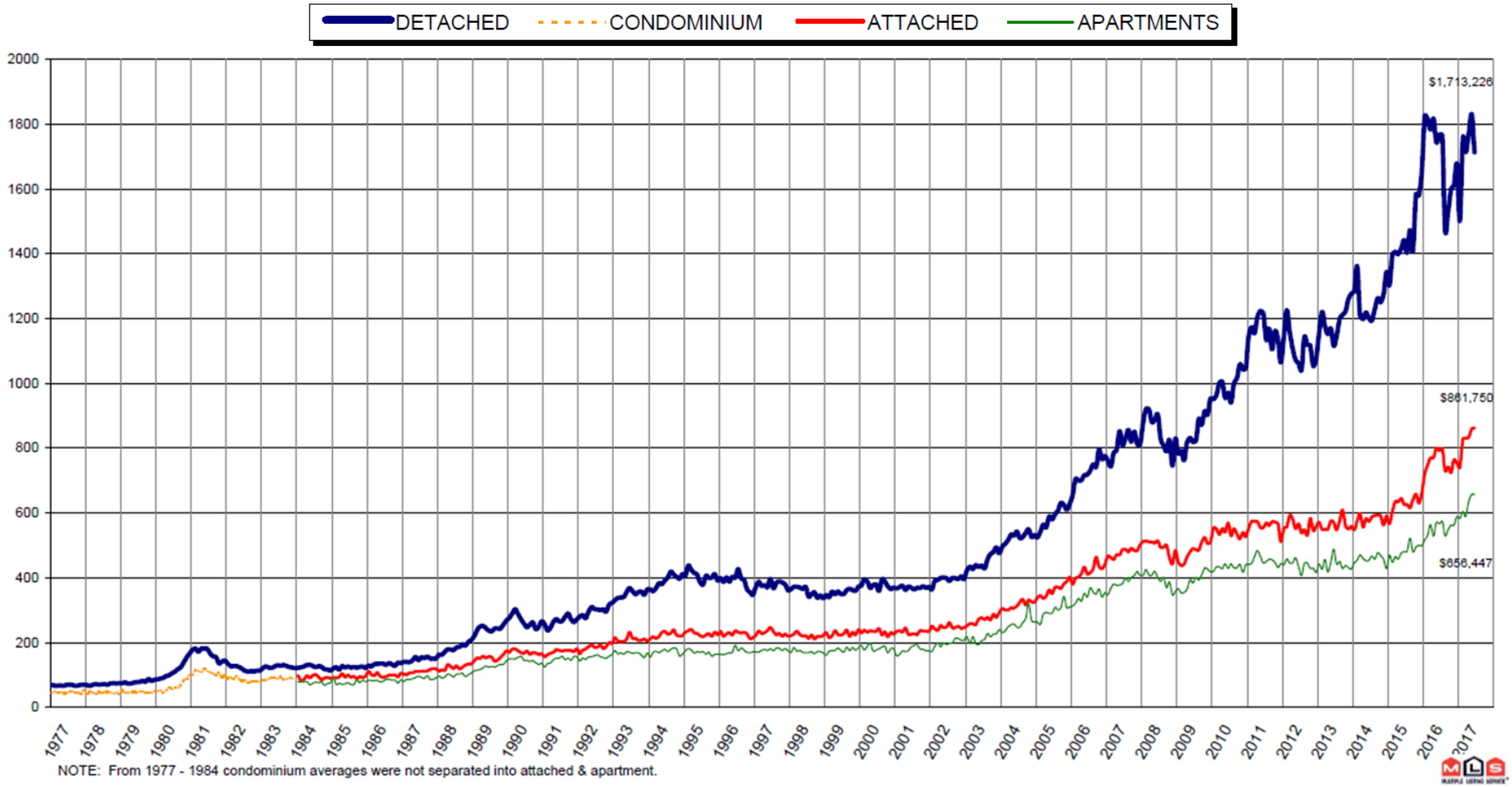


Source: Statistics Canada – Census 2016. Catalogue Number 98-400-X2016016.

In Vancouver with the continuously rising housing prices with the highest relative inflation observed in the single-family home segment (see Figure 3.4) that houses 37% of the population, housing is a very acute issue. In addition, a growing number of the region's single-family homes (SFH) have moved into the average price band of over CAD $1 million, rising from 19% in 2006 to 91% of the city's detached homes in 2016 (see Figure 3.5).

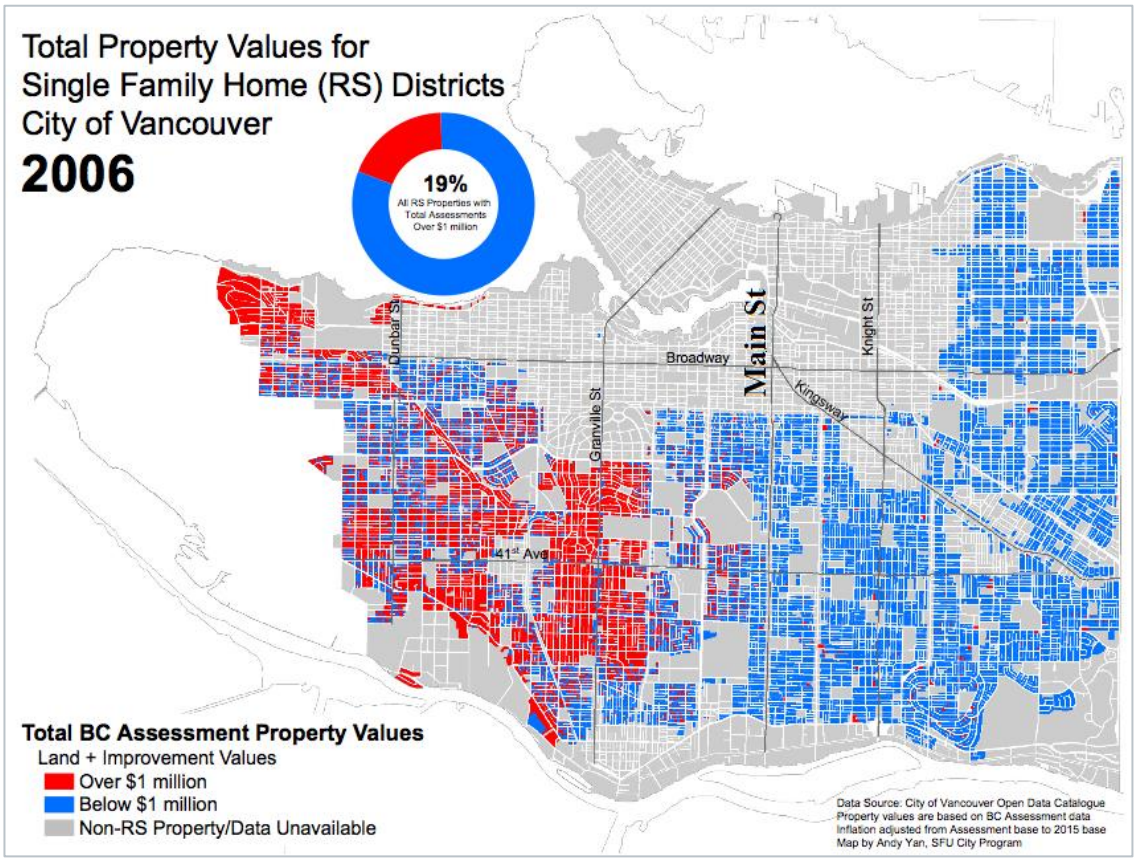
Figure 3.4. Residential Average Monthly Sale Prices, Jan. 1977 to June 2017

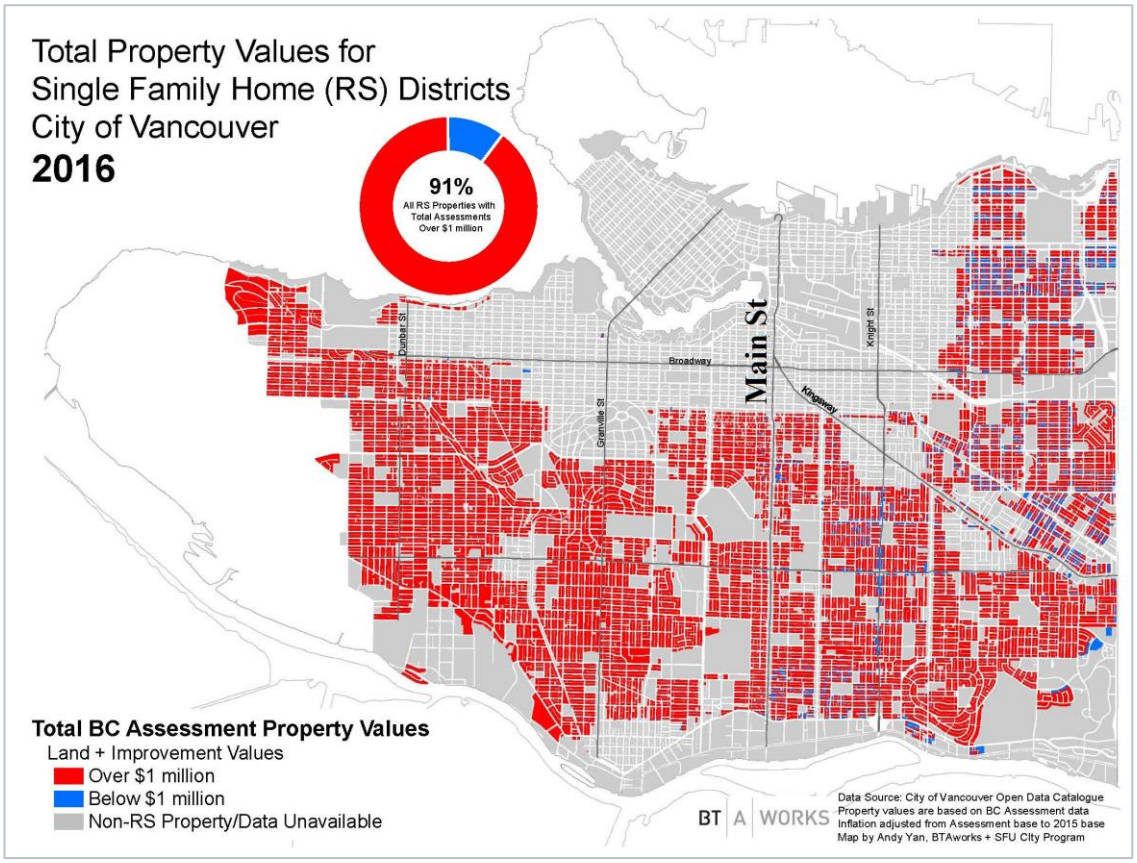
MLS HPI benchmark prices per unit in Greater Vancouver Area



Source: Canadian Real Estate Association ("National Average Price Map – CREA," 2016). Reprinted with permission.

Figure 3.5. Assessed Property Values for Single-Family Homes, 2006 & 2016





Source: BTA Works, Maps by Andy Yan (Yan, 2016). Reprinted with permission.

Both the price graph and the maps (Figure 3.4 and Figure 3.5) represent a striking price surge for single family homes. The graph in Figure 3.4 demonstrates that prices for SFH increased significantly faster that in the other two market segments, townhouses and condominium apartments. Aside from the difference in growth rate, the general trend for all three segments is similar with notable growth in the late 1980s – early 1990s and slowdown in the late 1990s – early 2000s until the prices in all segments took off around 2003-2004. The initial boom of the late 1980s is connected to the post-1986 Expo immigration and investment inflows as Expo marked the first large-scale investments from East Asia, namely from Hong Kong. The investment inflow followed the purchase of the entire Expo waterfront site by Li Ka-shing, the leading entrepreneur from Hong Kong. Immigration was also driven by increasing uncertainty prior to the handover of Hong Kong in 1997 from the UK to Mainland China (Ley, 2010).

In the late 1990s, a slowdown is mostly associated with the Asian crisis of 1997 and its aftermath that affected the Vancouver market indirectly through investors' behavior. As the Asian crisis was also felt globally, many of the foreign investors already present in the Vancouver market started repatriating their capital to buttress key investments in the Asian markets, thereby safeguarding the losses they might have incurred during the Asian crisis. Furthermore, there had been a significant return migration to Hong Kong related to the optimism of future Hong Kong's post-colonial status (Ley, 2010, p. 159). During that period, Canada overall experienced a slowdown in housing prices (see Figure 2.1).

Since the early 2000s, house prices have exhibited unprecedented growth with the slope during this period significantly higher than the previous growth periods before the 2000s. Since 2002-2003 until 2016-2017, detached house prices have more than quadrupled, while townhouses have almost quadrupled in the same period and apartments have tripled in price. For comparison, the previous growth period of about the same length from mid-1980s to mid-1990s led to an increase of about 2.5 times in the single-family homes while the other two segments have approximately doubled.

The maps in Figure 3.5 paint a rather depressing picture as we observe the absolute majority of houses that were under CAD $1 million in 2006 have already turned red (assessed above $1 million) in 2016. That number has further increased and reached 99.7% of all detached properties in the City of Vancouver being valued at more than CAD $1 million in 2017 BC assessment data (based on Andy Yan's map in Jang, 2017) (see Appendix B). The one-million-dollar line has now moved beyond the city's limits into many suburbs making most of the city's home owners millionaires in terms of their assets value, while driving out more and more people further away from the center as they are not even able to afford a down payment on those over-one-million-dollar properties. Debt burdens have sky-rocketed, especially in the new suburbs (Walks, 2013). It is worth noting that maps also highlight the

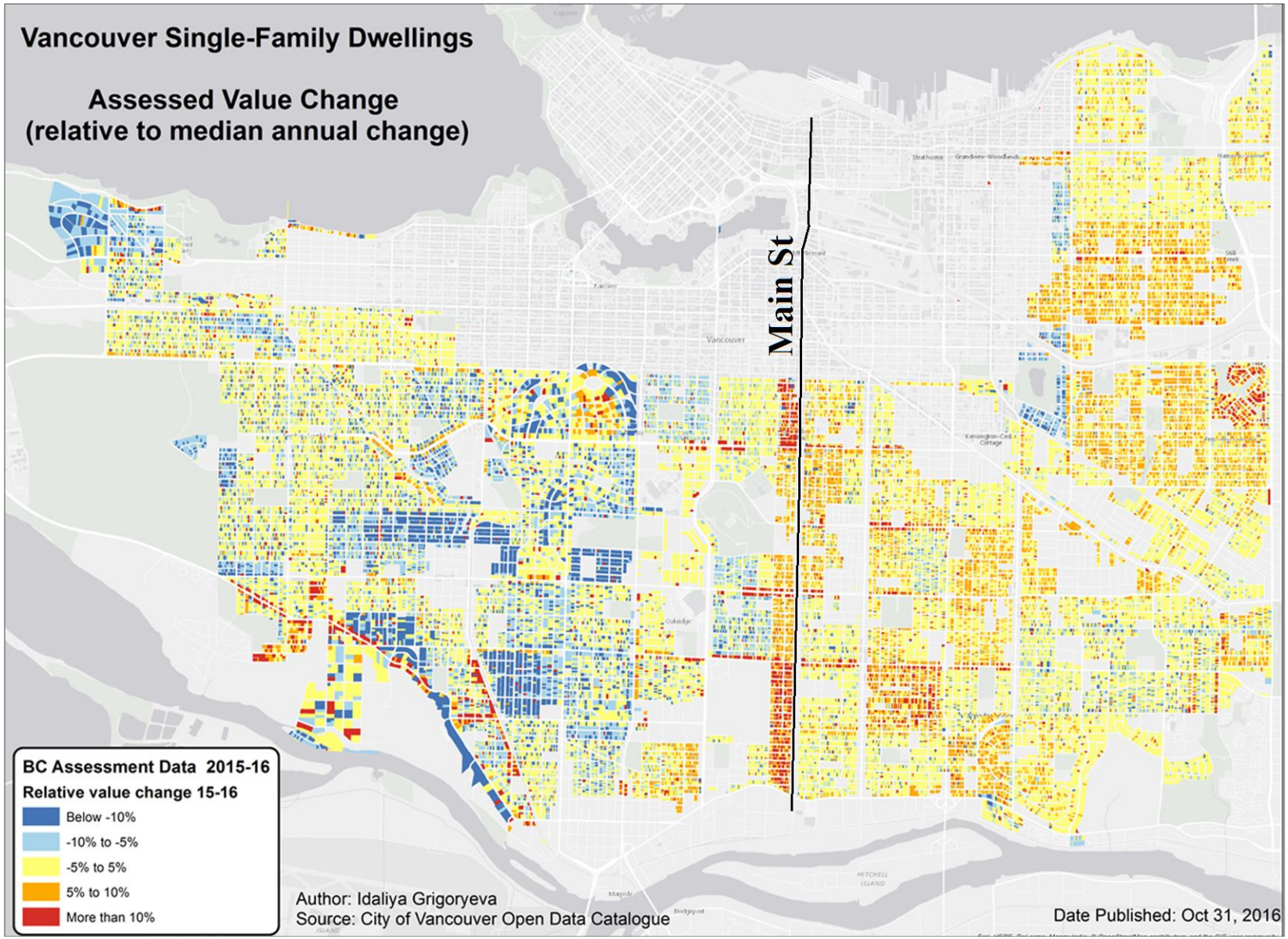
spatial pattern of price diffusion as the former Main Street, $1 million 'border', with most of the houses assessed above CAD $1 million located to the west in 2006, scarcely exists in 2016.

At the city scale we can also attempt to have a closer look at the diffusion of property assessment values throughout the city on a more detailed level compared to the maps in Figure 3.5. Using BC assessments statistics publicly available from the City of Vancouver, the changes in annual assessment are mapped on Figure 3.6 to get a better idea about the different scale of changes across the city's neighborhoods. Assessment data take into account local sales of similar houses and are reviewed annually. As they are reviewed based on past sales data, the change in assessment in 2015-2016 actually corresponds to the change in 'real' values in 2014-2015. Using assessment data instead of sales data directly enable us to have a fuller picture as the sales numbers would be insufficient to analyze block-level changes. Furthermore, the access to the dwelling-level sales data is restricted, and assessment data is sufficient for this map.

The map in Figure 3.6 shows the change in assessment measured relative to the city's median in that year (median assessment change was 23% in the given period). Relative change represents absolute change in assessment after subtracting the city's median value. Therefore, for the red areas on the map for example, the "above 10%" category does not mean that their assessment had increased by 10% or more in that year, it means the assessment has been raised by at least 33% (23% + 10%). This map enables a comparison of the neighborhoods rather than the region overall to track the character of changes in the different areas of the city.

The map (Figure 3.6) demonstrates an important spatial pattern in assessment changes throughout the city. First, even though the assessments on average were increasing by 23% throughout the city (BC Assessment 2016), the increases are unevenly spread throughout the area. Large parts of the more expensive neighborhoods on the West Side, such as West Point Grey, Shaughnessy, Kerrisdale, display changes in assessment significantly below the city-wide median value (dark blue areas include a high share of dwellings with the assessment change more than 10 percent points below the city median change of 23%). At the same time, areas growing in assessed value fastest are mostly located in East Vancouver and along Main Street, the street historically dividing the city of Vancouver into West Side and East Side. Allowing for local noise, what this map shows is the transmission of earlier price gains on Vancouver's West Side to the East Side.

Figure 3.6. Map of Relative Changes in Assessed Values of SFH, City of Vancouver, 2015-2016



Source: Author's original map based on BC assessment data.

3.3 Vancouver Housing Market Drivers

A large number of aforementioned studies point out the lack of affordability and presence of a housing bubble in Vancouver (Carter, 2012; City of Vancouver, 2014; Demographia Affordability Report, 2016; Gordon, 2016; Ley, 2017; Ley & Tutchener, 2001; Ley, Tutchener, & Cunningham, 2002; Milne, 2012; Murdie, Maaranen, & Logan, 2014; UBS, 2015; Walks, 2013, 2014; Yan, 2016). The data presented above clearly show the rapidly growing residential real estate housing prices, but the figures presented so far do not provide much insight into the factors behind price growth, knowledge necessary to evaluate the sustainability of the current trend along with the possibility of a bubble. These two points are addressed next by presenting data on the local fundamentals and looking at correlations between them and house prices.

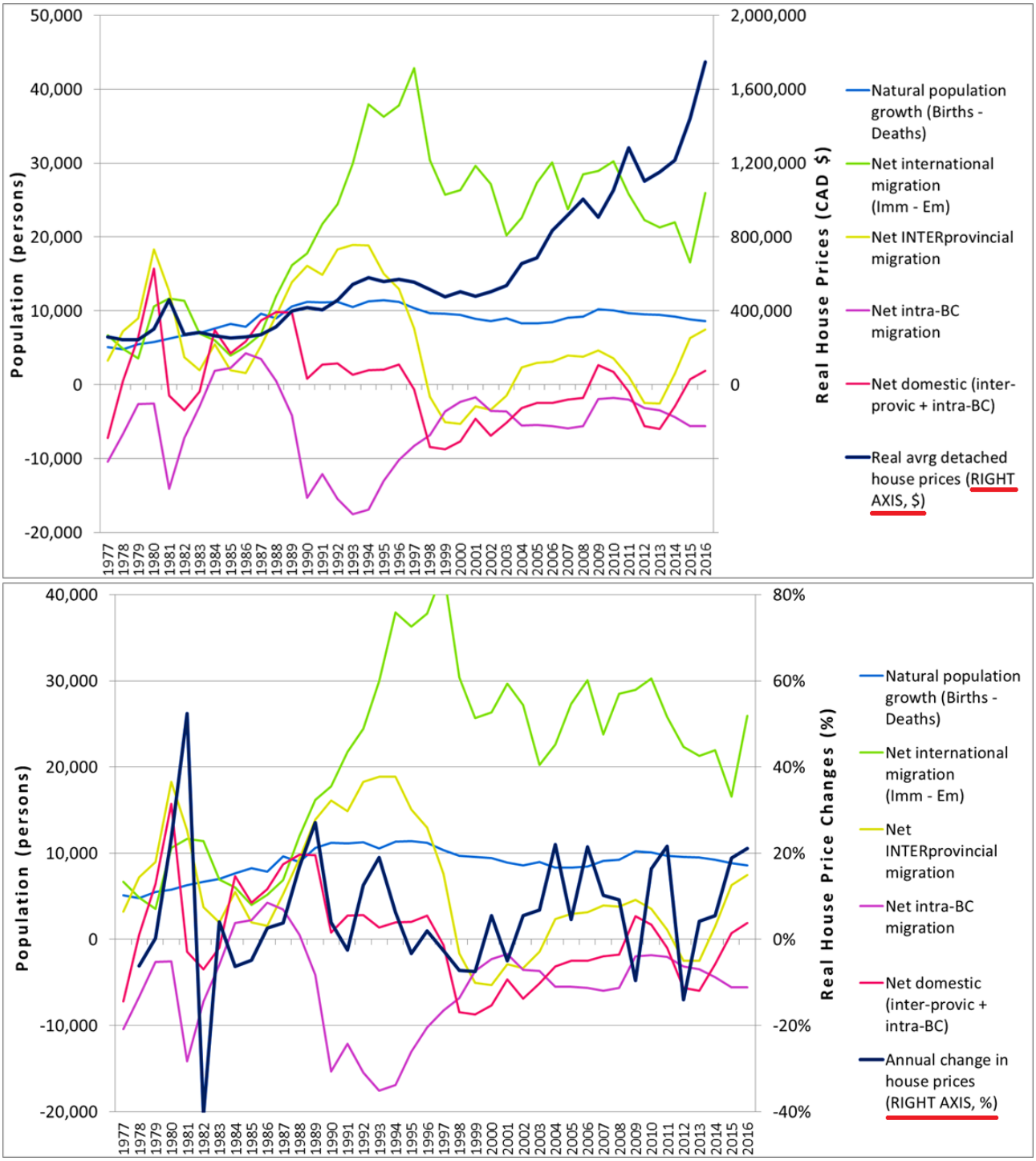
Building on the theoretical approach to identifying and analyzing housing bubbles as periods when actual value (selling price) is diverging from the fundamental drivers of the residential property market, the following fundamentals are analyzed:

1. **Demand factors**: population (natural growth, domestic and international migration), city incomes and unemployment, provincial economic growth, and interest rates.
2. **Supply factors**: housing starts and completions, new unabsorbed completions, building permits and rental vacancy rate

Graphs for select fundamentals are presented in the figures below with the trends in fundamentals are compared to absolute price trend as well as annual price changes in Metro Vancouver (Figure 3.7 – Figure 3.9). Specific sources for individual indicators can be found in the Appendix (Appendix A). The values of house prices and price changes are displayed separately on the right axis in each figure while other indicators correspond to values on the left axis of each graph respectively.

The first two graphs below (Figure 3.7) specifically highlight population trends compared to the dynamics of house prices. The overall price trend displays no evident correlation with any of the population fundamentals that would be consistent in the given period. Natural population growth along with net international migration appear to have been correlated with the price trend until the mid- to late 1990s, but not since then as in the last 10-15 years the astounding price growth has been happening against declining immigration and natural population growth rates. For domestic immigration, there is no clear correlation with the indicators; if anything, there is an inversed relationship between house prices and joint net domestic migration, measured as the net effect of inter- and intra-provincial migration.

Figure 3.7. Housing Price and Population Trends, Vancouver CMA, 1977-2015



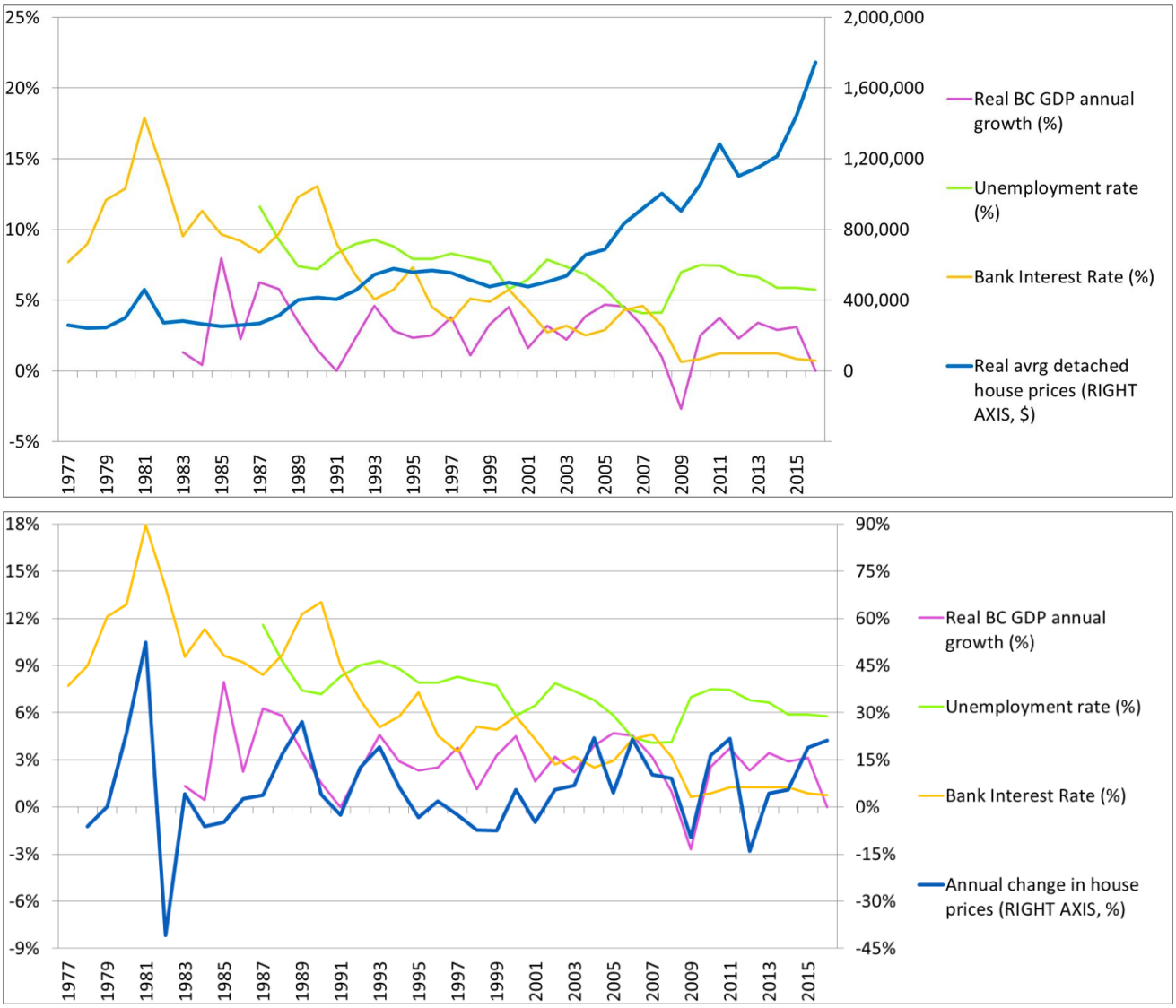
Source: original layout based on data from Statistics Canada, REBGV and other sources.

These results would be inconsistent with the generic expectations for a housing market driven mostly by local fundamentals, yet are in line with the later discussion of the impact external factors have had on Metro Vancouver housing prices. Interestingly, when looking at the price changes on Figure 3.7, they do not display an apparent relationship with either natural population growth or international migration, while the relationship to domestic migration indicators has been reversed and

the price changes appear to be somewhat positively correlated with overall net domestic migration and specifically inter-provincial migration. The estimated bivariate correlations between price dynamics and all the fundamentals for which data were found will be reviewed shortly in Table 3.2.

The graphs in Figure 3.8 introduce further market fundamentals related to general macroeconomic dynamics in the city and region overall. While unemployment is reported for Vancouver CMA, GDP data is only available at the provincial scale and interest rates refer to the national level.

Figure 3.8. Housing Prices and Other Demand Fundamentals, Vancouver CMA, 1977-2015



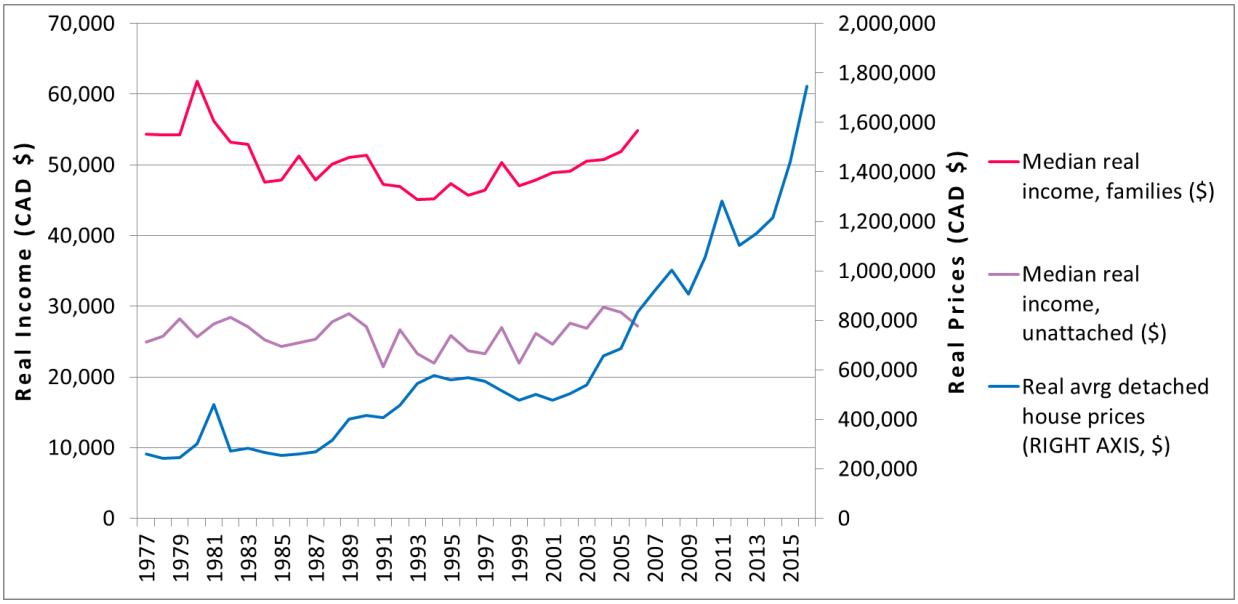
Source: original layout based on data from Statistics Canada, REBGV and other sources.

The overall price trend in Figure 3.8 displays no strong correlation with real BC GDP growth rate (unexpectedly), and a negative relationship with unemployment and interest rates (both as expected). As for price changes, the only significant correlation appears to be a positive relationship of

price changes with the provincial economic growth, which is consistent with our expectations. The fundamentals represented in this figure appear to have more explanatory power than the population trends.

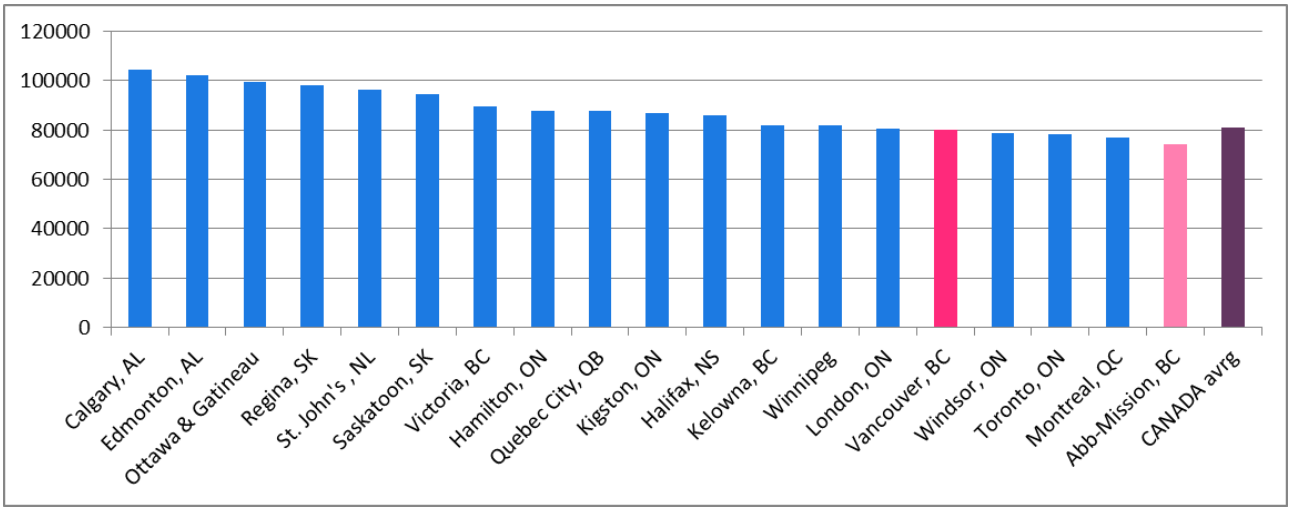
The final demand factor to look at is local incomes, for which the data are presented on Figure 3.9. Comparable statistics could not be found for the last 10 years to prolong the time series, but even so, what we observe is no relationship, if not a negative relationship between real house prices and real incomes implying that even before the last 10 years with striking price growth house prices in real terms have already been decoupled from local incomes, which is further supported by Figure 3.10 and Figure 3.11 with a snapshot of more recent data on income. Figure 3.10 shows that among all CMAs in Canada, Vancouver offers a relatively low income, which is just around Canadian average household income. And that occurs in a city with the most expensive housing in the country that is almost double the price of the next city, Toronto, that offers a similar median income.

Figure 3.9. Real House Prices and Real Median Income Trends, Vancouver CMA, 1977-2006



Source: original layout based on data from Statistics Canada, REBGV and other sources.

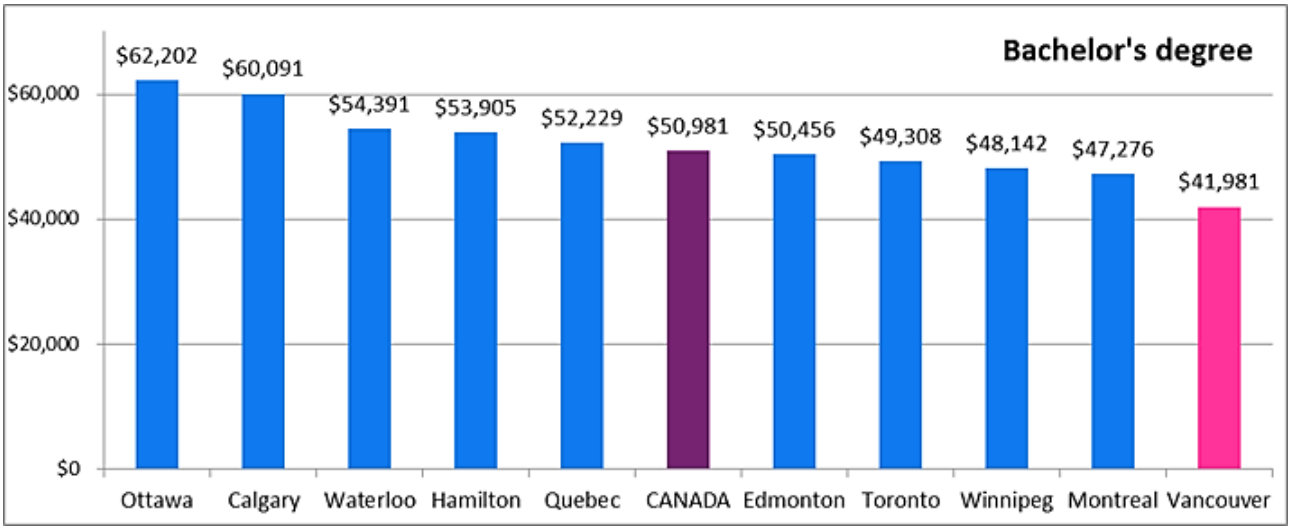
Figure 3.10. Median Household Income in Canadian CMAs, 2015



Source: original layout based on Statistics Canada, CANSIM table 111-0009.

The comparison of Vancouver's housing prices and income levels to other Canadian cities gets even more bleak when looking at higher-qualified people, for example the labor force with completed higher education (Figure 3.11). In this indicator, Vancouver offers the lowest income to its qualified workforce of the 10 largest CMAs in Canada, over $5,000 below even the next city, Montreal, and $9,000 below the Canadian average. The same regional trend is true when looking at people with post-graduate training as well (this graph can be found in Appendix C) with Vancouver being the lowest of the 10 CMAs.

Figure 3.11. Median Income for 25-55 Year Olds with Bachelor's Degrees in select CMAs, 2011



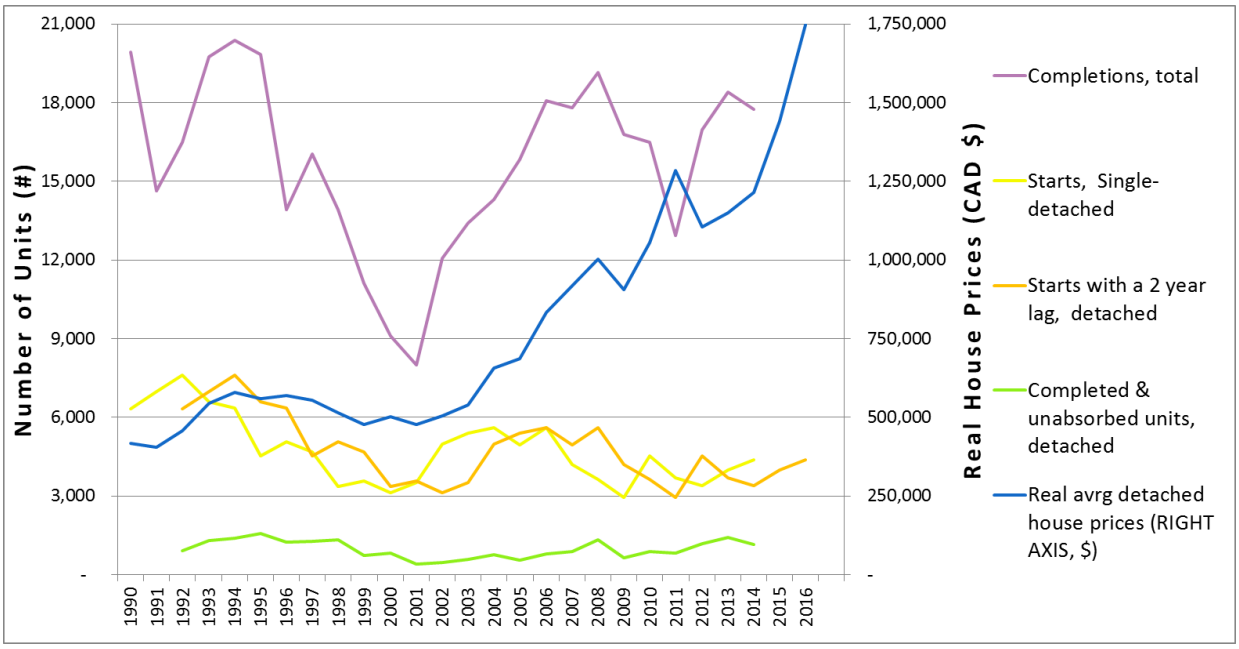
Source: original layout based on Canadian Statistics National Household Survey 2011.

These findings regarding the dynamics of the demand factors clearly indicate the decoupling of the house prices from the local market fundamentals. Even though a number of weak relationships

could be observed, they are insufficient to fully explain the scale of house price growth, especially in the recent decade. Furthermore, a potentially negative correlation between house prices and real incomes contradicts the regular market assumption that house prices follow local incomes and other economic dynamics.

Next, we can look at supply factors to see if they might explain the current house price trends (Figure 3.12). The graph shows the number of total completions, new housing starts and newly completed and unabsorbed units specifically in the detached SFH segment. Completions data was not available by dwelling type, and needs to be looked at with caution. We do observe a declining trend for the housing starts in the SFH sector which could partially account for the rising house prices as the supply is not expanding as much, however, the magnitude of decline in not nearly the same as the soaring house prices in the last 10-15 years.

Figure 3.12. Housing Prices and Supply Fundamentals, Vancouver CMA, 1990-2015



Source: Canadian Mortgage and Housing Corporation (CMHC), author's layout.

Finally, the correlation estimates for all indicators included are presented in Table 3.2. Bivariate correlation was estimated for each of the 'fundamental' factors separately with absolute real house prices and price changes. The results are reported in respective columns with values highlighted to make the stronger correlations (positive or negative) stand out. Factors are grouped first into demand- and supply-related and then into further thematic clusters. Additionally, the information on the number of observations included and the time period covered is included in the last two columns. Shorter time periods correspond to indicators that could not be found or do not exist for the entire period of 1977-2016.

Table 3.2. Housing Price and Price Changes' Correlations with Fundamentals, 1977-2016

Correlations	Real avrg detached house prices (CAD)	Annual house price change (%)	# of obs's	Period covered by the data
Demand factors				
Population				
GVA Population	0.93	0.37	21	1996-2016
GVA Population y-o-y growth (%)	0.02	-0.40	20	1997-2016
Natural population growth (Births - Deaths)	0.28	-0.02	40	1977-2016
Net international migration (Imm - Em)	0.43	0.02	40	1977-2016
Net Inter-provincial migration	-0.21	0.32	40	1977-2016
Net intra-BC migration	0.01	-0.17	40	1977-2016
Net domestic (inter-provic + intra-BC)	-0.26	0.24	40	1977-2016
Immigration (persons)	0.57	0.04	40	1977-2016
Income				
Median total income - Economic families (nominal $)	0.87	0.13	30	1977-2006
Median total income - Unattached individuals (nominal $)	0.82	0.13	30	1977-2006
Median total income - Economic families (real $)	-0.25	0.29	30	1977-2006
Median total income - Unattached individuals (real $)	0.06	0.23	30	1977-2006
Economic growth				
Unemployment rate (12-mnth avrg, Jan to Dec)	-0.56	-0.14	30	1987-2016
BC GDP, 2007 const prices (in mil)	0.93	0.12	35	1981-2015
BC GDP, Y-o-Y growth, 2007 const pr (%)	0.03	0.62	34	1982-2015
Bank Rate (12-month average, January to December)	-0.75	0.08	39	1977-2015
Supply factors				
Construction				
Starts, total	0.35	0.54	25	1990-2014
Starts, Single-detached	-0.45	0.42	25	1990-2014
Starts with a 2 year lag, Single-detached	-0.36	0.03	25	1992-2016
Completions, total	0.28	0.18	25	1990-2014
Residential Building Permits (#)	0.34	0.59	25	1990-2014
Available supply				
Newly completed and unabsorbed, total (# units)	0.03	-0.33	23	1992-2014
Newly completed and unabsorbed, single & semi-detach (#)	0.16	-0.10	23	1992-2014
Rental vacancy rate (%)	-0.17	-0.48	25	1990-2014

Source: Excel correlation analysis, author's layout.

For absolute house prices, strong[6] positive correlations are observed with total population (0.93), net international migration (0.43), total immigrant population (0.57), nominal median income (~0.8) (but not real incomes), and aggregate provincial GDP in real terms (0.93). These relationships coincide

[6] Correlation is considered 'strong' if it is above 0.3 or below -0.3, which also corresponds to the significance of individual bivariate correlation values.

in sign with our expectations. However, it is interesting to note that once we switch from totals to annual changes ('flow' instead of 'stock'), the aforementioned relationships lose significance with population growth and BC GDP growth being insignificant with 0.02 and 0.03 correlation coefficients respectively. It is quite notable that even though below the -0.3 threshold, the relationship between absolute prices and internal migration (specifically, inter-provincial migration and total domestic migration) emerges as negative, which is opposite to the expected sign. One potential explanation for the latter could be that it is not domestic migration driving the prices, but the other way around: as people can be more mobile within Canada than across countries, if housing becomes ever-more expensive, it drives more people out of the area to other cities and provinces in search of better pay and more affordable housing.

Real house prices are found to be inversely related with real income in economic families (-0.25), unemployment rate (-0.56), bank interest rate (-0.75) and total and single detached house starts as well as lagged starts to account for the impact of starts entering the market[7] (-0.45 and -0.36 respectively). While economic growth and supply indicators correspond to the expected direction of the relationship, real income trends appear to go against the house price trend, which indicates a degree of decoupling of house prices from income.

The difference in results between real prices and price changes along with the fact that all of the aforementioned relationships decline in or lose significance when switching to price changes imply that even if the overall trend is consistent with our expectations (e.g. total population or total number of immigrants), the growth rate of market fundamentals cannot account for the growth in house prices. Even though accounting for short-term changes is harder than finding explanatory variables for long-term trends of absolute indicators, the striking insignificance of multiple market fundamentals expressed in 'flow'-type variables is indicative of other processes occurring in the market potentially involving external factors and foreign actors.

Among the potential factors of annual house price changes, we observe the strongest positive correlation with total population (0.37), net inter-provincial migration (0.32), provincial GDP growth rate (0.62) and house starts (total 0.54, detached 0.42) along with the number of issued building permits (0.59). The data on supply contradict the expected direction, which also implies more complexity in the housing market. Even though supply is increasing, the price growth is not slowing down indicating unexpected demand response. One of the most surprising observations is the reversal of the relationship

[7] We include this indicator since completions specifically for single-family homes are not available in the CMHC general market indicators dataset.

of price changes compared to house prices with domestic migration patterns, as well as for the SFH house starts, which could hardly be explained based on basic assumptions about the housing market dynamics and local fundamentals.

This primary analysis has not revealed substantial explanatory power of standard market fundamentals for understanding the housing market dynamics. We now turn to the studies that revisit the possible causes of current house price dynamics in Vancouver alluding to the presence of the housing bubble in the market, driven by external factors. Being a gateway city for foreign investment and buyers heavily involved in commodified housing assets (Ley & Tutchener, 2001) and foreign money involvement in the housing market (Gordon, 2016; Ley, 2017; Yan, 2017), Vancouver has shown a tendency towards becoming more and more decoupled from local economic fundamentals.

If not the local economy, there must be a different driver that could complement explanation of the housing prices (Gordon, 2016). In his recent report, Gordon (2016) careful considers a variety of potential supply and demand factors, to evaluate whether the common notions about the local fundamentals work in the case of Vancouver. The local economy, people's incomes, and recent immigration trends, along with allegedly insufficient supply, and rezoning and land constraints, Gordon argues, do not account for the recent steep upward price trend. While the city's desirability, its constrained land and low interest rates do present potential stimuli for strong demand on the housing market, they have not changed significantly in recent years to justify the change of the Vancouver house prices since the 2000s. Therefore, Gordon concludes, supported by Yan (2016, 2017) and a number of other studies (Ley, 2010, 2017), it is foreign investment in the market that disconnects the house prices from the local economy. When the source of income to pay for (multi-) million-dollar homes is elsewhere in the world with no local taxes paid or local economic activity generated, it becomes an apparent explanation for the current housing dynamics in Vancouver.

As interesting a hypothesis as it is, there is no comprehensive way to evaluate it with conventional quantitative methods due to the striking limitations in data gathered and available. Occasional studies point out the foreign money rationale with specific case studies; however, no data was collected by the government until 2016 when for the first time, it became mandatory to record the buyers' immigration status differentiating between citizens and permanent residents (PRs), and foreign buyers. Still, this dataset is quite limited as it does not take into account the source of the money, and not just citizenship status, as foreign capital can still come through PRs who might have received status through the Business Immigration program (BIP) (Ley, 2010) before it was closed. Furthermore, the number of transactions involving foreign buyers is not distinguished by market segment (property type)

limiting the potential of interpretation and connecting that data to the house price dynamics in specific submarkets of detached SFHs, townhouses or condos.

The way Gordon and others are able to assign explanatory power to the role of foreign investment on the Vancouver housing market is through a few case studies and extrapolations from the data available in specific instances. First, while there was no direct data on foreign buyers before 2016 and there is still no specific information on foreign direct investment, we can estimate the plausibility of the argument for Vancouver by looking at secondary evidence.

It has been established that major cities are top immigrant destinations and sites to invest, and BC (essentially, Vancouver) has attracted 65% of investor immigrants from BIP (Gordon, 2016). At the same time, Vancouver is in top-3 places for real estate purchase and immigration among high-net-worth individuals (HNWIs) from China, the major source of property investment (Ley, 2017). In 2015, Andy Yan conducted a study of ownership patterns in most expensive West Side neighborhoods (West Point Grey, Dunbar and the University Endowment Lands) analyzing 172 sales transactions over 6 months in 2015 (Yan, 2015). He found that 66% of owners had non-anglicized Chinese names, which, according to him, most likely implies that the buyers are 'recent arrivals', or new immigrants. Even though it is not evidence in stone, it is still very suggestive of the general pattern. Similarly, McDonald Realty sales data from 2014 indicated that 70% of buyers in the higher end of the market (purchases over CAD $3 million) were from Mainland China (McDonald Realty 2014 cited in Yan, 2015). Another fairly recent real estate agency report from 2013 (Sotheby's International Realty 2013 cited in Surowiecki, 2014) found that half of the 1,200 luxury-home sales in Vancouver in the first half of 2013 involved foreign buyers.

Given that the global capital flows are not typically considered to be market fundamentals, their impact is not often considered in evaluating the changing "real value" of housing units. At the same time, the concept of a housing bubble is typically brought up to explain the observed price dynamics dissociated from the local economy. There are a few academic studies targeting the issue of a housing bubble in the Vancouver residential housing market directly or indirectly. Most of them have already been mentioned, but two of them will now be presented in more detail being the most recent and most relevant to develop an understanding of the phenomenon of the housing bubble in Vancouver. Both papers draw on extensive work with existing literature to construct a narrative incorporating topics such as global capital, foreign investment flows, rising China, and immigration and housing policies affecting Vancouver.

The first paper by Moos and Skaburskis (Moos & Skaburskis, 2010) is more quantitative introducing a model of the user cost of housing as a function of market fundamentals and immigration indicators. The paper introduces spatial analysis at the neighborhood level and finds that "immigrants as agents of the globalization process shape local housing markets in Vancouver" (Moos & Skaburskis, 2010, p. 744) revealing a complex relationship between immigrant status, household income and housing consumption. Specifically, some of the recent immigrants' housing consumption was not tied to their local labor market participation (unlike other residents) as they might continue to receive income abroad, which contributes to the decoupling of housing from the local labor market. The issues of housing bubbles and affordability are not discussed directly, but the idea of decoupling clearly contributes to a better understanding of the underlying reasons behind the bubbles discussed elsewhere.

Another relevant study is a recent paper on Global China in relation to the private housing market (Ley, 2017). Exploring the impact Chinese capital and immigrants have had on Vancouver's residential property market, Ley establishes the success of the Asia Pacific outreach program to boost BC's economy, while revealing that it has also created inequities such as "excessive housing unaffordability, precarious mortgage indebtedness, and disillusioned out-migration" (Ley, 2017, p. 17) that are not addressed because of the entanglement of public and private interests. This again highlights the mechanisms through which the housing prices are diverging from the local markets and emphasizes the reasons for lack of policy response and controversial outcomes.

Others consider the uncoupling of the housing market from the local economy not to be a sign of a housing bubble, but an incentive to overhaul our "our basic assumptions about housing prices", especially in the case of a "truly global market" we can no longer expect that housing prices reflect the local fundamentals (Surowiecki, 2014). In his New Yorker article, Surowiecki (2014) argues that global dynamics and foreign investors' behavior could be considered a fundamental factor in a market such as Vancouver giving the overwhelming evidence (Surowiecki, 2014).

3.4 Policy Context

Despite initial reluctance to instill additional constraints and regulation on the housing market in Vancouver, the previous BC Liberal government did implement a few recent initiatives to cool the Vancouver housing market, including the foreign buyers' tax and the empty homes tax. The initiatives accompanied Ottawa's "stress test" for mortgage lending (October 2016) to alleviate the potential shock of increasing interest rates, which eventually began later, in the summer of 2017.

With CMHC eventually raising the risk assessment for the Vancouver housing market to 'moderate' in April 2016 and then to 'strong' (i.e. a strong evidence of potential problems) (Doiron, 2016), the former BC Liberal Government leader Christy Clark announced the foreign buyer's tax of 15% in July 2016 that would come into effect in early August 2016 leaving a two-week window to finish transactions in their final stages (Shaw, 2016). Once the tax came into effect, every purchase made by a foreign buyer (i.e. anyone without Canadian citizenship or permanent residence) became subject to an additional 15% tax. The tax was meant to cool off the market in which 10% of homes in Vancouver CMA were sold to foreign buyers (Hager & Stueck, 2016), according to the newly collected statistics by the BC Ministry of Finance on transactions involving foreign buyers. Indeed, there was an immediate drop in transactions and a slight decline in prices. But as we now know by June 2017 the market has almost fully recovered from the tax in both absolute prices (REBGV stats presented in Figure 3.4) and the sales number (CMHC, 2016).

The change in government action on housing was meant to raise political support for the party for the upcoming elections that were held in May 2017 and when announcing the foreign buyers' tax, the provincial government also pledged to roll out more strategies to improve the housing affordability in the region (Hager & Stueck, 2016). But the next significant initiative came from the City of Vancouver. The empty homes tax came into effect in January 2017 putting "homes that are deemed empty" under an additional 1% tax of the property's assessed value. The City of Vancouver highlighted that "most homes will not be subject to the tax, as it does not apply to principal residences or homes rented on a long-term basis" (City of Vancouver, 2017). The outcomes of the tax cannot be assessed until the 2017 tax forms are filed and evaluated, but one can already encounter the expected negative reaction (Bula, 2017) from owners who do not live in Vancouver full-time and are unwilling to rent out their Vancouver residence.

Finally, there was also national legislature that brought some changes to housing market regulation. In October 2016, Ottawa announced a new mortgage "stress test" that new mortgage applicants would have to pass that analyzes their potential to be able to meet higher payments in case of "potentially higher interest rates if the mortgage is insured and the initial principal payment is less than 20% of the purchase value" (Dunn, 2016). The stress test came ahead of the interest rate hikes that were eventually announced in July 2017 (CBC News, 2017b).

Even though not a measure directed at slowing down the housing market, the slightly tightened mortgage lending with the recent increase in interest rates could pose a potential obstacle for unobstructed price growth. However, at present (August 2017) it is too soon to say how the interest rate hike will affect the Vancouver market. We have observed that to date Vancouver has been very

resistant to negative external shocks, such as the 1997 Asian crisis, the 2008 GFC, and the 2016 foreign buyer's tax to name a few, and if there is a price bubble, it has not burst yet.

3.5 Social Outcomes

Supporters of the status quo for the Vancouver housing market often apply the free market argument that the current state of Vancouver housing is the result of free market forces that are known to be more efficient in allocating scarce economic resources, thus advocating against more regulation or further taxes. One issue with such an argument is whether market efficiency is the only goal that any level of government, consumer interest group or a corporation should have.

I would argue that despite the overwhelming support for market efficiency as the ultimate goal, specifically in the Vancouver case study one could argue that it is not in the interest of the public good to maintain existing housing trends without restriction, given the potential risks of the external shock that might lead to recession and a housing bubble bursting. Moreover, in an interventionist state such as Canada, the interests of different social groups are taken into account and the issues of generational equity and housing stress in reducing the life satisfaction for local residents need to be taken into account when designing housing policies. Market efficiency is most often not enough. Moreover, in the long run the current house price trends might actually lead the city to a decline in economic activities and vibrancy as more young and qualified people leave or choose not to migrate to the city and it becomes dominated by empty houses held as investments by non-local owners (Surowiecki, 2014) with demographics skewed by those who could still afford living in the city, for instance like a 'resort town' (Gordon, 2016).

The current lack of affordability already has palpable negative social outcomes, such as generational inequities and a dangerous debt level (Walks, 2013), increasing housing stress leading to psychological and physiological problems, poverty and homelessness, extra obstacles in recruiting and retaining talent and essential workers (police, firefighters, teachers, etc.), a deteriorating sense of community with an increasing number of empty homes across Vancouver, overstretching the regional transport infrastructure with increasing commuting time (Batch, 2017), etc. Because of Vancouver's demographics with a strong presence of East Asian ethnicities coupled with the perceived typical portrait of a regional house buyer, the city could potentially face rising racial tensions (CBC News, 2016b; Yu, 2015). These issues come at a cost to the society, that is not just moral or tangential, but very tangible if measured, for example, in the costs of additional income assistance, health care, infrastructural maintenance and new construction projects, as well as the rising cost to the public and private sector to recruit employees and compensate for the additional housing expenses. For these

reasons, housing should not be left with the existing status quo. The potential issues and risks (as already acknowledged by the researchers, as well as Moody's rating agency and the Bank of Canada) need to be addressed to ensure provision of a decent standard of living for the current and future residents with preventative or corrective measures introduced sooner rather than later.

3.6 The Outlook for Vancouver

A number of studies explore the relevance of the housing market's decoupling from the local economy for the potential 'unsustainability' of house price dynamics (Gordon, 2016; Ley, 2017; Moos & Skaburskis, 2010; Walks, 2013, 2014). The socio-economic indicators presented in this chapter in comparison to house price trends largely support the decoupling hypothesis, yet do not fully explain the reasons behind the astounding inflation of prices in the city. An alternative explanation of Vancouver's house price dynamics posits the influence of external actors, namely foreign buyers and foreign investment in general (Gordon, 2016; Ley, 2017; Yan, 2015, 2017). This explanation was partially shared eventually by the former provincial government, which introduced a foreign buyers' tax in an attempt to cool off the housing market and win extra votes in the election.

A concept that could be very useful for studying Vancouver housing is that of a bubble. A bubble is, by definition, prone to bursting, sending domino effects across the system (Armstrong, 2017; MacBeth, 2015; The Globe and Mail, 2017; Todd, 2017). Consequently, the potentially unsustainable price trends should not be overlooked or dismissed. The existing academic literature inadequately addresses the question of a current housing bubble in the Vancouver residential real estate market. Whether there is not enough data, will, or capacity to determine how risky the bubble is or how likely it is to burst, careful monitoring of the market and evaluating the efficiency of introduced housing initiatives are essential in the short run in the hopes of preventing a major crisis that might happen.

A number of characteristics of the Vancouver housing market are clear and unequivocal, such as the overvaluation of residential properties, the astounding lack of affordability that might have costly socio-economic consequences, as well as the seeming inability of current legislation so far to address the lack of affordability. Another fact that is quite apparent about the local housing market is the significant impact of inflows of people and money from outside that generate a strong demand for housing while reinforcing its decoupling from the local economy. It could be argued that in a gateway city like Vancouver, it might be reasonable to include external factors (people and foreign capital flows) as market fundamentals rather than labeling them only as drivers of a bubble. Regardless of labels and interpretations, however, at present the primary concern for the government, Vancouverites and

employers is the city's status as the least affordable in North America (Demographia Affordability Survey, 2017).

In order to address issues as important as this, which are capable of affecting the economy in a number of ways, the first step is to develop a comprehensive understanding of the market dynamics. This is essential for informing policies and making them effective in addressing the issues they are designed to address. Since a number of recent initiatives have not yielded the results they might have aspired to, there is room for improvement if the market is understood better not just in time, but also across space. The spatial dynamics of the housing market will be examined in the next chapter.

Chapter 4. A Ripple Effect on the Vancouver Housing Market

This section presents original data analysis of the patterns of price diffusion throughout the Greater Vancouver area (GVA) along with two Fraser Valley (FV) regions as an extension including Mission and Abbotsford. This whole area is contiguous but larger than the Vancouver Census Metropolitan area (CMA), and will be subsequently referred to as Metro Vancouver. A total of 21 municipalities[8] are included with a slightly varying total number at different levels of analysis depending on data availability and pre-existing spatial subdivisions in data reporting. The potential presence of a ripple effect is first evaluated by visually analyzing spatio-temporal change patterns on graphs and maps followed by volatility and break-point analysis across municipalities relative to distance to downtown Vancouver. Finally, several specifications of regressions are run to quantify the ripple effect across Metro Vancouver.

4.1 Data Sources and Overview

This project is utilizing data on median selling prices and sales numbers of detached single-family homes (SFH) by municipality in Metro Vancouver, which are provided by the Real Estate Board of Greater Vancouver (REBGV) and the Fraser Valley Real Estate Board (FVREB). Annual and monthly data go back to 2004 and are updated with the most recent available period: 2016 for annual data and second quarter (June) 2017 for quarterly data. Quarterly data are not reported separately and we calculate the entry for each municipality as the average monthly median selling price weighted by the monthly sales number.

Statistical reports that include these indicators are publicly available and were obtained by contacting the respective Boards as statistical reports for earlier years have not been published on their websites. The choice of median sales price instead of average or benchmark sales price is motivated by selecting a more representative measure of price changes across municipalities with minimal outliers. As the raw sales data by dwelling are not open to the public, we are limited to using data available from the Boards' monthly reports, which is why the earliest year is 2004, as before that date the monthly reports did not include median selling prices consistently.

The focus primarily on quarterly regional sales prices in our analysis is motivated by two reasons. First, most of the ripple effect studies (as presented in Chapter 2) are estimating the ripple effect using quarterly prices, so this choice is consistent with most of the existing research. Second,

[8] Some of the illustrations based on annual data include a different number of municipalities as some of them were joined together at certain levels.

using quarterly prices enables correcting some of the monthly outliers of median prices with a larger sample size of dwellings. Furthermore, it could be argued that three-month periods are more representative for changes in behavior among individuals to be observed. For the factors of a ripple effect identified by Meen (1999) (see section 2.4.2) to take place, a quarterly time frame appears to be more feasible. External shocks, however, could also send ripples by altering the patterns of investors' behavior who enjoy more liquidity, and as such, they will react within a shorter time period, and this will be demonstrated with the example of Vancouver housing prices responding to the global financial crisis later in the chapter (see section 4.4).

There are a few limitations to using quarterly data that need to be acknowledged. While monthly and annual indicators are published online in statistical and analytical reports for the Vancouver area, the quarterly aggregate indicators are not present in those materials implying that the market actors might not be basing their decisions from them. However, it does not prevent us from capturing more general patterns that are not as fine-grained, yet still consistent with the local dynamics. Another concern could also be that the ripple effect might be obscured at the quarter interval if it occurs within the 3-month time frames. This concern will be addressed by including some monthly data in the break-point analysis to get a clearer picture of the external shock diffusion throughout the area. Besides the CMHC report (Batch, 2017) provides evidence that quarterly prices do display a ripple effect throughout Metro Vancouver and other urban areas in BC, so this aggregation is relevant for our case study.

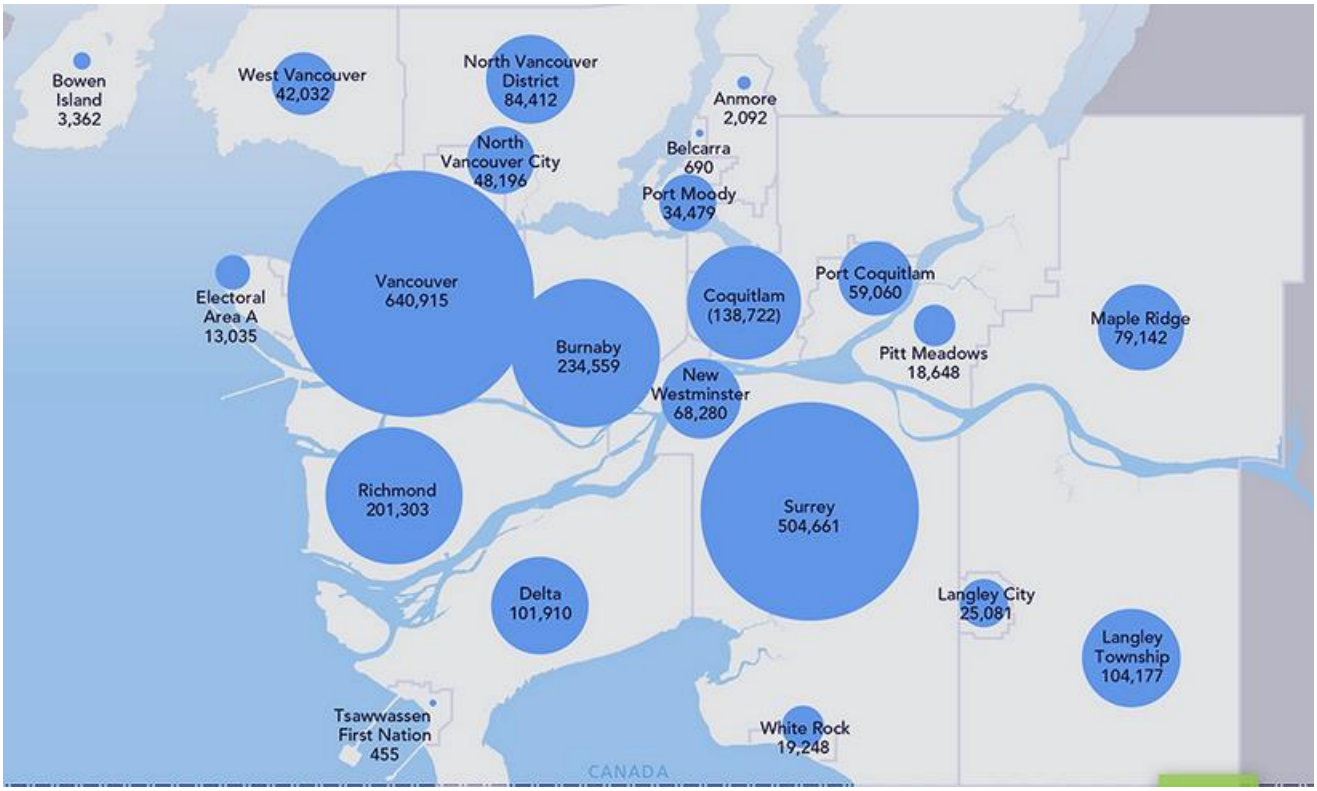
After quarterly prices were generated based on a monthly average weighted by sales number by municipality, index values along with relative and absolute price changes were additionally calculated for mapping and creating graphs. Quarters are identified as consecutive three-month periods, starting January-March (Q1), and ending October-December (Q4). Additional specific calculations and indices will be described in more detail for the respective graphs and maps.

We are focusing on selling prices for detached single-family houses only without looking at attached houses or condominiums. It provides more consistency across municipalities to use a comparable indicator for the same housing type, rather than accounting for different housing structures across the region, and it also captures the majority of the market as almost 70% of the population in Metro Vancouver lived in detached SFH in 2016 (Census 2016 data from Yan, 2017) with only 27% of people living in townhouses and a mere 4% in high-rise condos.

The official map of municipalities in the GVA is presented below (Figure 4.1), Mission and Abbotsford are not present as they technically belong to the Fraser Valley region, but are included in

this analysis as potential commuter zones with their price dynamics connected to the GVA to an extent. Other municipalities further east were excluded due to their increasing distance from the City of Vancouver with less potential to be part of the commuter shed, as well as due to accessible data constraints as median selling prices by the FVREB are not reported beyond Mission and Abbotsford. Bowen Island is on the GVA map but is excluded from analysis due to a consistently low sales number and North Vancouver City and Langley City identified on the map (Figure 4.1) are aggregated into North Vancouver and Langley regions respectively. This is determined by the way data is reported in the Boards' statistical reports.

Figure 4.1. Official Map of Greater Vancouver Municipalities with Population Data



Source: Metro Vancouver government website[9].

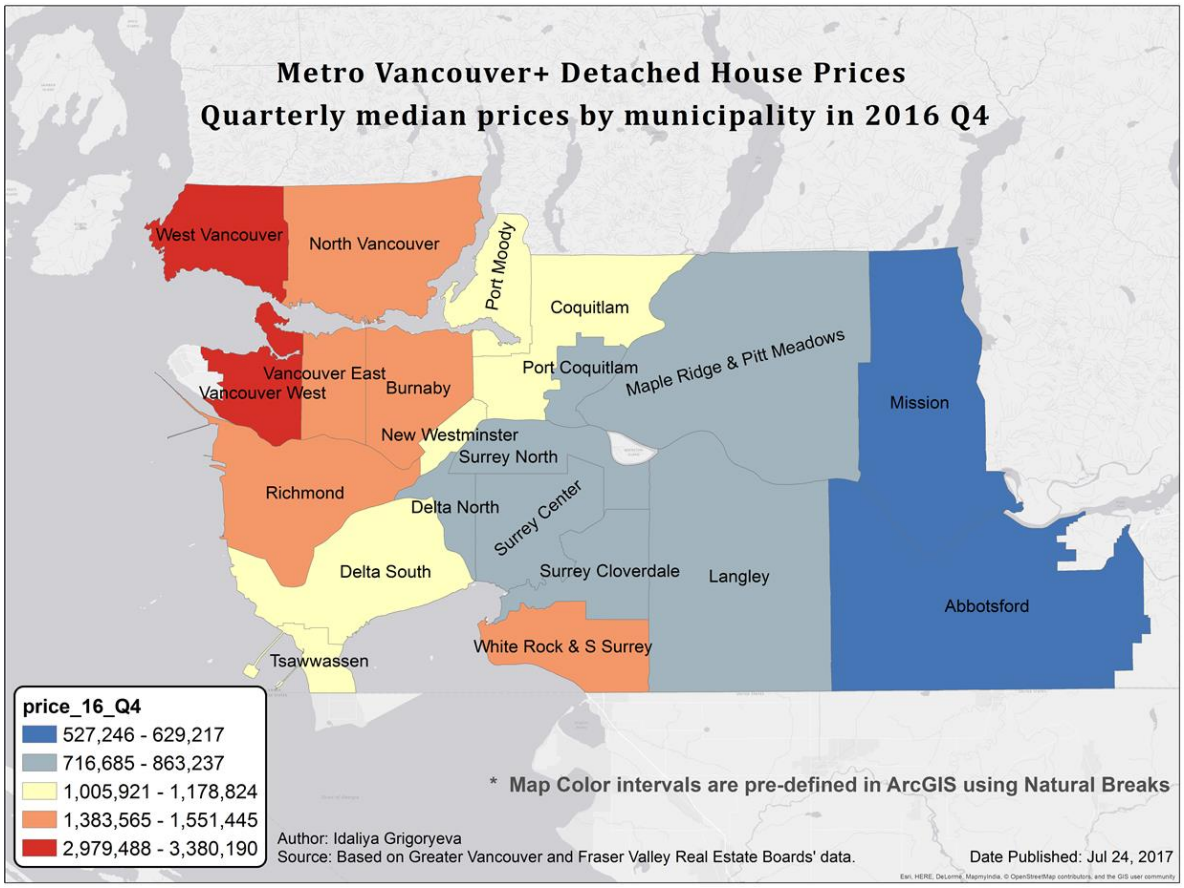
The full map of municipalities included in the analysis is displayed below (Figure 4.2). It shows the subdivisions actually used by the Real Estate Boards across the area covered by the Greater Vancouver and the Fraser Valley Boards. There might be minor inconsistencies in the specific borders from the original price aggregation algorithm as the map had to be drawn manually for certain regions (especially Surrey subdivisions) from the generic information provided by the Boards. Nevertheless,

[9] Metro Vancouver online portal http://www.metrovancouver.org/about/Pages/default.aspx (accessed 2017.07.10).

the maps provided here and thereafter are still valid representations of the spatio-temporal price change patterns and it is non-essential if some borders do not align exactly with the original municipal units.

In total, there are 21 municipalities: 19 that officially belong to Metro Vancouver (see map in Figure 4.1) including subdivisions of Surrey into Surrey Center, Cloverdale and Surrey North, and of Delta into Delta North and Delta South; and 2 from the Fraser Valley – Abbotsford and Mission. For Surrey and Delta, the subdivisions are based on similarities in the sub-regional housing markets rather than more arbitrary administrative boundaries. For example, South Surrey is added to White Rock due to the similarities in the housing stock and consumer behavior. On the contrary, Pitt Meadows is joined together with Maple Ridge because of the small sample size, so in the subsequent analysis they represent one region and are referred to as just Maple Ridge.

Figure 4.2. Map of Municipalities as Identified for Analysis, Median Prices in 2016 Q4



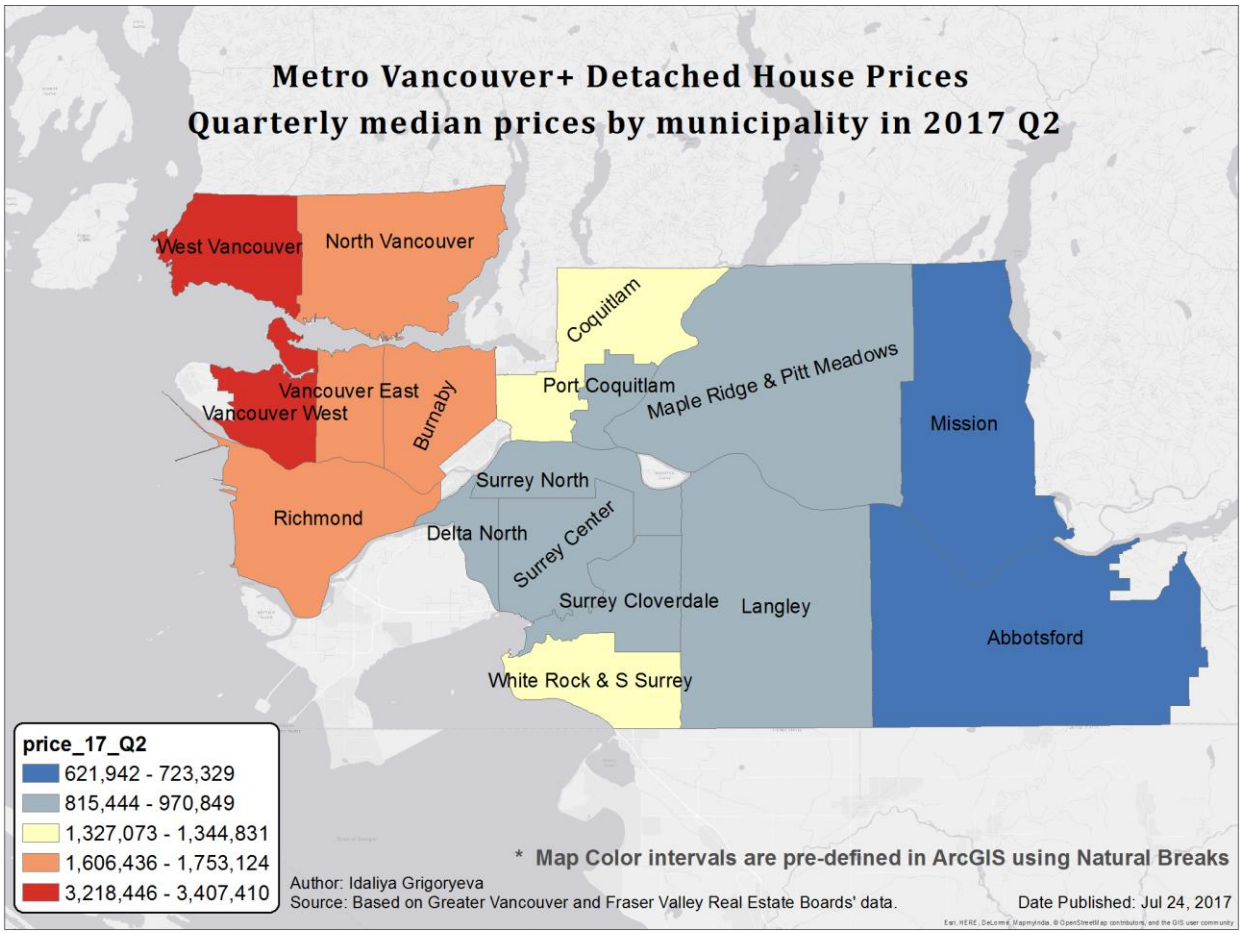
Source: original map based on the REBGV and FVREB data.

In subsequent analysis, a few municipalities were dropped from the sample due to insufficient sales number to generate a representative median selling price. The inclusion threshold of at least 10 sales a month throughout the period was set, which enabled us to exclude sales outliers and still have a decent sample size of 17 municipalities with 49 quarterly observations each. The following

municipalities were excluded based on this criterion: Tsawwassen, Delta South, New Westminster, and Port Moody. Given that these municipalities are smaller and overall less significant in shaping the general regional price trends, their exclusion is acceptable. Besides, they are still included in maps and some of the graphs to provide a more complete picture of the price change geography, yet their exclusion in in regression analysis removes potential bias where outliers on a fairly small sample such as ours could lead to inconsistent estimates. The full sample of 21 municipalities is only updated to 2016 Q4 and the most recent data update to 2017 Q2 was only performed for the smaller sample of 17. Therefore, the map above (Figure 4.2) is drawn for the fourth quarter of 2016 as it is the most recent data collected for the 21 regions.

The map with the final sample of 17 municipalities with 10+ sales in any month during the period used to calculate quarterly sales is provided below (Figure 4.3):

Figure 4.3. Final Sample of Municipalities for Data Analysis, Median Prices in 2017 Q2



Source: original map based on the REBGV and FVREB data.

4.2 Regional Price Trends

Both maps in the previous section (Figure 4.2, Figure 4.3) highlight a very prominent spatial price distribution with the highest median prices (well over CAD $3 million) prevalent in the western coastal part of Metro Vancouver, namely Vancouver West (also referred to as the West Side) and West Vancouver (*red color*). The 2nd tier in prices (*orange color*) is represented by neighboring municipalities of Vancouver East, North Vancouver, Richmond and Burnaby (and also includes White Rock on the 2016 Q4 map).

The median priced municipalities just above CAD $1 million are Coquitlam, the suburb that used to be priced somewhat lower yet caught up with the $1 million threshold, and White Rock, the area further away from the City of Vancouver that exhibits prices exceeding $1 million arguably due to the influence of higher "offshore interests", specifically from Mainland China and Saudi Arabia as more investors get interested in purchasing larger agricultural farmlands (Sam Cooper, 2017). For growing farmland prices are "no longer attached to agricultural revenue, but instead are following red-hot Metro Vancouver residential land prices, and reflect a trend of 'estate' building on country acreage" (Sam Cooper, 2017), which is evident in White Rock, and also in Richmond, Delta and Fraser Valley, all of which are areas with considerable farmland.

The lowest-priced areas in the sample are the most distant: Abbotsford at just over $723,000 and Mission at roughly $622,000 median selling prices for detached single-family homes in 2017 Q2. This overall spatial trend is consistent for the larger and smaller sample at the end of 2016 and midway through 2017 respectively, with slightly lower ranges in 2016, yet the identical pattern.

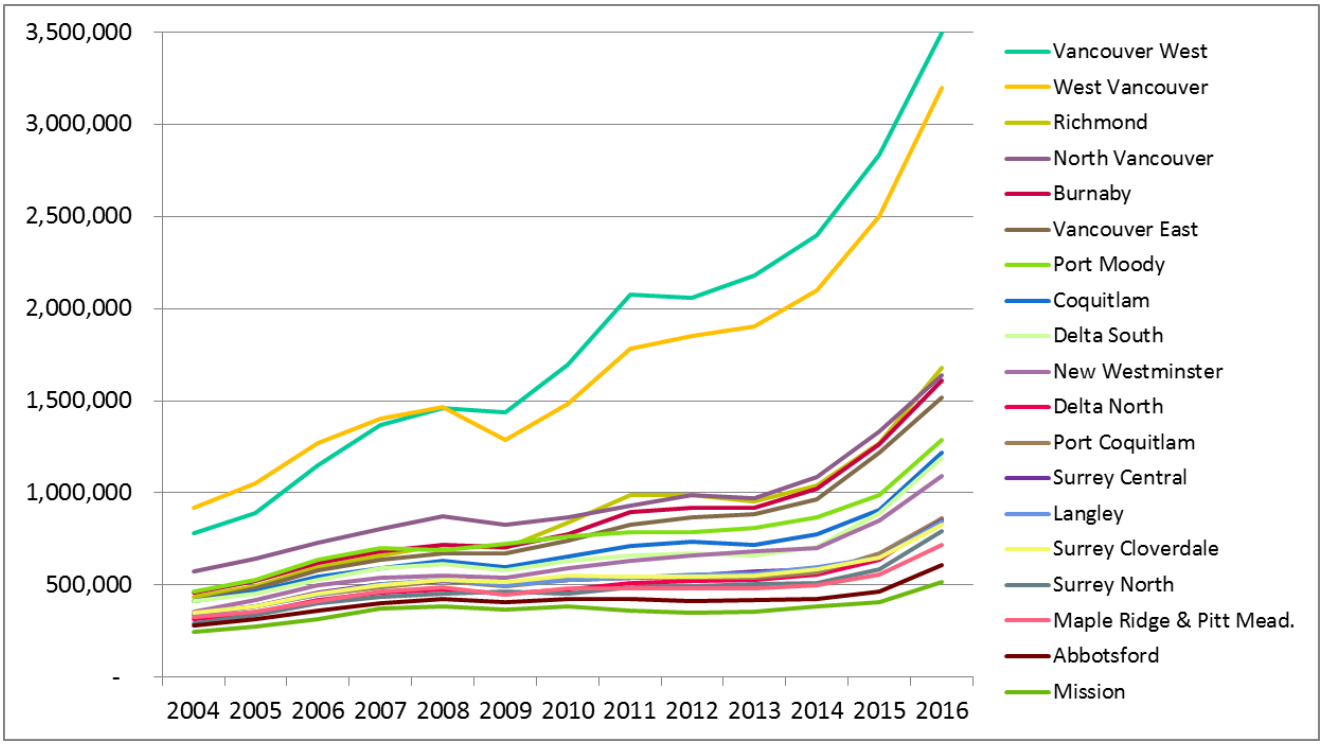
4.2.1 Annual Price Trends

The trends will now be analyzed in more detail examining absolute prices and price change graphs. We start by analyzing annual price figures to get a better understanding of the overall trends in Metro Vancouver over the last decade that included two major external shocks: the Global Financial Crisis (GFC) in 2008-09 and the 2016 foreign buyers' tax that have significantly affected the market. Nominal median selling prices, as well as indices and annual changes are shown in the following graphs (Figure 4.4 – Figure 4.7).

The dynamics of absolute prices (Figure 4.4) reveal a stark difference between the most expensive areas from the rest of the region, that is even more conspicuous than the evidence from the map (Figure 4.3), with Vancouver West and West Vancouver not only being most expensive but also exhibiting divergence from the rest of Metro Vancouver as prices rise even faster than the rest of the

metropolitan area. This pattern is consistent with trends for an earlier period (Ley et al., 2002). These two areas will potentially constitute the "center" of the ripple effect being the highest-priced areas most susceptible to external and local shocks with a high share of non-local investment and in general more investment and speculative behavior driven by the dwellings' exchange value and not necessarily their use value. In this respect, it is worth noting the extraordinary nominal price inflation of $2-$2.5 million for detached houses between 2004 and 2016 in Vancouver West, an annual average of 17%, and 21% over the previous 3 years. The second tier of higher-priced regions includes the four regions closest to the 'centers', that are also nodes of economic activity and jobs in the region: North Vancouver, Burnaby, Vancouver East and Richmond, which is consistent with the observation from the map (Figure 4.3).

Figure 4.4. Annual Nominal Median Selling Price by Municipality, 2004-2016[10]



Source: Median selling prices from the reports by the Real Estate Board of Greater Vancouver (REBGV) and the Fraser Valley Real Estate Board (FVREB).

Mission and Abbotsford invariably enjoy the lowest prices in the given period, and these are the two regions furthest from the City of Vancouver and outside of the official Greater Vancouver region[11], yet still part of the Vancouver commuter shed (Batch, 2017; Mitham, 2017). Other relatively cheap municipalities include Maple Ridge and Pitt Meadows, the Surrey regions, and Port Coquitlam.

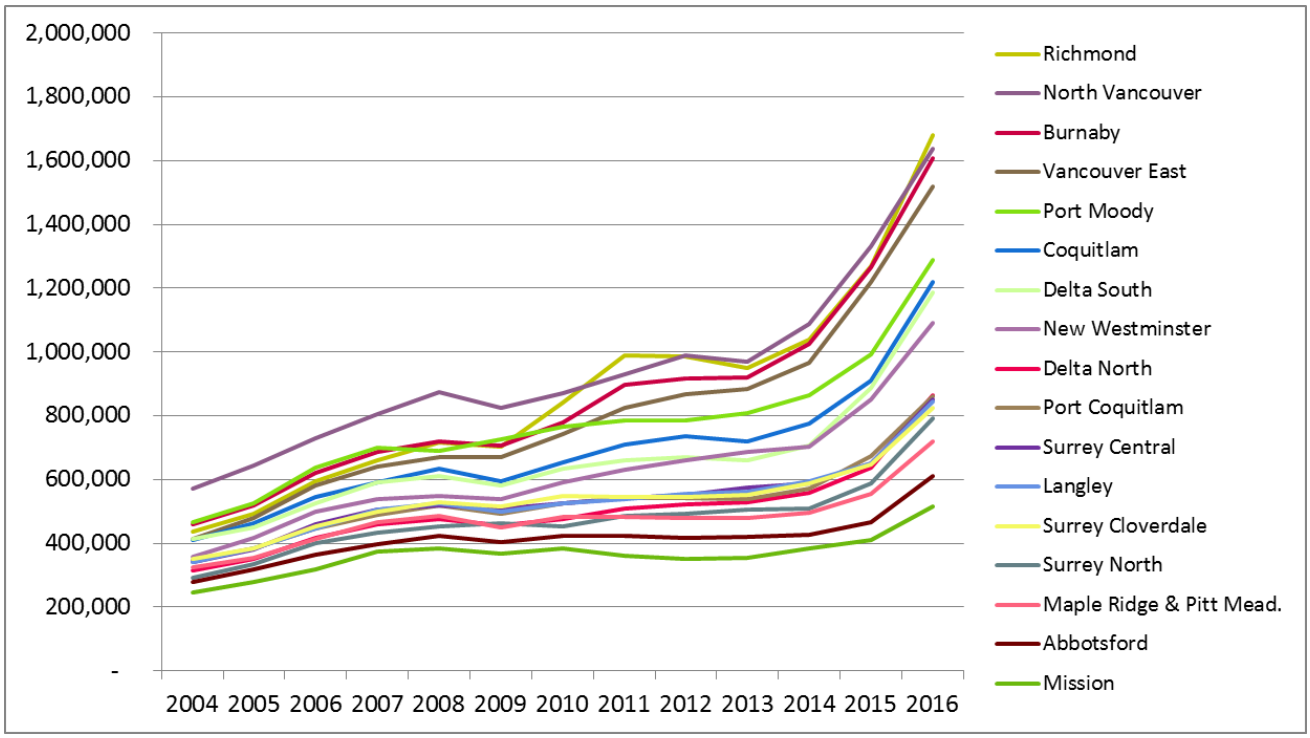
[10] White Rock was not part of the original annual data package sent over from the FVREB to the author; this municipality will be included in the analysis in the next subsection based on quarterly prices.

[11] Metro Vancouver government portal http://www.metrovancouver.org/about/Pages/default.aspx

This trend of prices lowering with distance from the city of Vancouver is consistent with the expectations from the existing literature on the ripple effect and housing market trends in general that identify commuting distance as a major price factor within a metropolitan housing market. For buyers must make trade-offs by either pursuing lower housing prices or paying more and being closer to the central business district with its economic activity and amenities.

In order to make the non-central area trends clearer visually, Figure 4.5 is provided with the West Side and West Vancouver removed from the graph. It becomes more evident now that non-central, or peripheral, municipalities cluster around different price segments as mentioned in relation to the regional maps above. Although the clusters are not completely consistent throughout the decade, they become more prominent especially in the last few years.

Figure 4.5. Annual Nominal Median Selling Price, 2004-2016 (select municipalities)

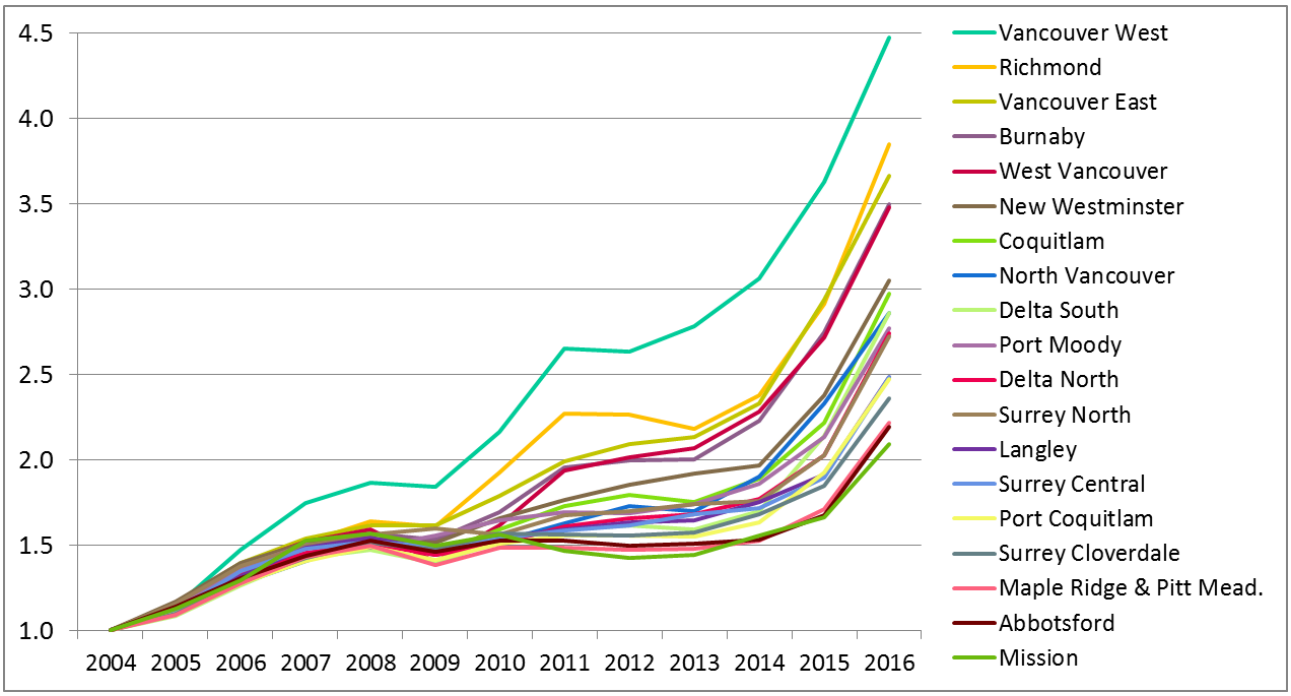


Source: REBGV and FVREB reports.

Further insight can be gained when inspecting the price index trends across Metro Vancouver Figure 4.6 shows that the most expensive areas (Vancouver West & West Vancouver) have been growing faster relative to most of the other areas, with Vancouver West being an unchallenged growth leader followed by Richmond, Vancouver East, Burnaby and West Vancouver (in order of the index value in 2016). All of these regions could potentially constitute 'growth centers', with the core being Vancouver West (the western part of the City of Vancouver).

Henceforth, Vancouver West will be regarded as the center of the ripple effect, with attention to West Vancouver as well given its nominal price dynamics similar to that on the West Side. Like Liao et al (2015) and Roehner (1999) in the Singapore and Paris case studies, we assume that the highest-priced regions with the most prominent role of foreign capital and profit-driven market behavior are the centers of price growth and volatility, as well as the ripple effect.

Figure 4.6. Nominal Price Index by Municipality, 2004-2016 (base year = 2004)



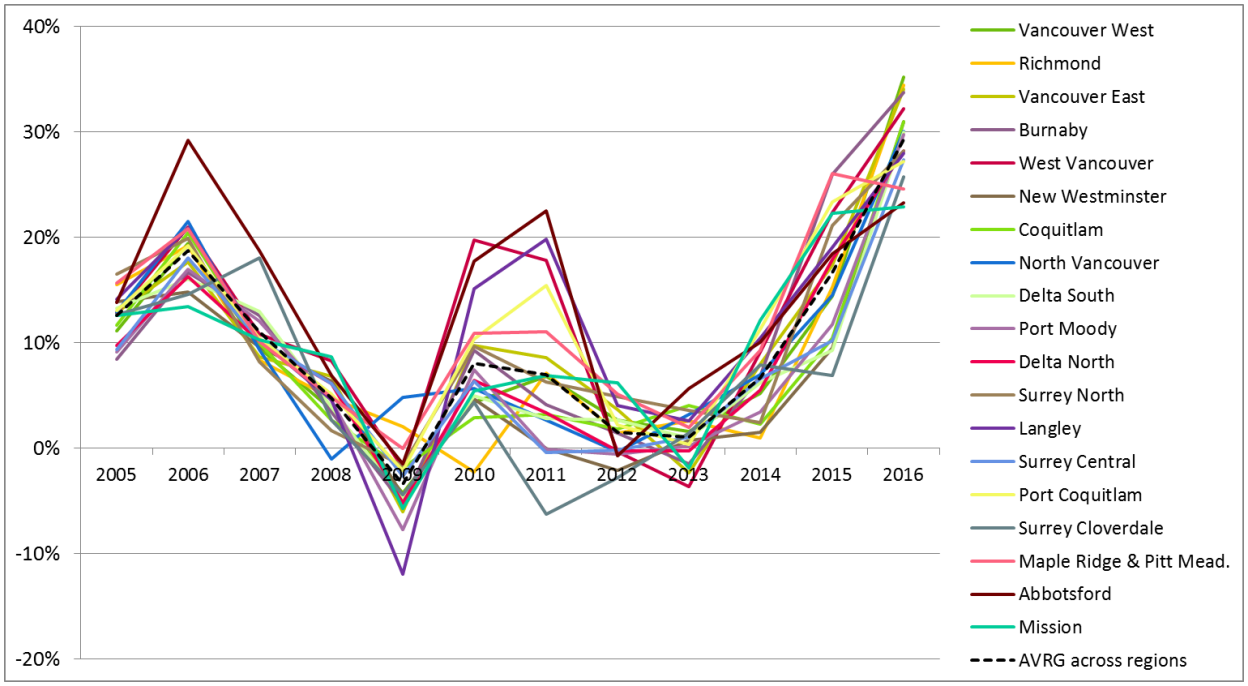
Source: author's calculations based on REBGV and FVREB monthly reports' data.

In relation to the ripple effect, speculative demand factors are essential in driving the rippling out of housing prices from a price shock in the central area as they directly relate to the origin of the ripple effect, such as a national or global economic crisis or a new policy on foreign investment providing a shock that would diffuse across the metropolitan area through the migration, equity transfer and spatial arbitrage mechanisms (as discussed in subsection 2.4.2). The share of speculative demand in the housing market of a given municipality can also affect "reaction speeds", the fourth diffusion factor, as investors enjoy higher liquidity and lower attachment to the property, thus changing their housing market behavior faster than local home buyers and existing home owners. These motivations account for different reaction speeds discussed in Chapter 2 and would apply to Vancouver as well.

According to the recent transaction data for Metro Vancouver (BC Ministry of Finance Property Transfer Tax Data 2016, 2017[12]), Richmond and Burnaby exhibit high shares of transactions with foreign buyers, taking first and second highest share of foreign purchases respectively, however, we are still not viewing them as centers because neither are the center of economic activity as much as the City of Vancouver. Therefore, these two regions are not regarded as primary centers just based on the foreign buyers' activity in the region since they do not fulfill the other inclusion criteria.

Now we look specifically at price changes, to get a snapshot of how a ripple effect might play out using annual data first (Figure 4.7)[13]. One of the first things to notice is the significant difference in price volatility by region. Volatility varies significantly even though the regions mostly follow the major trend with some areas subject to much higher volatility than others (West Vancouver, Vancouver West, and Richmond). The highest volatility can be seen in these regions in 2008-2010 with plummeting price changes in 2008-2009, yet a fast recovery and acceleration in 2010-2011. In the last two years (since 2014), though, there appears to be more convergence around the fast price growth trend with smaller variations in volatility especially in 2016 with the range of price growth across the entire Metro Vancouver within a 23%-33 range (a strikingly high number too).

Figure 4.7. Annual Changes in Median Selling Prices by Municipality, 2004-2016



Source: author's calculations based on REBGV and FVREB monthly reports' data.

[12] BC Government Portal – Ministry of Finance – Property Transfer Tax Data for 2016 and 2017 https://catalogue.data.gov.bc.ca/dataset/property-transfer-tax-data-2016 & https://catalogue.data.gov.bc.ca/dataset/property-transfer-tax-data-2017

[13] Annual price changes are calculated as year-on-year change in per cent format (% of the previous year's price).

While the lower-priced regions took off in 2015, the higher-priced regions, namely Vancouver East, North Vancouver, and Burnaby, slowed in growth in 2016. The major factor behind this slowdown is most likely the foreign buyers' tax introduced by the BC government in July 2016 (Ferreras, 2017). The graph (Figure 4.7) illustrates preliminary evidence on the delays of reaction in peripheral regions (e.g. Mission, Langley, Surrey regions) that are most vivid during the 2015-2016 take off in these areas compared to a noticeable *slowdown* in 2016 (but not yet a decrease) in the central regions and their neighbors, specifically in Vancouver East, Burnaby and North Vancouver. A delay in price take off is detectable for the regions further away from the center (Mission, Abbotsford, Surrey Center, Maple Ridge) that did not show a clear upward trend until 2014-2015 whereas other regions, such as the City of Vancouver (both East and West side), Richmond, North Vancouver, Burnaby, have been evidently growing at an *accelerating pace*[14] since 2012-2013.

And despite the aforementioned new 2016 foreign buyers' tax and the slowdown beginning in the central areas and their neighbors, the prices in some of the non-central regions are recently soaring faster than at any other point in the last decade (e.g. Surrey regions, Abbotsford, Maple Ridge and Pitt Meadows) with the annual price change in 2016 reaching its peak during the study period. Interestingly, Richmond has not yet displayed signs of a slowdown by the end of 2016, contrary to expectation that a region with a higher share of foreign purchases would be more affected by the foreign buyers' tax as well (Hager, 2017). This is one of the first cases when looking at a more fine-grained scale with quarterly data can give us a more informative picture of the response to external shocks that might be (and in this case are) obscured by the longer-term annual data.

Time lags in the ripple effect are not observed as much in the 2008-2009 GFC-related price changes based on the annual data and that is true for most of the municipalities in the sample. As the crisis occurred globally on a much larger scale than a shock generated for example by the foreign buyers' tax, the annual data would not attest to the difference in potentially existing time lags that could be observed on a quarterly or even monthly level. Furthermore, the GFC was not only an investment shock for non-local buyers, registered in their changing market behavior, but its overwhelming impact on the economies around the world meant that not only would investment asset decisions be affected, but market fundamentals throughout the regions would have changed as well. It was not just the central areas that were affected directly, but the entire Metro Vancouver since residents in all municipalities might have experienced job loss or at least deteriorating job security and housing stress with the rising

[14] Note that interpretations of the price change graph are not the same as the nominal price trend. A positive slope indicates acceleration whereas a negative indicates a slowdown, but not decline until the value drops below zero.

debt burden (Walks, 2013), all of which consequently affect housing market behavior both from the ripple effect *and* directly from the GFC.

Looking more specifically at the change in growth indicators in the last two years (Table 4.1), we observe *slowing growth* in the regions further away from the center (two in the Fraser Valley, plus Langley, Surrey, and Maple Ridge) in 2014-2015 (the correlation between driving distance to downtown and growth change is -0.63 for 2014-15). In the next year, however, they catch up and outstrip the central regions with growth acceleration in 2015-2016. As opposed to non-central municipalities' acceleration, there is a clear slowdown in the growth centers, especially in Burnaby and Vancouver East (the correlation with distance from the center is 0.76, with a changed sign, for 2015-16). This is one of the potential indications of a ripple effect as the prices in the periphery catch up with the center in later periods with a time lag.

Table 4.1. Price Growth Acceleration and Slowdown in 2014-2016[15]

Municipality	Growth change 2014-15	Growth change 2015-16	Driving distance (km)	Note
Langley	3%	21%	53	
Abbotsford	8%	21%	76	FV
Surrey Central	8%	21%	43	
Delta North	9%	21%	32	
Mission	-1%	19%	78	FV
Surrey North	14%	19%	30	
Maple Ridge & Pitt Mead.	8%	18%	44	
Surrey Cloverdale	4%	17%	37	
Coquitlam	9%	17%	31	
Port Coquitlam	12%	10%	33	
Richmond	13%	10%	17	Center 2[16]
West Vancouver	9%	9%	13	Center 1
Delta South	19%	8%	20	
New Westminster	19%	7%	26	
Vancouver West	8%	5%	7	Center 1
Burnaby	12%	4%	14	Center 2
North Vancouver	10%	1%	14	Center 2
Vancouver East	17%	-2%	8	Center 2
REGIONAL AVERAGE	**10%**	**13%**		**–**

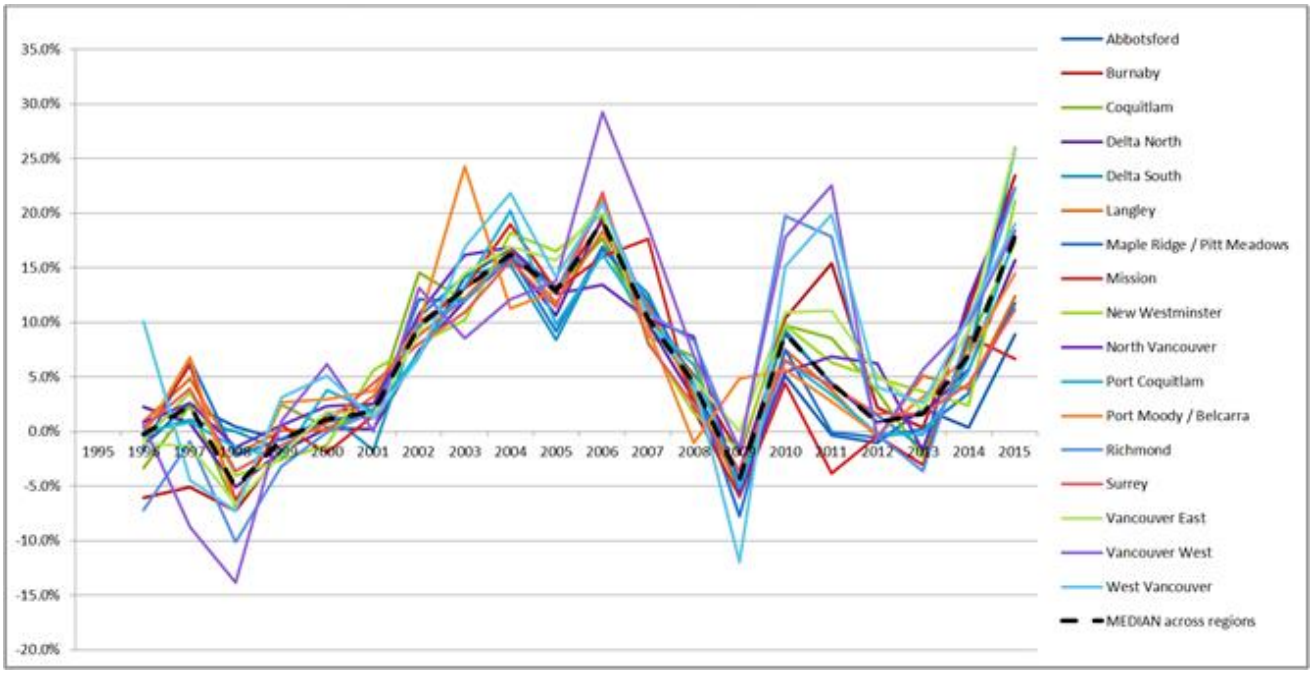
Source: author's calculations based on REBGV and FVREB monthly reports' data.

[15] 1) Sorted by 2015-16 growth change; 2) Interpreting the speed of changes are not the same as the nominal price trend. The indicator is calculated as 2015 growth rate minus 2014 growth rate for the 1st column, and 2016 minus 2015 growth rate for the 2nd column. A *negative* value indicates *growth slowdown* (not decline), a *positive* value indicates *acceleration*.

[16] 'Center 2' refers to the 2nd tier of highest-priced regions that are also neighboring to the identified 'central' regions, Vancouver West and West Vancouver

Figure 4.8 expands the time span of price dynamics under investigation to begin in 1996, displaying price changes for detached houses over the last two decades. Even though the figure encompasses a larger time period and could potentially provide more information, the graph can only be used with caution as the original data used to produce it are not as consistent. In this figure, price changes for seven municipalities reported by the FVREB (Abbotsford, Langley, Mission, Surrey regions, White Rock) are based on average selling price change as the median selling prices are not available before 2004. For the rest of the municipalities (REBGV) median selling prices are used. This inconsistency can be overlooked for this one graph, but it is not acceptable for conducting the subsequent analysis, so we will go back to median prices over a shorter time period. This graph is provided additionally to give a general idea about the longer historical trends while the rest of the figures in this chapter only span the period of 2005-2016(17).

Figure 4.8. Annual Changes in Selling Prices by Municipality, 1996-2015



Source: author's calculations based on REBGV and FVREB monthly reports' data.

High market volatility overall is evident from the graph, with annual changes ranging from below -10% to over +20% around peak years. Year-on-year changes of over 10% is illustrative of a volatile market exposed to external dynamics. The observed trend changes are closely tied to the global macroeconomic trends: the Asian crisis in 1997 led to two years of significant correction in Vancouver West in particular, as foreign capital was being re-patriated to buttress home needs (Ley, 2010), while it was West Vancouver that experienced the sharpest slowdown around the GFC in 2007-2008. The peak price increases of over 20% were registered in 2003-04, 2006, 2011 and 2015; notably, Vancouver

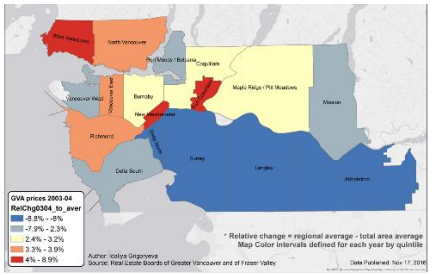
West had the highest positive price change at two of these four peaks, suggesting the role of international dynamics through this most globally connected of Vancouver's submarkets.

Figure 4.9 presents the original maps of Metro Vancouver area with annual relative price changes tracing the pre-crisis (GFC) price growth in the central areas with consequent slowdown and the ripple effect of the negative price shock by the GFC throughout the Greater Vancouver Area with the periphery still experiencing slower price growth in 2014-2015, while the center has already begun a new growth cycle. The maps indicate, albeit with local noise, a multi-year cyclical change in spatial price diffusion: price gains are initiated in the west, transmitted to the east, and as they fade there a new round begins in the west.

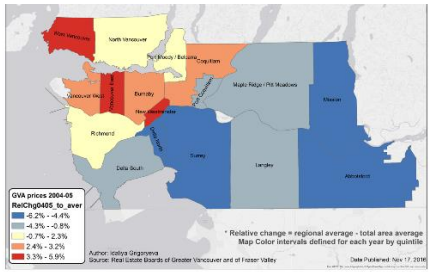
Figure 4.9. Annual Price Changes *Relative* to Regional Average, 2002-2015

Blue colors indicate change below regional average in a given year, red and orange – above average; yellow – around the average. Color category range automatically assigned in ArcGIS using quintile method.

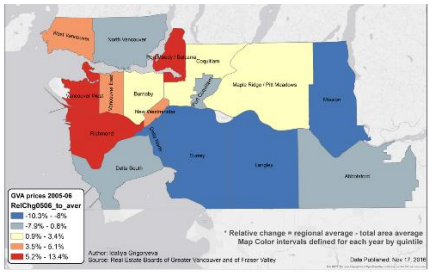
2002-2003



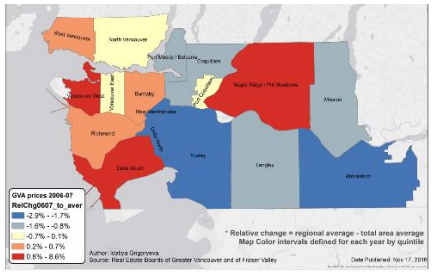
2003-2004



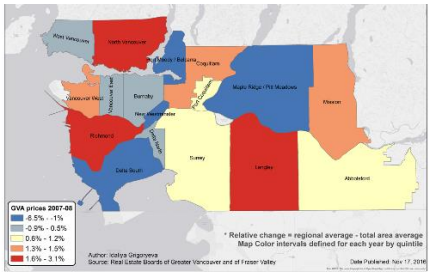
2004-2005



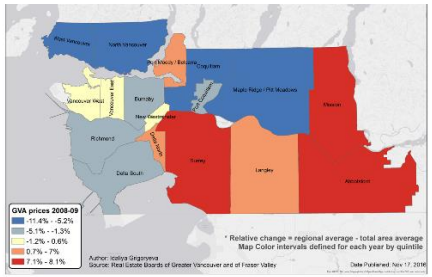
2005-2006



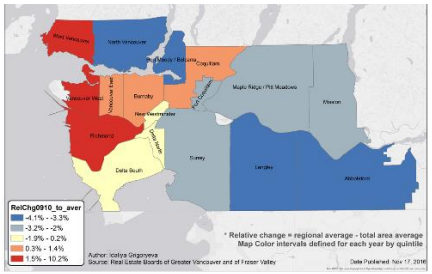
2007-2008



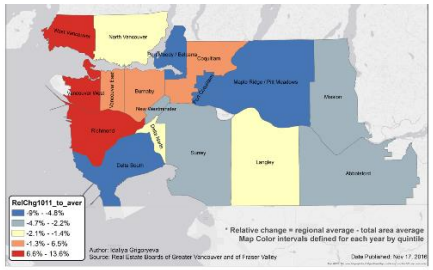
2008-2009



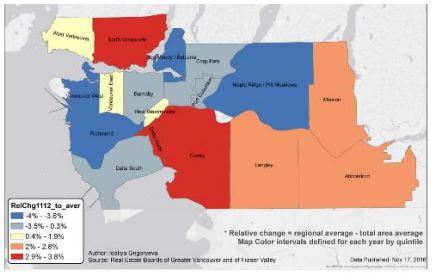
2009-2010



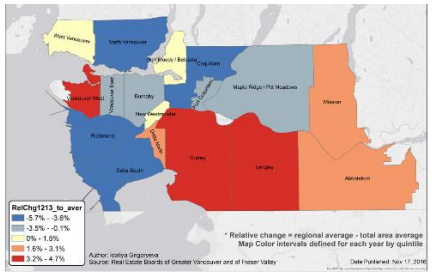
2010-2011



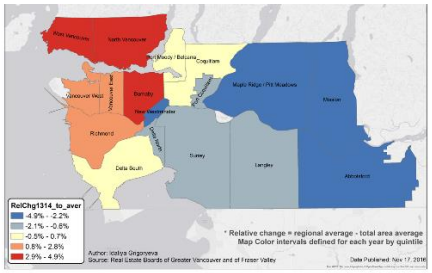
2011-2012



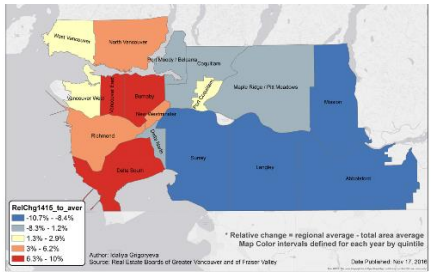
2012-2013



2013-2014



2014-2015



Sources: original maps designed in ArcGIS based on REBGV and FVREB data.

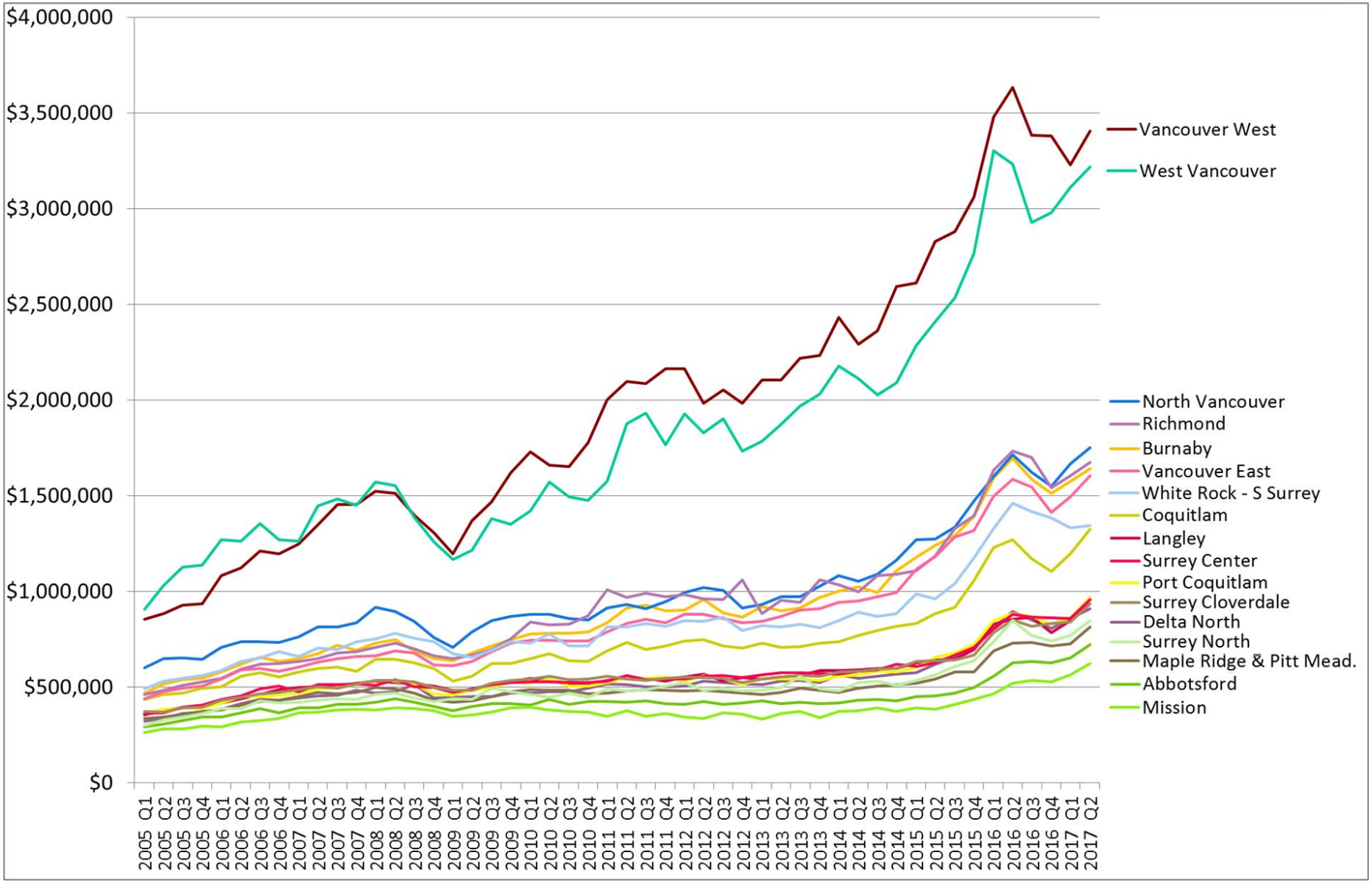
4.2.2 Quarterly Price Trends

Continuing the analysis with the quarterly prices provides further insight into the spatio-temporal impact of external shocks and subsequent price diffusion, for example with the 2016 foreign buyers' tax leading to a slowdown and temporary price decline in some areas with eventual rebounding of housing prices in the spring of 2017 (McFarland, 2017). The quarterly prices were calculated based on the monthly median sales prices reported in the REBGV and FVREB statistical summaries, with the quarterly price defined as the average price over the three months weighted by the number of sales to correct for outliers. Quarters correspond to consecutive three-month periods with the first one starting in January.

As we move to quarterly price analysis, the sample is reduced to 17 municipalities since the other four did not pass the threshold of a minimum ten monthly sales necessary to generate a more consistent and representative median selling price. As a result, Delta South, Port Moody, and New Westminster were excluded from the sample and all the municipalities included can be seen on the following graph (Figure 4.10). It displays the detached single-family home (SFH) price trends across the region from the beginning of 2005 to the 2nd quarter of 2017, which is the most recent data available as of this writing. This provides a total of 49 observations for each of the 17 municipalities. This is the dataset that will be eventually used to run the ensuing volatility, break-point and cross-correlation analysis, as well as regression models.

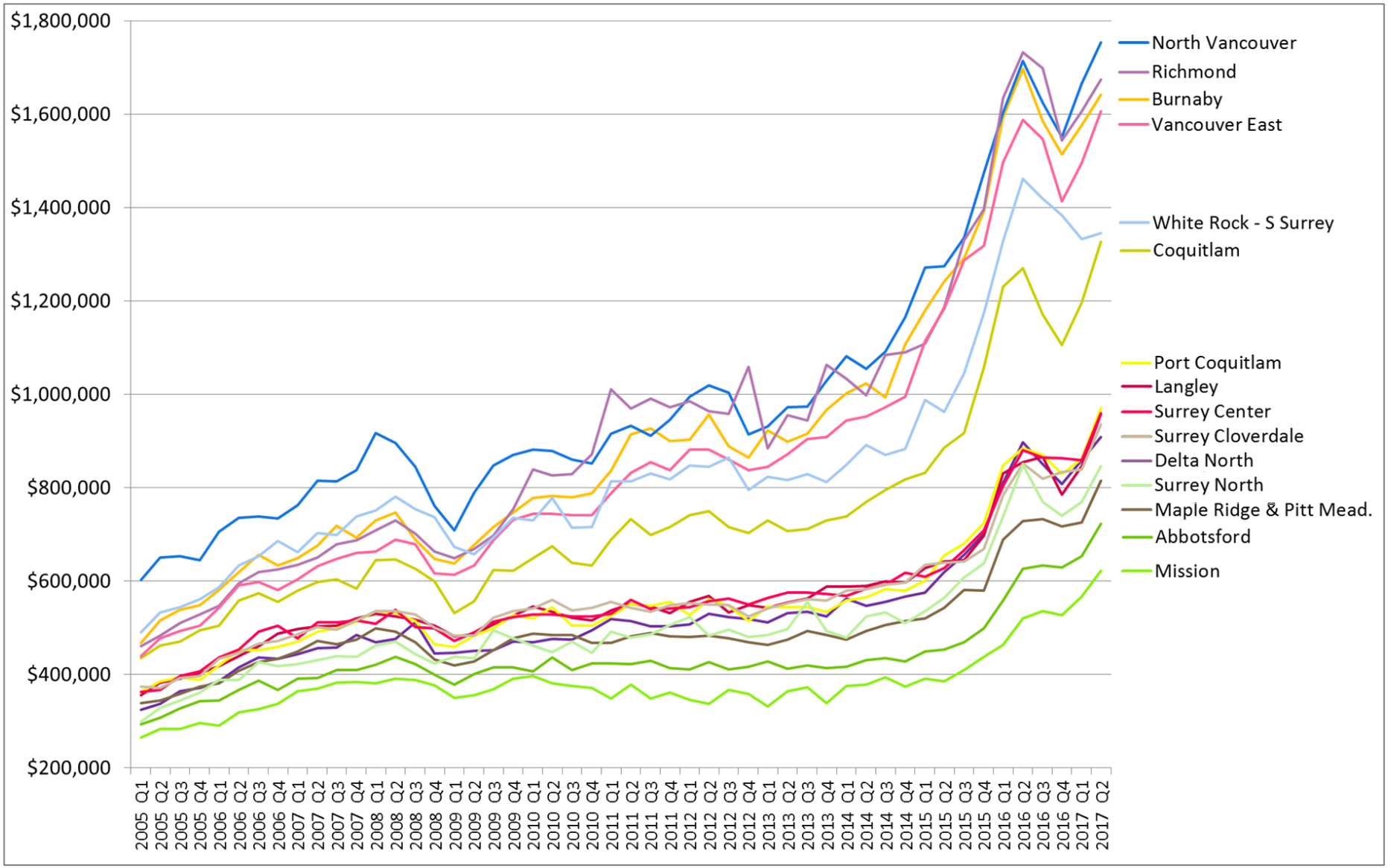
In comparison to annual price graphs, more fluctuations can be observed at the quarterly level (Figure 4.10). Overall, most municipalities are displaying a clear upward trend during the period of study (since 2005), with most striking growth in the central areas. On the periphery, it can be seen that not all regions have grown as dramatically, especially the lowest-priced ones. As for the dynamics in the non-central areas, Figure 4.11 enables us to better see the price trends as Vancouver West and West Vancouver are excluded from the graph. The upwards trend is less prominent among the Surrey regions and other areas further away from the City of Vancouver, such as Maple Ridge, Langley, Delta North, and as for the Fraser Valley regions (Mission and Abbotsford). This group did not start consistently rising in price until late 2014.

Figure 4.10. Quarterly Median Sales Prices for SFH in Metro Vancouver, Q1 2005 – Q2 2017



Source: author's calculations based on REBGV and FVREB monthly reports' data.

Figure 4.11. Quarterly Median Sales Prices for SFH in Metro Vancouver, 'Non-Central' Areas

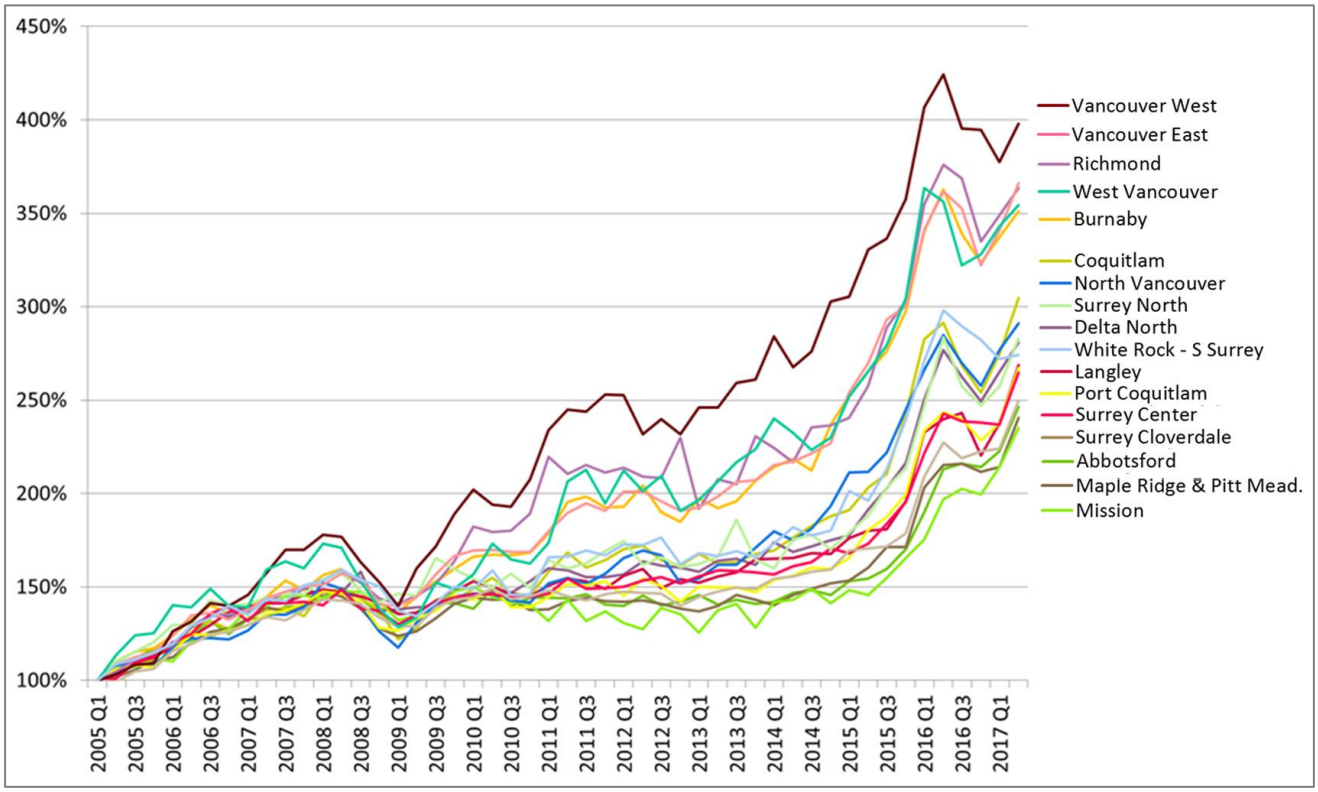


Source: author's calculations based on REBGV and FVREB monthly reports' data.

The reaction to the foreign buyers' tax introduced in July-August 2016 (Q3) can now also be analyzed in more detail. We observe more significant decline and slower recovery in the central regions (Vancouver West and West Vancouver) that have not yet recovered their 2016 Q2 peak. and 2nd tier higher priced regions (Burnaby, Richmond, North Vancouver, Vancouver East, Coquitlam) that are just reaching or just slightly surpassing the pre-tax peak in 2017 Q2.

While the central areas and their immediate neighbors unveil a rather consistent trend of rapid decline and rapid recovery, the trends among peripheral areas are more diverse. Some areas do mimic the central trends, for example, Langley, Delta North and Surrey North whereas other regions barely took a hit flattening out for a few quarters and then significantly surpassing the pre-tax peak in the first quarters of 2017 (Surrey Center and Cloverdale, Maple Ridge, Mission and Abbotsford, and to an extent Port Coquitlam). It is worth noting that among the aforementioned municipalities, Abbotsford and Mission are the only areas where the tax does not apply, yet they exhibit a trend remarkably similar to areas like Maple Ridge and Surrey Center.

Figure 4.12. Median Price Index by Municipality, 2005 Q1 – 2017 Q2



Source: author's calculations based on REBGV and FVREB monthly reports' data.

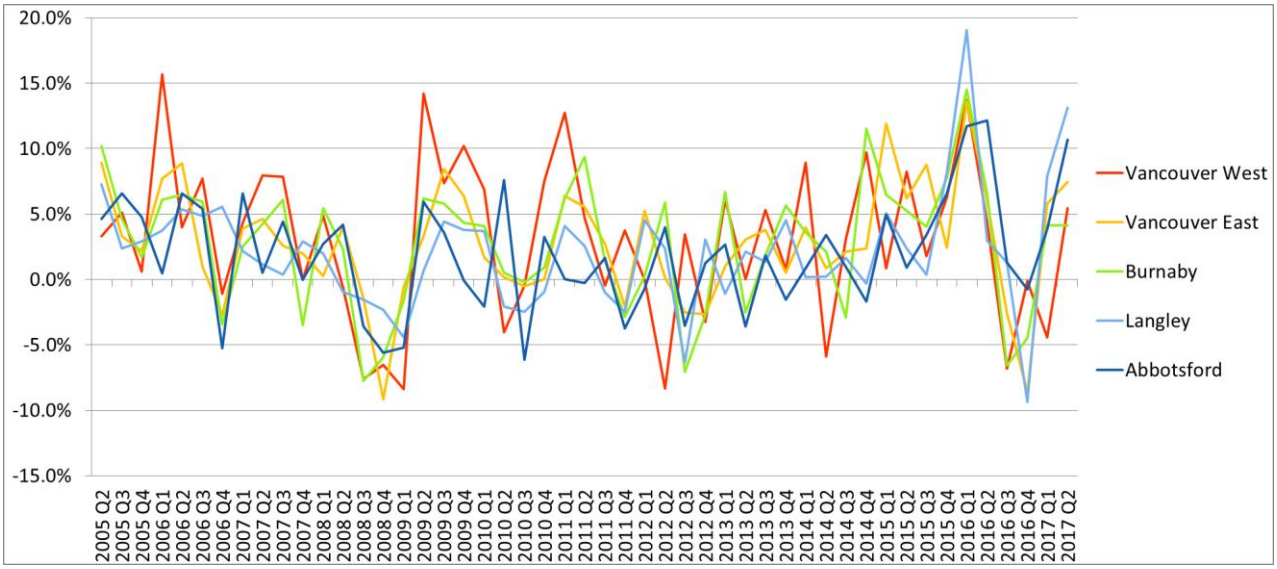
The case for regional divergence, notably after the 2008-09 correction, is further supported by the price index data (Figure 4.12), calculated from the quarterly median selling prices and taking 2005 Q1 price as the baseline. The prices in the most expensive areas (Burnaby, Richmond, Vancouver East,

West Vancouver, and especially Vancouver West) have increased significantly more (by 350-400 percent) than in the rest of Metro Vancouver. Therefore, even in relative terms there is more inequality in housing prices now than 10-12 years ago. Still, it is quite striking that every single municipality more than doubled in price since 2005, which is definitely indicative of a hot housing market with high liquidity and a potential bubble-like house price trends decoupled from the local economy that did not display much growth (see Chapter 3).

4.2.3 Quarterly Price Changes by Municipality

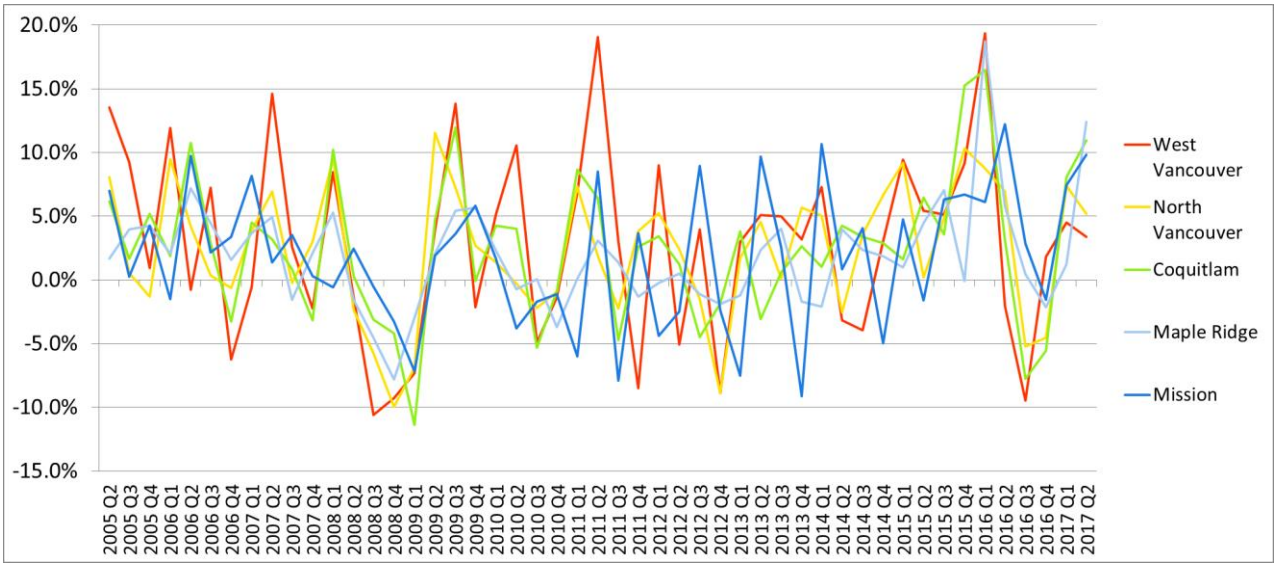
The following figures present data on quarterly price changes in select municipalities to demonstrate how external shocks can ripple through the metropolitan area. The graphs (Figure 4.13 and Figure 4.14) demonstrate directional change with rainbow colors changing as the distance from the center increases. Figure 4.13 features the price changes from Vancouver West to Abbotsford through the East Side, Burnaby and Langley, while Figure 4.14 highlights the price change patterns in a similar eastward direction, but from West Vancouver to Mission through North Vancouver, Coquitlam and Maple Ridge. The color theme is selected to enable a better visualization of change patterns as rainbow sequence denotes spatial progression of municipalities from West to East.

Figure 4.13. Quarterly Price Changes in Vancouver West to Abbotsford



Source: author's calculations based on REBGV and FVREB monthly reports' data.

Figure 4.14. Quarterly Price Changes in West Vancouver to Mission



Source: author's calculations based on REBGV and FVREB monthly reports' data.

Both the 2008-09 GFC and 2016 the tax implementation were negative shocks to the market and we can analyze the price peaks and troughs associated with them. The graphs (Figure 4.13 and Figure 4.14) provide a generic demonstration of how external shocks can affect local price changes. In Figure 4.14, it is noticeable that the first regions to reach the bottom during the 2007-2008 crisis were West Vancouver, North Vancouver and Maple Ridge in the same quarter and then Coquitlam and Mission in the next one, which, even though not perfectly aligned in space, still indicates diffusion from West Vancouver eastward. Interestingly, the trend is not as evident in Figure 4.13 as Vancouver West exhibited significant price declines over consecutive quarters, and we only see a spatial trend partially. Vancouver East plummeted in the quarter following the first significant decline in Vancouver West and it recovered later too. Similarly, Langley bottomed out later than other municipalities, even though it is closer to the city than Abbotsford.

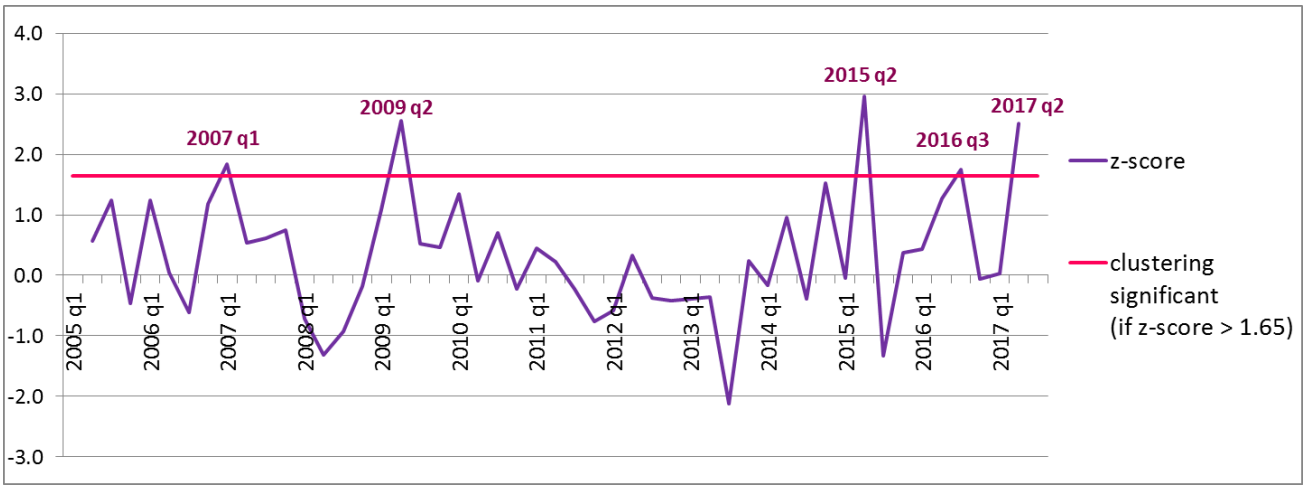
As for the 2016 tax effects on the market, the spatial trend is again more evident on the second graph (Figure 4.14) with Mission and Maple Ridge bottoming out two quarters later than the other municipalities even though the pre-tax peak had occurred during the same quarter for all but Mission on the graph. At the same time, Figure 4.13 presents a delayed trough in price changes in both Langley and Abbotsford with the peak occurring in the same quarter in all included regions except for Abbotsford. Note, too, in Figure 4.13, how in the 2016-17 peak and trough, the most distant municipalities are the ones that express the greatest volatility, unlike earlier cycles, where the greatest volatility is in the central districts.

Besides visually analyzing the sub-sampled graphs, we can also look at spatial autocorrelation of price changes on the full sample. In this case, it is not specifically responses to external shocks that

are being investigated, but the general patterns over time and space with an attempt to identify whether regions with similar price change values cluster in certain periods or whether the price change distribution is largely random. To test the presence of spatial autocorrelation and clustering, we use Moran's I test in ArcGIS that indicates whether there is statistically significant clustering together in space of areas with similar values of a given indicator at a set time period.

The test estimates a Z-score which is then compared to the normal distribution. A Z-score higher than 1.65 means that there is significant spatial clustering in the sample, or that the null hypothesis implying random spatial distribution can be rejected at the confidence level of 10% (pv < 0.1). More information on the report interpretation generated by ArcGIS along with an example can be found in Appendix D . The test was run for each quarter from 2005 Q1 to 2017 Q2 on the sample of 17 municipalities and the results are reported in Figure 4.15. For convenience, the threshold significance value (1.65) is added and quarters that exhibit clustering are pointed out on the graph.

Figure 4.15. Moran's I Test Results – Z-score Distribution by Quarter



Source: author's original layout of ArcGIS Spatial Autocorrelation test results.

In general no permanent autocorrelation is evident that would be consistent across all time periods. That is understandable given that price changes are determined by a variety of factors and we do not expect them to be autocorrelated uniformly throughout the last decade. Another limitation concerns the sample size as Moran's test is recommended for a minimum sample of 30 spatial units, and we apply it on 17 municipalities only. Nevertheless, 5 periods from the sample did prove to be significantly autocorrelated in space and four of them are displayed on the maps below (Figure 4.16). Interestingly, the quarters with significant clustering mostly occur around the time of the same two external shocks to the market described earlier. The periods of 2007 Q1 and 2009 Q2 relate to the price

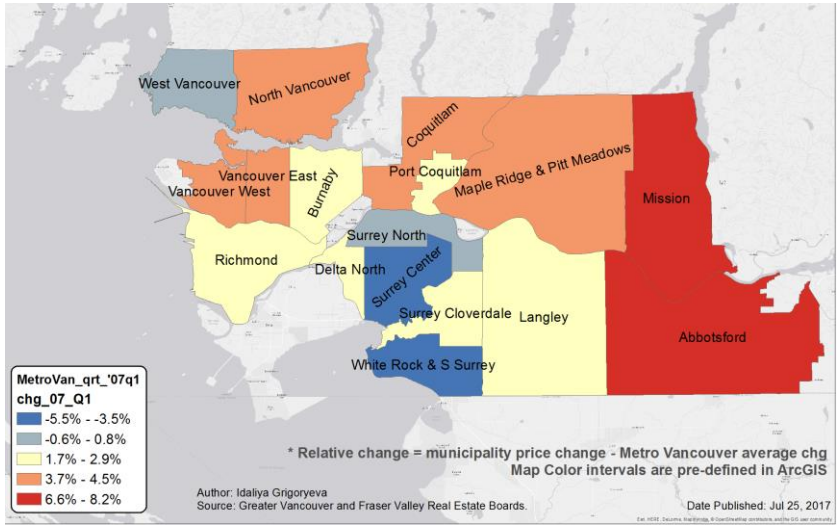
dynamics during the GFC while the spatial distribution of price changes in 2016 Q3 and 2017 Q2 is connected with the immediate aftermath of the 2016 tax.

Following the GFC, the central municipality of Vancouver West was the fastest growing in price along with North Vancouver followed by a few neighboring regions. It is consistent with the expectation that while the center declines most during a major economic crisis, it is also the first one to recover (e.g. consistent with the findings in Liao et al 2015 for Singapore). The two most recent periods with spatial clustering, 2016 Q3 and 2017 Q2 demonstrate a more significant decline and slower growth in the center and neighboring areas in the two quarters while the peripheral areas of Maple Ridge, Langley, Mission and Abbotsford were barely affected in 2016 Q3 and manifested remarkable price increases in 2017 Q2 with this period marking one of the highest quarterly price increases in the 'red' and 'orange' municipalities in the past decade. Even the post-GFC price increases that were occurring from a lower base after a longer macroeconomic downturn were not as high in the peripheral municipalities.

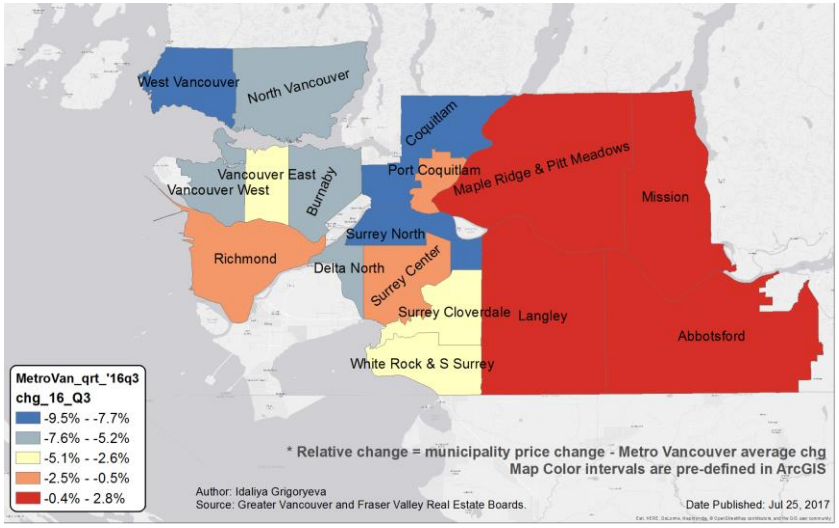
Figure 4.16. Maps with Regional Clustering in Price Changes

During the GFC (2007-2009)	Post –foreign-buyers tax (2016-2017)

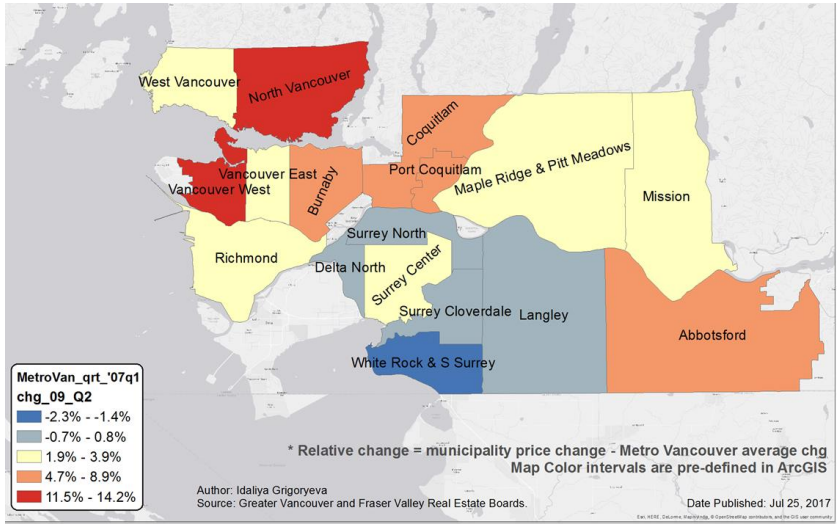
2007 Q1



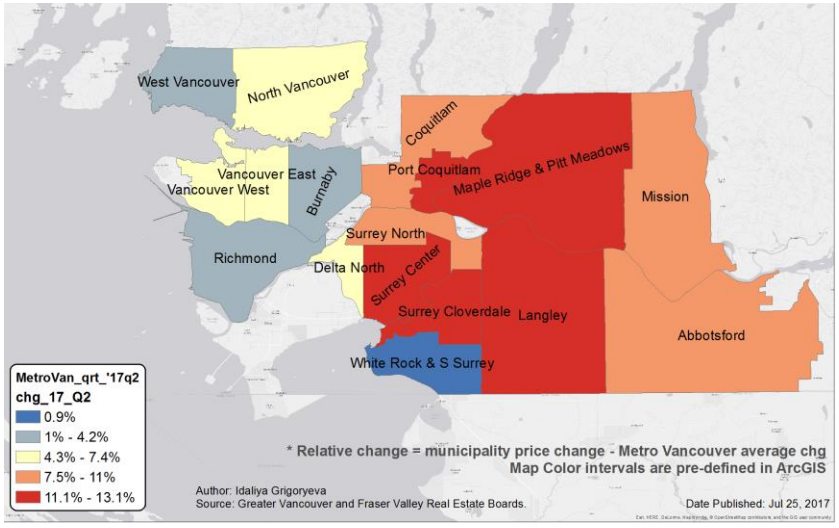
2016 Q3



2009 Q2



2017 Q2



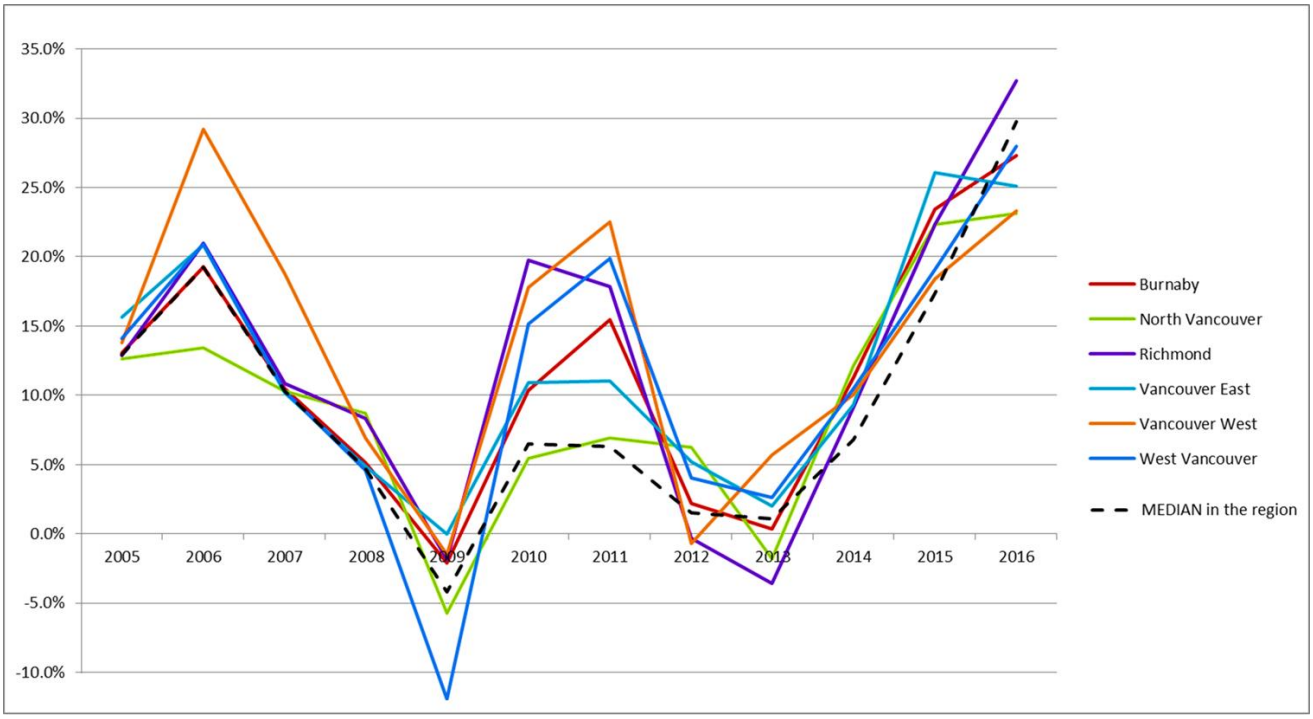
Sources: author's original maps.

4.3 Price Volatility Analysis

4.3.1 Annual Price Volatility

Having identified important patterns around the periods of external shocks to the market, the following subsections will engage with the spatial distribution of price volatility across Metro Vancouver. Volatility in median prices varies significantly by municipality, which can be observed comparatively for Figure 4.17 and Figure 4.18. The central regions typically experience significantly higher price fluctuations, of over 20-25% during this period, compared to the median change in the region (Figure 4.17), with the highest volatility in Vancouver West and West Vancouver (the two primary centers), and in Richmond, a municipality affected by foreign investment shocks due to a higher share of foreign residential buyers (Hager, 2017; Ley et al., 2002). High volatility in Richmond, even though it is not a primary center of economic activity, testified to the strong connection of the local market to the Asian markets in general and the Chinese economy specifically, as this is where most of the money (Ley, 2010) and residents (Statistics Canada 2016) are coming from.

Figure 4.17. Annual Prices Changes in 'High Volatility' Regions

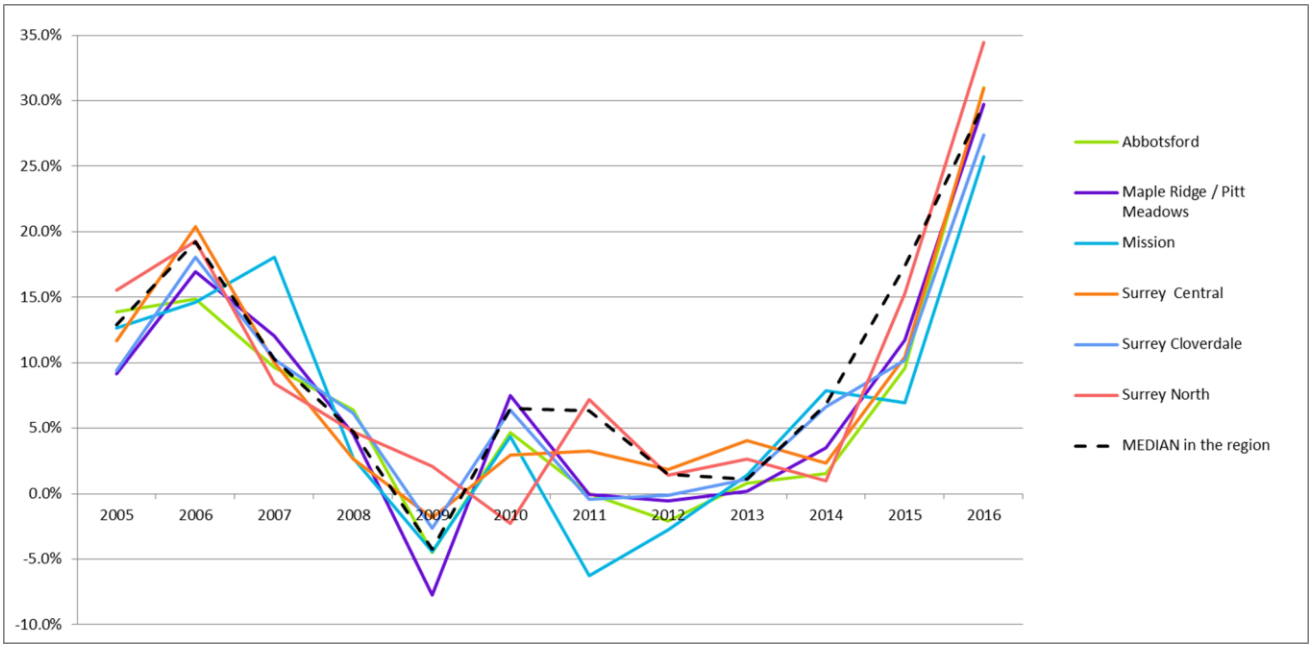


Source: REBGV and FVREB reports, author's calculations.

Conversely, the volatility in cheaper regions further away from the center is lower with the municipal housing markets being affected by the price shocks, but not to the same extent as the central areas (Figure 4.17). Price changes much closer to the regional median are observed in Abbotsford,

Mission, Maple Ridge, and the Surrey municipalities. A startling exception to the subdued 'echo effect' is the boom of 2015-16, where some low volatility municipalities had price growth of 30%.

Figure 4.18. Annual Prices Changes in 'Low Volatility' Regions



Source: REBGV and FVREB reports, author's calculations.

Next, we apply volatility indicators typically used in financial analysis to the absolute median home prices by municipality in order to quantify the observed regional differences. Table 4.2 provides evidence to confirm the trend in the graphs, i.e. highest-priced regions also being the most volatile ones (10% above average). The Table clearly shows that both 1st and 2nd tier centers are at the top of the list. At the same time, Fraser Valley municipalities farthest from the city normally have a much lower volatility, well below the GVA average.

The spatial pattern of price volatility is significant for evaluating the presence of the ripple effect since lower volatility in the peripheral regions hints at the smoothing-out of the ripple effect the further from the city center a municipality is. This assumption is consistent, for instance, with the findings of the ripple effect studies on Singapore and Finland (Liao et al., 2015; Oikarinen, 2004). The data have not yet proven or disproven the existence of a ripple effect directly, but they signify that if the ripple effect exists, the price shocks decline in their impact on the periphery with the distance from the center. The shocks could still be transmitted, but they do not affect the periphery to the same extent as the center, which is consistent with ripple effect interpretations in the academic literature and with common sense. Such a spatial trend in volatility can be and typically is an accompanying condition in the presence of the ripple effect.

Table 4.2. Regional Volatility in Annual Prices, 2005-2016

Municipality	Volatility (CV)[17], 2005-2016	Note[18]
Vancouver West	43%	Center 1
Richmond	39%	Center 2
Burnaby	37%	Center 2
West Vancouver	37%	Center 1
Vancouver East	37%	Center 2
Delta South	30%	
Coquitlam	30%	
North Vancouver	30%	Center 2
New Westminster	30%	
Port Moody / Belcarra	27%	
Delta North	27%	
Surrey North	25%	
Port Coquitlam	24%	
Surrey Central	23%	
Langley	23%	
Surrey Cloverdale	22%	
Maple Ridge & Pitt Meadows	20%	
Abbotsford	19%	FV
Mission	18%	FV
REGIONAL AVERAGE	**28%**	**All**

Source: REBGV and FVREB reports, author's calculations.

4.3.2 Quarterly Price Volatility

Volatility patterns are further analyzed using quarterly data to see if the pattern for annual prices is consistent at a different level of aggregation. We now introduce a more exact measure of distance to the 'central areas' by estimating the driving distance in km and public transit travel time in minutes from the region to the center. It is specifically measured as the distance from an approximate geographic center[19] of each municipality to the center of downtown Vancouver. Both distance measures are calculated using Google Maps' estimates of the best driving route and shortest public transit commute

[17] Volatility is measure by the Coefficient of Variation (CV). CV is calculated as sample standard deviation divided by the sample mean; CV is used as a measure of volatility

[18] FV = municipality designated to the Fraser Valley; Center 1 indicates one of the two primary growth centers; Center 2 indicates 2nd tier regions by the price band (in comments to the Figure 4.11).

[19] Exceptions of absolute geographic center are made for North Shore areas that are only partially populated with natural parks and mountains covering a substantial portion of each region (Maple Ridge, Mission, North Vancouver, and West Vancouver). For these, the center is approximated to the center of the populated area, which would be more representative of commuting patterns and general transit accessibility.

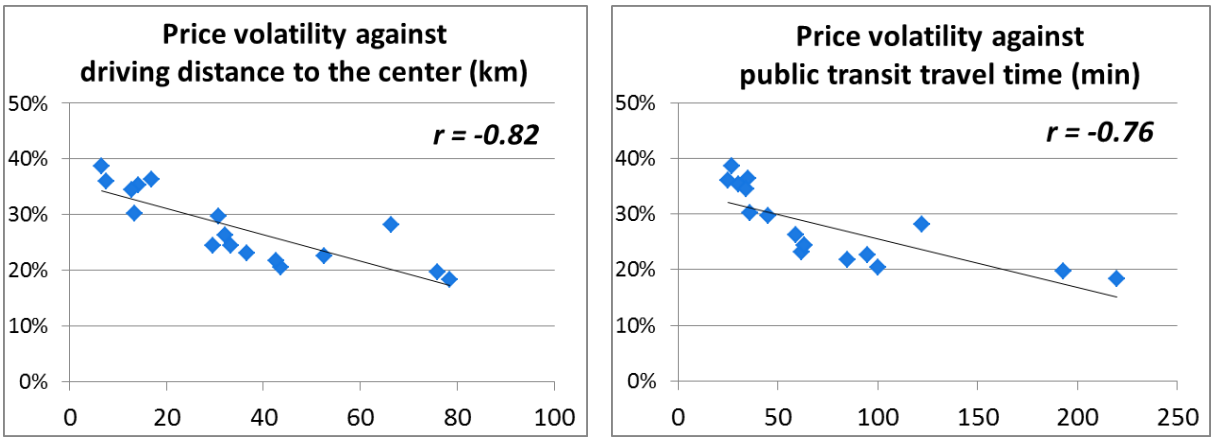
on a weekday if departing at 8am[20]. This estimate serves as an indicator of different areas' appeal to potential commuters and overall accessibility to the city's services and amenities.

While two types of distance are estimated and presented in this subsection, in subsequent modeling only driving distance will be reported for convenience. This does not introduce a bias in our estimates since driving distance and public transit commuting time are correlated at 0.95 implying that the estimates can be used interchangeably. Hence, we will use driving distance in the ensuing sections.

The comparative results of distance and price volatility are reported in Figure 4.19 while details on specific municipalities can be found in Table 4.3. First, there is a clear inverse relationship between volatility and distance to downtown Vancouver (both for driving and public transit estimates). Most volatile regions are the ones most affected by foreign investment, which fulfills our expectations regarding external factors and actors' role in shaping the local housing market dynamics. This relationship is significant and consistent for both distance estimated with r = -0.82 correlation between price volatility and driving distance and -0.76 correlation with public transit commuting time.

Such price dynamics are consistent with the spatial equilibrium approach to analyzing individuals' location choices based on housing and transportations costs (described in detail in Glaeser 2008). Initially suggested by Alonso (1964) and extended by Mills (1967) and then Muth (1969), the housing cost variation across space is explained by people facing a tradeoff between lower house prices and higher transportation costs (including time). Since commuting behavior refers to local residents rather than non-local investors who might not even be living in the city, it confirms the trend of lower volatility on the periphery that is typical of local residents' market behavior rather than the more flexible purchase and sales activities exhibited by external investors.

Figure 4.19. Price Volatility Plotted Against Distance to Downtown Vancouver



Source: Author's original calculations based on REBGV and FVREB monthly sales data.

[20] The estimates reported in this study were specifically pulled for Monday, July 24th, 2017, departure time set at 8am.

Table 4.3. Quarterly Prices Volatility Relative to Driving Distance and Public Transit Time

	CV for prices	Driving distance (km)	Public transit travel time (min)
Vancouver West	39%	7	27
Richmond	36%	17	35
Vancouver East	36%	8	25
Burnaby	35%	14	30
West Vancouver	34%	13	34
North Vancouver	30%	14	36
Coquitlam	30%	31	45
White Rock - S Surrey	28%	66	122
Delta North	26%	32	59
Surrey North	24%	30	63
Port Coquitlam	24%	33	63
Surrey Center	23%	37	62
Langley	23%	53	95
Surrey Cloverdale	22%	43	85
Maple Ridge & Pitt Mead.	20%	44	100
Abbotsford	20%	76	193
Mission	18%	78	220

Source: Author's original calculations based on REBGV and FVREB monthly sales data.

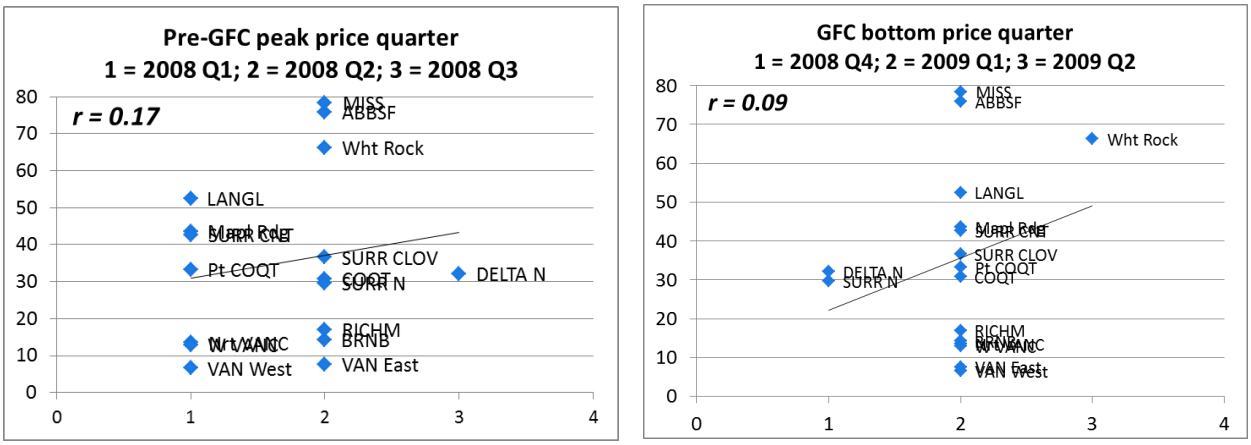
4.4 Break-point Analysis

Having established a consistent spatial pattern in volatility, we are now turning to a more detailed analysis of price changes in response to external shocks moving beyond descriptive comments from the overall price trend presented in an earlier section. To conduct break-point analysis, we identify price peak and trough periods related to external shocks and compare them across time and space. The idea is adopted from Liao et al (2015) adjusting for the local context in choosing the shocks. First, the shock response is analyzed based on quarterly prices, and then the pre-GFC peak, the GFC bust, and the pre-2016-tax price peak periods are calculated for monthly prices to capture a potentially faster response and correction to major shocks, and the results are compared.

4.4.1 Quarterly Turning Points

First, the price dynamics around the time of the global financial crisis are analyzed. Most of the municipalities display a trend reversal within the 2008-2009 time frame which will serve as the time window to identify the periods of highest pre-crisis peak and the lowest price period. The results then are plotted against the driving distance to downtown Vancouver (Figure 4.20). The pre-crisis peak is the highest price in 2008-2009 that is followed by at least two subsequent quarters showing decline and the GFC bottom period is the quarter with the lowest price observed within the 2008-2009 time frame.

Figure 4.20. Global Financial Crisis Peak and Bottom Quarter against Driving Distance (km)

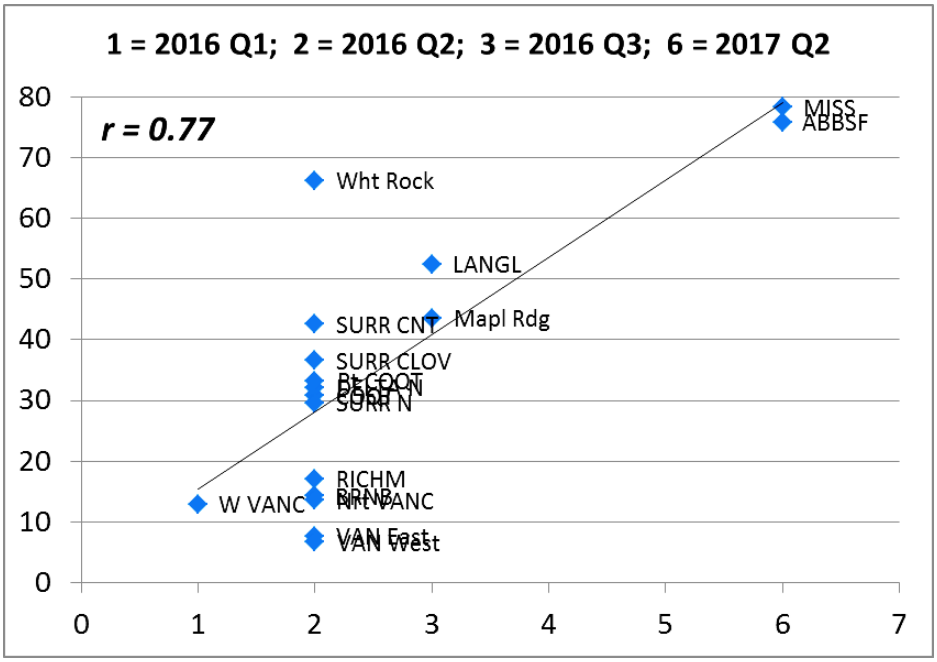


Source: Author's original calculations based on REBGV and FVREB monthly sales data.

Quarterly prices do not show a clear spatial effect for the GFC peak and bottom periods, the correlations are low (0.17 and 0.09) and insignificant. The unfulfilled expectation for the data at this level could be explained by the overwhelming impact that GFC had had on the market not only through the external price shock to the central areas that may have caused a ripple effect, but also through directly affecting other municipalities across the entire metropolitan area. Given the scale of the crisis, one could also expect that the ripple effect might have worked on the monthly basis, but quarterly data obscures those more fine-grained change patterns, a proposition that will be tested later.

The pre-2016-tax-adjustment peak is similarly defined as a period with the maximum price during 2015-2016 that is followed by at least two consecutive quarters with lower prices, ensuring that the identified peak was actually followed by decline and does not include post-correction price growth (Figure 4.21). For the municipalities that did not evidently experience a price decline over more than one quarter due to the tax (Abbotsford and Mission), the peak is assigned as 2017 Q2, the last available quarter. As they become outliers from the rest of the sample, correlation will also be estimated without them to check for robustness of the relationship.

Figure 4.21. Pre-2016-tax Price Peak Quarter Plotted against Driving Distance (km)



Source: Author's original calculations based on REBGV and FVREB monthly sales data.

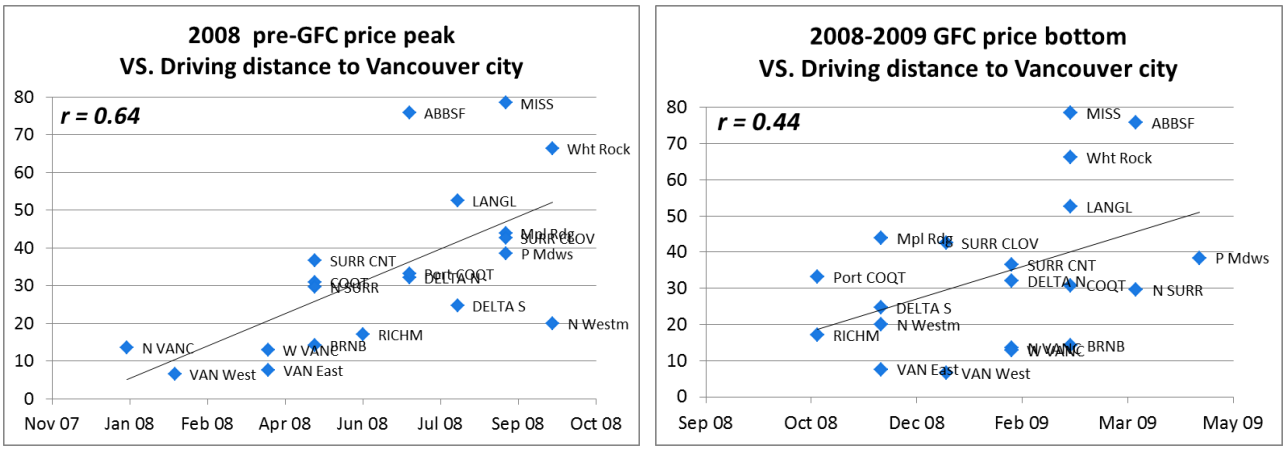
In this case, we observe a more clear correlation in the pre-tax peak period and driving distance indicating delayed price peaking and a potential ripple effect throughout the Metro Vancouver. Since Mission and Abbotsford did not actually exhibit a decline in prices for more than one quarter after the tax and were assigned the latest quarter available, they end up being outliers in comparison to the rest of the sample and could arguably be driving the high correlation for the estimate (0.77). Therefore, the correlation without these two outliers was tested as well and it was reduced but moderate and significant at 0.48 indicating a consistent spatial trend in the price dynamics response to the foreign buyers' tax implementation.

4.4.2 Monthly Turning Points

Next, the trend turning points were estimated using monthly prices to evaluate price responses to the shocks with higher sensitivity. Similar to the previous subsection, the pre-crisis peak and GFC bust periods are identified for 2008-2009 (Figure 4.22) and then pre-tax-adjustment peak months are determined during 2016 (Figure 4.23). Again, the peak period is the month with the maximum price that is followed by at least two months with declining prices within the time frame and the bottom is the lowest price month. If no peak can be identified (e.g. there were no two consecutive months with declining prices, the last month of the period is assigned as the peak.

Overall, we now observe a more evident spatial pattern in price shock diffusion throughout the metropolitan area from the center. In this case, the fact that quarterly prices did not show a spatial effect could be attributed to a quarter being a longer time span that obscured faster price change transmission that had occurred. The GFC might have presented such a significant shock to the economy overall and individual municipalities directly that it had rippled throughout the area within a shorter time frame.

Figure 4.22. Financial Crisis Peak and Bottom Month against Driving Distance (km)

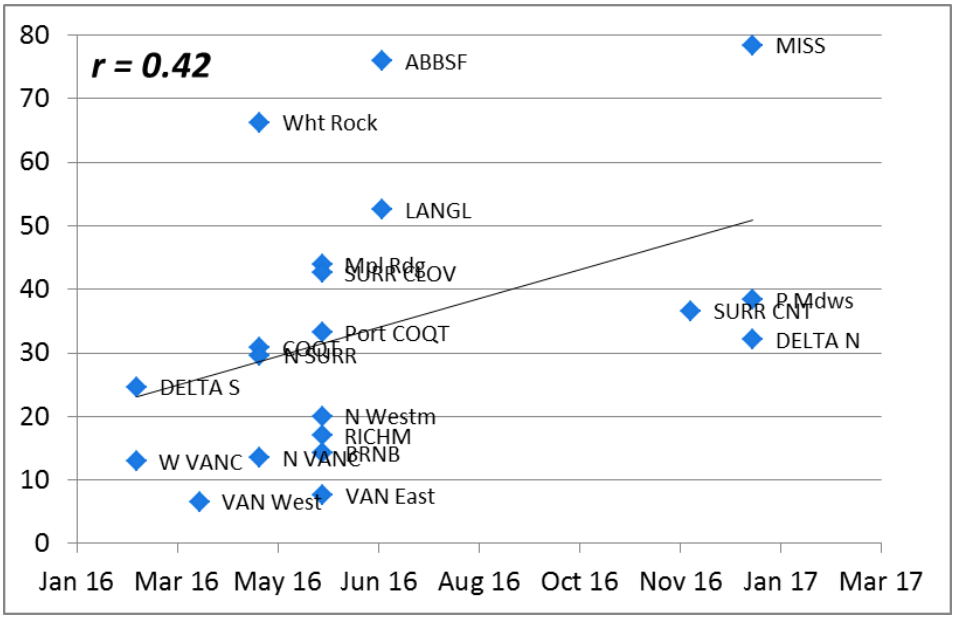


Source: Author's original calculations based on REBGV and FVREB monthly sales data.

Interestingly, it can be observed from Figure 4.23 that the monthly pre-tax peak correlation (0.42) with driving distance is not higher than that based on quarterly prices unlike the case of the GFC (0.77 for the full sample or 0.48 without outliers, Figure 4.21). This could indicate that the foreign buyers tax has had a different effect on the price diffusion on the market as it is a more local specific shock that only directly affects one segment of the market, foreign buyers, but not the economy overall. In this case, quarterly price dynamics might have been a better indicator of the spatial diffusion pattern to account for consumer behavior changes.

Looking at the price turning points as structural breaks, we have found a significant correlation with the distance to downtown Vancouver as a spatial measure for all cases apart from quarterly break estimates for GFC peak and bottom periods. The latter can be explained by the longer quarterly periods concealing the more sensitive and faster responses observed at the monthly level. At the same time, the break-point analysis of the peak before the market adjustment to the 2016 foreign buyers' tax has revealed a similar trend based on both monthly and quarterly prices indicating the difference in how the ripple effect pans out depending on the type of the external shock and how it affects different areas within the sample.

Figure 4.23. Pre-2016-tax Price Peak Month Plotted against Driving Distance (km)



Source: Author's original calculations based on REBGV and FVREB monthly sales data.

4.5 Ripple Effect Regression Modelling

The final section of this chapter includes the results of regression modeling of the ripple effect in several model specifications, the last stage of evaluating the presence of the ripple effect on the single-family housing market in Metro Vancouver. First, cross-correlations for non-central municipalities on lagged changes from the center are analyzed and then two approaches to regressions are presented: individual regressions by municipality and a panel data approach.

4.5.1 Cross-correlations

Building on the Oikarinen (2006) paper analyzing the housing market ripple effect in Finland, we present cross-correlation results between the quarterly price change dynamics in individual municipalities and the changes in the two identified centers (Vancouver West and West Vancouver) in the same period and with lags (Table 4.4). 'Vanc West' or 'West Vanc' refers to the price dynamics in the corresponding center while T-0 in the first column indicates that the correlation is estimated between the price changes in a given non-central region with the changes in the central in the same period (T-0). The following columns display correlation estimates for the current price changes in a non-central regions with the lagged changes in the center: changes in the previous quarter are denoted as T-1, two quarters ago – T-2, three quarters ago – T-2, a year ago – T-4. 'Vanc West' stands for Vancouver West (the West side of the city) and 'West Vanc' stands for the West Vancouver municipality. Bivariate correlations are reported in each cell. For the centers themselves, we include

correlations with lagged changes in the other center. The lower section with summary statistics is based on absolute values of correlations (i.e. disregarding the direction) to focus on the strength of relationship rather than its direction.

Table 4.4. Cross-Correlation Results on Lagged Quarterly Price Changes in the Center

	VANC West T-0	VANC West T-1	VANC West T-2	VANC West T-3	VANC West T-4	West VANC T-0	West VANC T-1	West VANC T-2	West VANC T-3	West VANC T-4
Abbotsford	0.30	0.37	0.14	-0.24	0.30	0.40	0.38	0.04	-0.02	0.25
Burnaby	0.63	0.42	-0.03	-0.25	-0.09	0.67	0.32	-0.21	-0.12	0.17
Coquitlam	0.56	0.40	0.00	-0.15	-0.01	0.62	0.19	-0.03	0.07	0.03
Delta North	0.41	0.34	0.08	-0.14	0.12	0.32	0.42	0.10	-0.08	0.13
Langley	0.38	0.52	0.08	-0.12	-0.14	0.45	0.33	0.05	0.06	-0.04
Maple Ridge	0.45	0.44	0.13	0.07	-0.27	0.51	0.40	0.05	-0.04	0.00
Mission	0.22	0.31	0.16	-0.05	-0.02	0.18	0.29	0.19	-0.18	0.10
North Vancouver	0.67	0.27	-0.03	-0.19	-0.01	0.63	0.08	-0.07	0.02	-0.05
Port Coquitlam	0.55	0.32	0.17	-0.24	-0.09	0.54	0.32	-0.05	-0.10	0.12
Richmond	0.39	0.41	-0.10	0.07	-0.16	0.24	0.35	0.03	0.06	-0.33
Surrey Center	0.53	0.35	-0.01	0.03	-0.21	0.53	0.32	0.00	0.07	0.11
Surrey Cloverdale	0.57	0.33	0.09	-0.08	0.03	0.55	0.20	0.11	0.10	0.03
Surrey North	0.37	0.23	-0.04	-0.16	0.05	0.44	0.26	0.01	-0.12	0.10
Vancouver East	0.54	0.57	-0.02	-0.33	-0.08	0.63	0.40	-0.08	-0.24	0.05
White Rock - S Surrey	0.39	0.54	0.11	-0.12	0.08	0.54	0.30	0.03	0.16	0.04
T-0 Vancouver West						0.60	0.05	0.05	-0.15	-0.16
T-0 West Vancouver	0.60	0.31	0.01	-0.13	-0.13					
MEAN	0.46	0.39	0.08	0.15	0.11	0.48	0.30	0.07	0.09	0.10
MEDIAN	0.45	0.37	0.08	0.14	0.09	0.53	0.32	0.05	0.08	0.10
MIN	0.22	0.23	0.00	0.03	0.01	0.18	0.08	0.00	0.02	0.00
MAX	0.67	0.57	0.17	0.33	0.30	0.67	0.42	0.21	0.24	0.33

Source: Author's original calculations.

This statistic can serve as an additional measure of the ripple effect as it demonstrates whether price changes in non-central municipalities are correlated with current and/or lagged changes in one of the central areas. We observe quite high correlations for the current period (T-0) and especially the first quarterly lag (T-1), i.e. how the current price changes in a peripheral area is correlated with the price changes in the center (either Vancouver West or West Vancouver) in the previous quarter. Interestingly, by the third lag the relationship changes from positive to negative, which might indicate high volatility and annual or three-quarter cycle patterns with the changes three quarters ago in the center actually corresponding to an earlier stage of the cycle before the subsequent trend reversal. It is worth noting that bivariate correlations were also estimated for the monthly prices, however, no consistent pattern was observed throughout the sample arguably due to the higher volatility of monthly sales prices

obscuring larger trends that become evident at the quarterly level. The monthly price cross-correlations can be found in Appendix E .

On the whole, these cross-correlation results are sufficient to proceed with regression analysis that will account for different lags at the same time rather than judging individual bivariate correlation values. From the results in Table 4.4, we would expect that T-2 and T-4 are probably not playing a significant role in shaping non-central price change dynamics given the low correlation values for these lags across the sample.

4.5.2 Model Individual Regional Equations

Developing further the cross-correlation analysis, we first estimate the presence of a ripple effect from the center outwards by regressing quarterly price changes in a municipality on the changes in each of the identified centers separately. The central price changes are included for the current period (T-0) and with four lags: previous quarter (T-1), two quarters ago (T-2), etc. The descriptive information about the model design is presented in Table 4.5.

Table 4.5. Regression Model Description Summary

Item	Description
Observations	quarterly ***price changes*** (43-47 observations for each depending on lags included)
Dependent variable (Y)	price changes in a non-central municipality
Explanatory variables (X's)	• price changes in the center in the current quarter (T-0)[21] • lagged price changes on the center in previous quarter(s): T-1, T-2, T-3, T-4
Equation optimization	models optimized to maximize R2 adjusted value

[21] Price changes in the center in the current quarter (T-0) are included for two reasons: as an indicator of the current economic trend in the absence of other macroeconomic statistics on the quarterly level, and then it also enables us to capture some price transmissions that might occur within one quarter. Then T-1, T-2, T-3, T-4 changes, if still significant, actually show the net lagged effect as the general trend is already accounted for by T-0.

The estimated equation is provided below:

$$\hat{dP}_t^{per} = \hat{\beta}_0\, dP_{t-0}^{ctr} + \hat{\beta}_1\, dP_{t-1}^{ctr} + \hat{\beta}_2\, dP_{t-2}^{ctr} + \hat{\beta}_3\, dP_{t-3}^{ctr} + \hat{\beta}_4\, dP_{t-4}^{ctr},$$

where

dP_t^{per} – price changes in the given non-central region ('periphery'), *t = 1, ..., 49*

dP^{ctr} – price changes in the center in the identified quarter (t-0 = current period, t-1 = previous quarter, etc)

This approach is based on the methodology used in Roehner (1999) in the study on Paris. More explanatory variables were included there to account for other demand and speculation factors along with the response delay, but since we do not have other macroeconomic data on the quarterly level by municipality for the region, the equations are based on current and lagged price changes in the center only measuring significance of central price changes lags. As a result, 15 equations were estimated for non-central areas. Then two additional equations were run for each of the central areas regressing the respective region's price changes on the current and lagged changes in the other center.

The final results for optimized regression models are presented in Table 4.6. The key finding is that almost everywhere (except for the North Vancouver – West Vancouver pair) at least one lagged variable is included in the final regression along with the current price changes in the center that is also found to be significant in almost all equations at the 10% significance level at least, with the exception of Richmond and Mission when regressed on West Vancouver price changes. This indicates a statistically significant ripple effect throughout Metro Vancouver even after accounting for the current economic trend as measured by factor T-0.

The most common lag found to significantly affect non-central areas is T-1 meaning that at the quarterly level, the price changes in the center in the previous quarter have the most impact on the current prices in peripheral areas as compared to other periods in the past year. As was expected from cross-correlation analysis, T-2 and T-4 lags were excluded from most of the optimized model equations due to insignificance. Furthermore, we also observe a somewhat consistent pattern in the distribution of explanatory power of the models measured by the adjusted R^2. There is a *-0.41* correlation between Vancouver West models' R^2 adj. and the respective distance of the given non-central municipality to downtown Vancouver (Table part A) and *-0.56* correlation for the same relationship in West Vancouver as center models (Table part B). Even though not perfect, these correlation values are notable.

Table 4.6. Optimal Regression Models' Summary[22]

A. Vancouver West as the central lagged region

Y	T-0 VANC West	*pv*	T-1 VANC West	*pv*	T-2 VANC West	*pv*	T-3 VANC West	*pv*	T-4 VANC West	*pv*	# obs	R2 adj	Model signif.	Driving dist (km)
West Vancouver	**0.53**	***			**0.17**	**[.11]**	**-0.13**	**[.20]**			**44**	**0.39**	***	**12.9**
Vancouver East	0.33	***	0.39	***			-0.18	**			44	0.59	***	8
North Vancouver	0.56	***	0.17	*							46	0.48	***	14
Burnaby	0.47	***	0.29	***			-0.11	[.25]			44	0.52	***	14
Richmond	0.36	***	0.39	***	-0.16	[.27]	0.17	[.24]			46	0.26	***	17
Surrey North	0.37	**	0.20	[.17]							46	0.14	***	30
Coquitlam	0.56	***	0.33	***					0.16	[.19]	43	0.45	***	31
Delta North	0.33	***	0.27	**					0.21	*	43	0.27	***	32
Port Coquitlam	0.38	***	0.20	**	0.13	[.20]	-0.12	[.24]			44	0.36	***	33
Surrey Center	0.35	***	0.19	**			0.10	[.27]			44	0.35	***	37
Surrey Cloverdale	0.35	***	0.18	**							46	0.37	***	43
Maple Ridge & Pitt Meadows	0.35	***	0.28	***			0.12	[.20]	0.08	[.31]	43	0.34	***	44
Langley	0.23	***	0.33	***							46	0.35	***	53
White Rock & S Surrey	0.34	***	0.49	***					0.24	**	43	0.43	***	66
Abbotsford	0.22	**	0.29	***			-0.15	*	0.33	***	43	0.39	***	76
Mission	0.24	*	0.26	*					0.14	[.23]	43	0.12	**	78

B. West Vancouver as the central lagged region

Y	T-0 West VAN	*pv*	T-1 West VAN	*pv*	T-2 West VAN	*pv*	T-3 West VAN	*pv*	T-4 West VAN	*pv*	# obs	R2 adj	Model signif.	Driving dist (km)
Vancouver West	**0.71**	***	**0.31**	***							**46**	**0.41**	***	**6.6**
Vancouver East	0.36	***	0.21	***			-0.10	[.15]			44	0.51	***	8
North Vancouver	0.43	***									47	0.39	***	14
Burnaby	0.43	***	0.19	**					0.13	[.11]	43	0.50	***	14
Richmond	0.18	[.13]	0.31	**			0.15	[.23]	-0.31	**	43	0.22	***	17
Surrey North	0.33	***	0.18	[.10]							46	0.19	***	30
Coquitlam	0.47	***	0.13	[.18]			0.08	[.37]			44	0.38	***	31
Delta North	0.18	**	0.25	***							46	0.22	***	32
Port Coquitlam	0.31	***	0.20	**					0.09	[.30]	43	0.33	***	33
Surrey Center	0.29	***	0.15	**							46	0.35	***	37
Surrey Cloverdale	0.33	***	0.08	[.23]	0.12	*	0.06	[.33]			44	0.36	***	43
Maple Ridge & Pitt Meadows	0.29	***	0.20	***							46	0.38	***	44
Langley	0.23	***	0.19	**			0.07	[.35]			44	0.24	***	53
White Rock & S Surrey	0.38	***	0.23	**			0.17	*			44	0.36	***	66
Abbotsford	0.21	***	0.18	**					0.16	*	43	0.27	***	76
Mission	0.13	[.23]	0.19	*	0.14	[.19]					45	0.09	*	78

- The table reports *beta* coefficient estimates for each equation for each variable, with the corresponding *p value*; *** – 1% significance; ** – 5% significance; * – 10% significance. If insignificant, the estimated *pv* is reported.
- Blank spaces indicate that the variable was excluded while optimizing the final model due to insignificance
- Model significance based on *p value* for the final model as a whole
- For each variable, significance level is reported using the same asterisk classification as mentioned above; if a variable's coefficient is insignificant, but it was still included in the model, the estimated *pv* is reported

Source: Author's original calculations and layout.

[22] Municipalities sorted by driving distance to the center with the equation estimate for the other center is reported in top line regardless.

An important additional iteration of the model is testing whether the identified ripple effect from the center might have occurred due to autocorrelation of current price changes with previous quarter's changes in the same municipality that we have not included yet. Therefore, we add each non-central municipality's price changes in the previous period (price changes in T-1 in the non-central area) as one of the variable and re-evaluate whether the results significantly change in comparison to the estimates from Table 4.6. The model is estimated as follows:

$$\hat{dP}_t^{per} = \hat{\alpha}_0 dP_{t-1}^{per} + \hat{\beta}_0\, dP_{t-0}^{ctr} + \hat{\beta}_1\, dP_{t-1}^{ctr} + \hat{\beta}_2\, dP_{t-2}^{ctr} + \hat{\beta}_3\, dP_{t-3}^{ctr} + \hat{\beta}_4\, dP_{t-4}^{ctr},$$

where

dP_t^{per}	– price changes in the given non-central region ('periphery'), *t = 1, ..., 49*
dP_{t-1}^{per}	– price changes in the given non-central region ('periphery') in the previous quarter
dP^{ctr}	– price changes in the center in the identified quarter: *t-0 = current period, t-1 = previous quarter,* etc.

Let us demonstrate the difference to the previous model with an example. In the previous model, we consider house price changes in Abbotsford as a function of the current and lagged price changes in the center (e.g. Vancouver West). However, that model did not account for the trend in Abbotsford itself and there might be a potential for the omitted variable issue since the previous price changes is Abbotsford itself might be driving the current changes and not the ripple from the center. Hence, the new model specification includes changes in Abbotsford in the previous quarter (T-1) as one of explanatory variables along with the current and lagged changes in the central region. The sample of 49 time observations allows us to include an additional variable.

Given that we consider T-0 in the center as an indicator of the economic trend and simultaneous changes, we might have a biased estimate if that effect coincides with the municipalities' longer-term price trend. Consequently, we re-run and optimize these regressions having included a T-1 variable for price changes in the given non-central region along with the same central current and lagged price changes. Surprisingly, the previous quarter's changes in the non-central region itself had no significant impact on the region's current prices across almost the entire sample apart from Mission, Richmond, and White Rock. In the latter three regions, including the lagged price change in the region itself did lead to an increase in the models' explanatory power (R^2 *adj.*), but has not changed the estimates of

central lags significantly. Since most of the equations remained as in Table 4.6, the new results are not reported.

4.5.3 Panel Data Approach

The final stage of regression analysis is treating the data on price changes across municipalities as a panel dataset with only one equation estimated for all non-center areas and one for each of the identified centers (Vancouver West and West Vancouver). The model specification is based on Holly et al.'s (2011) error-correction model suggesting two separate specifications for modeling price changes in the central and non-central areas. A number of changes were made to the model to exclude absolute prices from the equation and only looking at price changes as that is what our research question focuses on. This approach is also generally supported in Liao et al. (2015) as they also include both non-central and central data into the regression and regress change on change as will be done in this subsection. To account for more features of the regional spatial relationships in the model, it is suggested to include neighboring regions' price changes in the current and previous quarter as an additional factor in the equation as in Holly et al. (2011). The neighbors' price changes required additional calculations composed of two stages:

1. Identifying the 'neighbors' of each region and filling out a spatial weight matrix[23] (see Appendix F)
2. Calculating the neighbors' price change by quarter as an unweighted average price change across the identified neighbors.

Once the neighbors were identified and the respective price changes were calculated, the variable was included into the model for both non-central and central areas. Two models each are estimated for non-central and central areas (Figure 4.24). Models 1.1 and 1.2 are panel samples of all 15 non-central municipalities with each municipality's price changes by quarter as the dependent variable (Y_1 and Y_2) according to the following equation:

$$\hat{dP}_{t,i}^{model\ 1.1,1.2} = \sum_{j=1}^{15} \hat{\alpha}_j X_j,$$

[23] In this study, we employ the simple method of contiguous regions only considered as neighbors and all of them weighted equally to determine the neighbors' price change in a given quarter.

where the dependent variable $dP_{t,i}$ corresponds to price changes across all non-central municipalities ($i = 1, \ldots, 15$) across all quarters ($t = 1, \ldots, 49$), and the independent variables X_1 to X_{15} include:

- X_1: Lagged price change in the non-central region in the previous quarter (t-1)
- X_2: Neighbors' average price change in this quarter (t)
- X_3: Neighbors' average price change in the previous quarter (t-1)
- X_4: Price changes in the center in this quarters (t)
- X_5-X_9: Lagged price changes in the center in the previous quarters (t-1 to t-5)
- X_{10}-X_{15}: Dummy variables for bordering the center (X_{10}), belonging to the 2nd-tier of high priced regions (X_{11}), belonging to Fraser Valley (X_{12}; 1 for Abbotsford and Mission); X_{13}-X_{15} – quarter dummies to correct for seasonal change

Figure 4.24. Panel Model Specification[24]

Model #	Dependent Variable (Y_i)	Independent Variables (Price Change Factors) (X_i)									
Model 1.1	Y1 non-central dP t	X1 non-central dP t-1	X2 neighbor non-cent dP t	X3 neighbor non-cent dP t-1	X4 Van W central dP t	X5 Van W central dP t-1	X6 Van W central dP t-2	X7 Van W central dP t-3	X8 Van W central dP t-4	X9 Van W central dP t-5	X10-X15 Dummies
Model 1.2	Y2 non-central dP t	X1 non-central dP t-1	X2 neighbor non-cent dP t	X3 neighbor non-cent dP t-1	X4 West Van central dP t	X5 West Van central dP t-1	X6 West Van central dP t-2	X7 West Van central dP t-3	X8 West Van central dP t-4	X9 West Van central dP t-5	X10-X15 Dummies
Model 2.1	Y3 Vanc W dP t	X1 Vanc W dP t-1	X2 West Van dP t	X3 West Van dP t-1	X4 West Van dP t-2	X5 West Van dP t-3	X6 West Van dP t-4				
Model 2.2	Y4 West Van dP t	X1 West Van dP t-1	X2 Vanc W dP t	X3 Vanc W dP t-1	X4 Vanc W dP t-2	X5 Vanc W dP t-3	X6 Vanc W dP t-4				

Source: author's original work.

Models 2.1 and 2.2 for the two central areas are similar in the inclusion of the previous quarter's price changes and then adding the other center's changes in the current quarter and with lags. No quarterly dummies are included due to a limit on the number of variables in the smaller sample.

[24] 'dP' stands for price difference in a given quarter as a percent of the previous quarter's price

Neighbors' prices are not included either since West Vancouver only has two neighbors including Vancouver West while for Vancouver West, the other center is one of the four neighbors, which means that in both cases, the neighbors' average prices would be highly correlated with the other center's price changes taken separately leading to multicollinearity across the explanatory variables. The estimated model specification for central price changes is expressed below:

$$\hat{dP}_t^{model\ 2.1,2.2} = \sum_{j=1}^{6} \hat{\alpha}_j X_j,$$

where the dependent variable dP_t corresponds to price changes across in one of the central municipalities (Vancouver West in model 2.1, and West Vancouver in model 2.2) across all quarters (*t = 1, ..., 49*), and the explanatory variables X_1 to X_6 include:

- X_1: Price changes in the same center as in the dependent variable in the previous quarter (t-1)
- X_2: Price changes in the other center in the current quarters (t)
- X_3-X_6: Lagged price changes in the other center in the previous quarters (t-1 to t-5)

The models were run and optimized using the same strategy as in the previous sub-section., and the optimal models' estimation results can be found in Figure 4.25. The main conclusion to be drawn from the final models is the overwhelming evidence for the presence of the ripple effect for non-central areas with the ripples originating in the identified centers (Vancouver West and West Vancouver), both granting a comparable explanatory power to the respective models as measured by the adjusted R^2. In all four equations as least one lagged variable of the central price changes is significant in explaining some of the variation of price changes in the periphery (Models 1.1.-1.2) or the other center (Models 2.1-2.2).

Figure 4.25. Panel Regression Model Summary[25]

Model 1.1. Vancouver West as the ripple effect center

Y_1	Non-central dP t-1	pv	Neighb dP t-0	pv	Neighb dP t-1	pv	Vanc W dP t-0	pv	Vanc W dP t-1	pv	Vanc W dP t-3	pv	Vanc W dP t-4	pv	DUM Q1	pv	DUM Q2	pv	DUM Q3	pv	# obs	R2 adj	Model signif.
OLS model	-0.38	***	0.71	***	0.432	***	0.077	***	0.059	**	−0.0304	[0.19]	0.05	**	NOT INCLUDED						675	0.536	***
Fixed Effects	-0.38	***	0.71	***	0.433	***	0.078	***	0.060	**	−0.0303	[0.19]	0.05	**	NOT INCLUDED						675	0.541	***
OLS model	-0.37	***	0.68	***	0.44	***	0.09	***	0.05	[0.1]			0.04	*	0.007	*	0.008	*			675	0.539	***

Model 1.2. West Vancouver as the ripple effect center

Y_2	Non-central dP t-1	pv	Neighb dP t-0	pv	Neighb dP t-1	pv	West Van dP t-0	pv	West Van dP t-1	pv	West Van dP t-3	pv	West Van dP t-4	pv	DUM Q1	pv	DUM Q2	pv	DUM Q3	pv	# obs	R2 adj	Model signif.
OLS model	-0.38	***	0.72	***	0.43	***	0.07	***	0.03	[0.2]					NOT INCLUDED						720	0.535	***
OLS model	-0.37	***	0.70	***	0.44	***	0.07	***	0.04	*					0.004	[0.264]			-0.005	[0.142]	720	0.536	***

Model 2.1. Vancouver West as the Dependent Variable

Y_3	Vanc W dP t-1	pv	West Van dP t-0	pv	West Van dP t-1	pv	West Van dP t-2	pv	West Van dP t-3	pv	West Van dP t-4	pv	# obs	R2 adj	Model signif.
Price changes in Vancouver West			0.53	***			0.17	[0.11]	−0.13	[0.20]			44	0.39	***

Model 2.2. West Vancouver as the Dependent Variable

Y_4	West Van dP t-1	pv	Vanc W dP t-0	pv	Vanc W dP t-1	pv	Vanc W dP t-2	pv	Vanc W dP t-3	pv	Vanc W dP t-4	pv	# obs	R2 adj	Model signif.
Price changes in West Vancouver	−0.14	[0.32]	0.71	***	0.42	**							46	0.41	***

Source: author's original work.

[25] Models 1.1, 1.2: T-2 and T-5 were not found significant in any equation and are thus excluded from the final summary. Models 2.1, 2.2: T-4 is excluded.

In the models 1.1.-1.2, the higher number of observations has allowed us to test additional dummy variables regarding the potential seasonality of price changes by adding dummies for specific quarters. Although quarters 1 and 2 were found significant in Model 1.1 and quarters 1 and 3 in Model 1.2[26], they have not drastically changed the coefficients' estimates or the determination coefficient. This implies that disregarding quarter dummies in the individual regional equations design in the previous subsection and in Models 2.1-2.2 has not prevented us from acquiring representative results given no significant seasonality could be observed in the dynamics of quarterly price changes. Besides, we have also tested dummies for different price segments to evaluate whether the dynamics of the ripple effect might vary significantly across clusters of regions (growth centers, over 1 million dollar band, Fraser Valley municipalities), but those dummies were insignificant and we found no clear relationship there.

For the panel equation (Models 1.1-1.2), we have modeled it using three different techniques: standard pooled OLS, fixed effects and random effects[27]. As the Hausman test rejected the random effects model, only OLS and fixed effects estimates are reported in Figure 4.25. When comparing the results of the two approaches, it is easy to notice that the coefficient estimates, their significance and the model's explanatory power vary only insignificantly switching from OLS to fixed effects and back indicating that either methodology is acceptable for modeling the ripple effect in this specification on this sample.

Interestingly, the neighbors' price changes were found to be significant in models 1.1 and 1.2 along with the ripple effect from the center. This indicates that there are specific trends present in the contiguous regions that also reinforce the ripple effect, yet introduce additional variability, since otherwise the neighbors' effect would not have been found significant *in addition* to the effect from the current and lagged price changes in the center. While we simply report the significance of contiguousness as identified in the regressions, further analysis needs to be conducted to unpack the specific features of the ripple effect transmission through neighboring areas in Vancouver that is beyond the scope of this research project.

[26] Only three quarters can be included at a time due to multicollinearity.

[27] The different estimation method determine how *beta* coefficients are estimated throughout the sample, all three estimation methods were run on the full sample with all variable included.

4.6 Ripple Effect in Vancouver Summary

Our analysis has identified a number of spatial trends present in the price dynamics and specifically price changes throughout Metro Vancouver since 2005. The general price trends indicate that the municipalities in the metropolitan area can be clustered by price segments and growth trends as the central areas (Vancouver West and West Vancouver) and their neighbors (Richmond, Burnaby, North Vancouver, Vancouver East) clearly stand out with higher prices overall and significantly faster price growth over time. These are the regions that are also most volatile and exposed to non-local actors' investment activities. Vancouver West and West Vancouver remain unchallenged growth centers and sources of the ripple effect evaluated throughout the chapter. Their position is supported by statistical data as well as interpretations of the generic economic and migration dynamics in the region. Furthermore, there is evidently regional divergence in prices typical of a 'hot' market overall with the slowest growing municipalities still having at least doubled in price in the last decade (10-12 years), yet not reaching the index values of around 350-400% for the growth centers.

Annual and quarterly prices have demonstrated the cyclical patterns of price changes in Metro Vancouver. Break-point analysis has further elaborated these patterns by identifying the specific delays in responses to external shocks observed during the GFC and the implementation of the foreign buyers' tax. The reaction speed and power are also determined by the type of the shock with different patterns observed for the GFC and the 2016 tax. Different types of shocks and their specific effect on different municipalities could be a promising direction for further investigation into the spatio-temporal price dynamics in the Canadian context that could help better inform local and provincial policy design as well as consumer decision making.

Overall this chapter has identified multiple indications of the presence of a ripple effect on the Vancouver housing market that has also been confirmed in the last stage of regression modeling. Median selling price trends for single family homes display observable spatial patterns in long-term dynamics of absolute prices and price indices further extended by volatility and break-point analysis. We find that with increasing distance from downtown Vancouver, volatility decreases and responses to external shocks are delayed (partially confirmed by quarterly prices, fully confirmed by monthly prices), providing prime signals of the presence of the ripple effect. Finally, regression modeling of the price change factors across individual municipalities and the whole sample has confirmed and quantified the ripple effect as lagged price changes in the center were found to be significant in partially explaining the current price changes on the periphery after accounting for the local and neighboring price trends. The significant impact of neighboring regions' prices on a given municipality has added another layer of spatial complexity of the trends, which could be analyzed in more depth in future research.

Chapter 5. Conclusion

This thesis has presented an extensive study of the spatio-temporal dynamics in the Vancouver housing market. Having carefully reviewed the trends of common market fundamentals, we find that the housing market is decoupled from the local economy which is consistent with other academic studies (Gordon, 2016; Ley, 2017; Walks, 2013; Yan, 2017) and estimates of the housing bubble risk (UBS, 2016; Walks, 2014). As Vancouver house prices are further detached from local incomes, the city becomes less and less affordable, and is currently once again the least affordable metropolitan area in North America (Demographia Affordability Survey, 2017). This problematic status leads to a range of negative social outcomes and palpable housing stress among local residents.

Different levels of government have attempted to address this issue, but nevertheless, recent policy initiatives, including the 2016 foreign buyers' tax in Greater Vancouver and the 2017 empty homes tax in the City of Vancouver, have cooled off the housing market only temporarily, and by the summer of 2017 price levels have almost fully recovered to pre-tax peaks. This is true both for Metro Vancouver as a whole and also for individual municipalities, some of which have not shown even a temporary trend reversal after the new regulations were imposed. Overall, the policies so far do not appear to have addressed the core of the issue as the external factors shaping the Vancouver housing market persist, while the local factors remain insignificant for house price dynamics.

This project contributes to the existing literature as it is the first comprehensive academic study of the ripple effect in the Canadian context. For Vancouver specifically, an original statistical analysis of spatial price diffusion uncovers the presence of the ripple effect in the housing market. The maps and graphs complement the quantitative analysis that includes price volatility analysis, structural breaks, and regression modeling in time-series and panel specifications. There is overwhelming evidence of the presence of the ripple effect at different scales. It can be observed in annual data as presented by maps of price changes in Metro Vancouver. Price volatility trends in price diffusion reveal consistency with the conditions expected for a ripple effect to occur as the price shocks decline in their impact on the periphery with distance from the center, the local point of origin of external shocks. Break point analysis further indicates the presence of a ripple effect for both monthly and quarterly data displaying delays in price changes in the regions further away from the center around the time of shocks from the 2008-2009 Global Financial Crisis (GFC) and the 2016 foreign buyers' tax.

Finally, the cross correlations and regression modeling based on median quarterly selling prices reveal a strong relationship between the current price changes in the non-central regions, and the current and lagged changes in the center, with the city's West side (Vancouver West) and West Vancouver being identified as centers, and points of origin of external shocks in the regional market. The estimates are

consistent for individual municipalities, and also for the entire sample analyzed as a panel, with the panel estimates exposing more complexity of spatial diffusion patterns, for the lags in both central municipalities and their neighboring regions are found to be significant at the same time. Having found the significance of contiguity, we identify this as one of the promising topics for further analysis to unpack the specific features of the ripple effect transmission through neighboring municipalities in Metro Vancouver.

It is important to acknowledge the limitation of this research project that could be improved on in further studies. While estimating the presence of the ripple effect, only price changes are considered while other potential explanatory variables are not included because of available data constraints and based on other similar studies that analyzed price dynamics without including other hedonic indicators, such as house size, age and other qualitative factors. While this presents a case of omitted variables, we still consider this study to be informative since based on the available data on price, we have found the significant presence of the ripple effect on different levels and for individual municipalities where those qualitative factors could be held constant. Therefore, the research in this area could be extended by including other housing quality factors and other characteristics, but the present study still offers an insight into the spatial price dynamics.

The evidence we found of the existence of a ripple effect could be used to inform policy decisions at the local and provincial level. It also contributes to a better understanding of the spatial dimension of housing price dynamics in Metro Vancouver, which could be useful for the growing body of housing researchers and consultants, as well as informing consumer choices by enabling a better understanding of the impact of external shocks on different regional submarkets.

One of the avenues for further research is delving deeper into the analysis at other scales that were not addressed in this thesis, using more fine-grained data that was not available for this study. Furthermore, incorporating census, and tax data from the 2016 surveys as they become available, and a longer series of foreign buyer purchases, might shed more light onto the changing migration patterns and impacts of foreign actors on the residential property market in Canada in general and in Vancouver in particular. Undoubtedly, the statistical and newspaper analysis integrated in this study could profitably be complemented with interviews with realtors and other knowledgeable stakeholders, a valuable contribution that could not be undertaken within the time constraints of this study. Besides the research potential at other scales, there is also the sense of urgency in addressing the issues of unaffordability and excessive indebtedness that are already evident (see, among others, Demographia Affordability Report, 2016; Ley, 2017; UBS, 2015; Walks, 2013, 2014) and more could be done on incorporating new knowledge of spatial trends into policy making.

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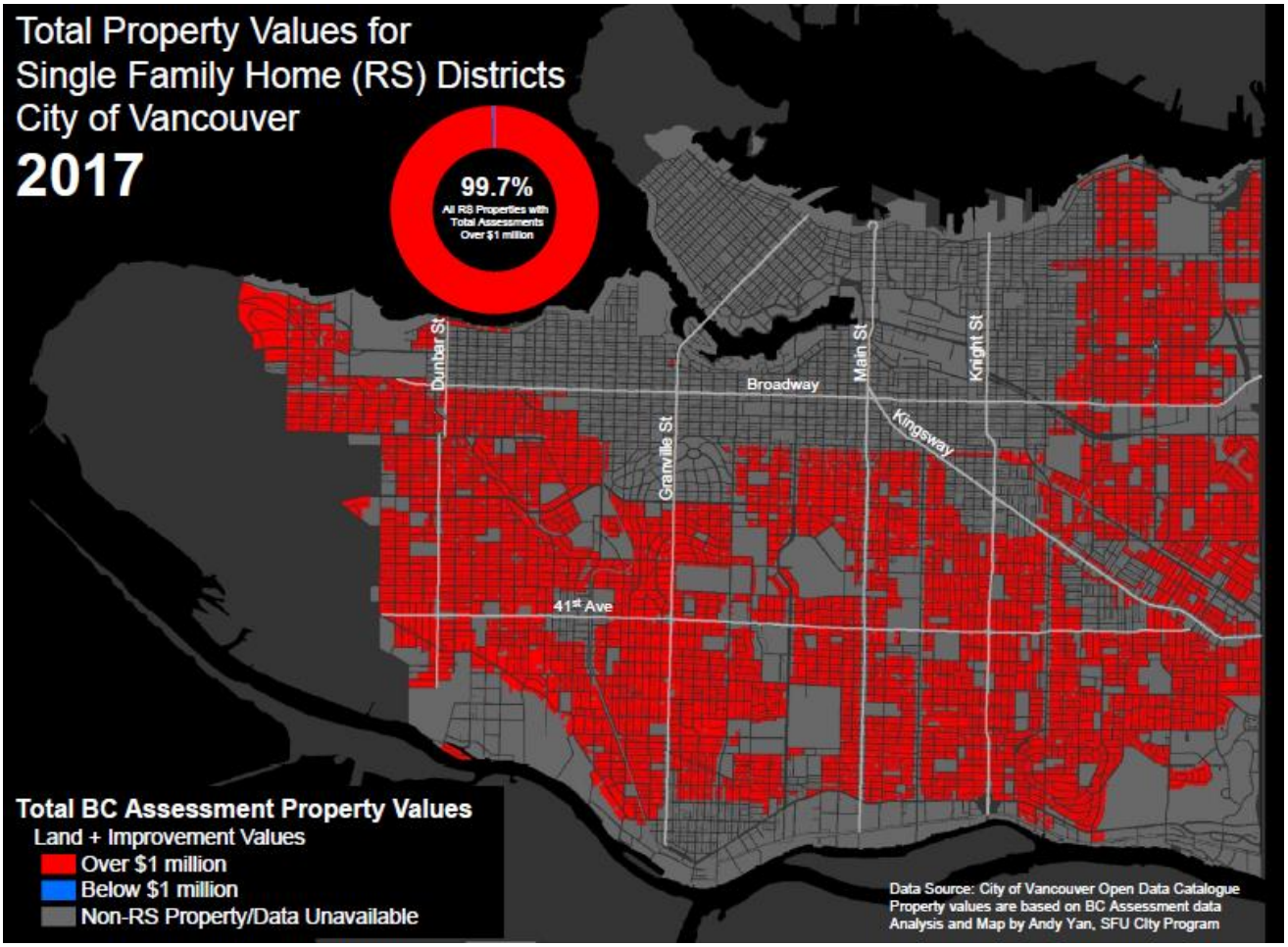
Appendices

Appendix A Data Sources of House Prices and Market Fundamentals

Domestic and international migration 1977-2014	Statistics Canada CANSIM tables 510031, 510035, 510057 Net domestic migration = "Net interprovincial migration" + "Net intra-provincial migration" * Data reflect 1981 CMA boundaries for the years 1977 to 1985, 2001 boundaries for the years 1986 to 1995, and 2006 boundaries for the years 1996 to 2011 ** The estimates are preliminary for 2014/2015 and final up to 2013/2014 (last update - August 2016)
Unemployment rate 1987 - 2012:	Statistics Canada CANSIM tables 2820053 and 2820110; since 2000 - CANSIM table 282-0135
House prices 1977 - 2016:	REBGV data (continuously monthly updated), prices for June of each year Notes: (1) received from a Communications person (2016: Andrea Westaway awestaway@rebgv.org) as an Excel sheet for research purposes (2) Average residential sold price for detached houses, June of each year Real values calculated using CANSIM table for annual inflation data on all items, 2015 = 100 (real for 2016 calculated Canada Inflation calculator based on monthly stats) Real prices can also be calculated using the Bank of Canada Inflation Calculator (but then manually for every data point)
RBC Housing Affordability Index	Housing Affordability Index is for 2nd quarter (Q2) of each year for Greater Vancouver Area from RBC data Contacted RBC directly to get a spreadsheet of affordability index since 1985 (media contact can be found on the RBC Website), they responded next day Online reports only go back to 1985 and are in PDF form, but the excel sheet sent by the RBC communications person included data by year and type of dwelling
Bank rate 1977 - 2015:	Bank of Canada, Selected historical rates - "Bank Rate": http://www.bankofcanada.ca/rates/interest-rates/selected-historical-interest-rates/ *Indicator:* Bank Rate monthly data averaged for each year

BC GDP 1981 - 2014:	Statistics Canada. CANSIM Table 384-0038 - Gross domestic product, expenditure-based, provincial and territorial, annual (millions of dollars) *Indicator:* Gross domestic product at market prices, current prices
Median income 1977 - 2006:	Series "Income trends in Canada, 1976-2006", Table 411.ivt (20/20 software), accessed through abacus at http://hdl.handle.net/10573/42142 Note: "The data prior to 1996 are drawn from the Survey of Consumer Finances. Beginning with 1996, the data are taken from the Survey of Labour and Income Dynamics(SLID). " The figures were converted to nominal dollars using CANSIM Table 326-0020, Consumer Price Index (CPI), 2009 basket monthly

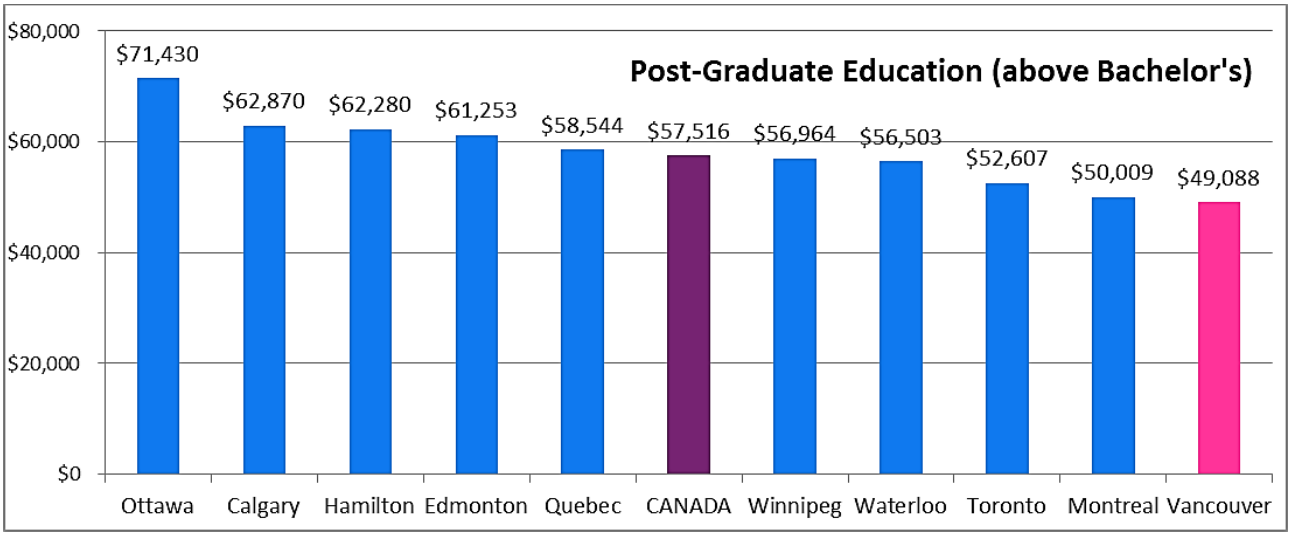
Appendix B Assessed Property Values for Single-Family Homes, 2017



Source: Andy Yan (2017). Reprinted with permission.

Appendix C Median Income across Canadian CMAs

Median Income for 25-55 Year Olds Post-Graduate Training[28] in top-10 CMAs, 2011



Source: original layout based on Canadian Statistics National Household Survey 2011.

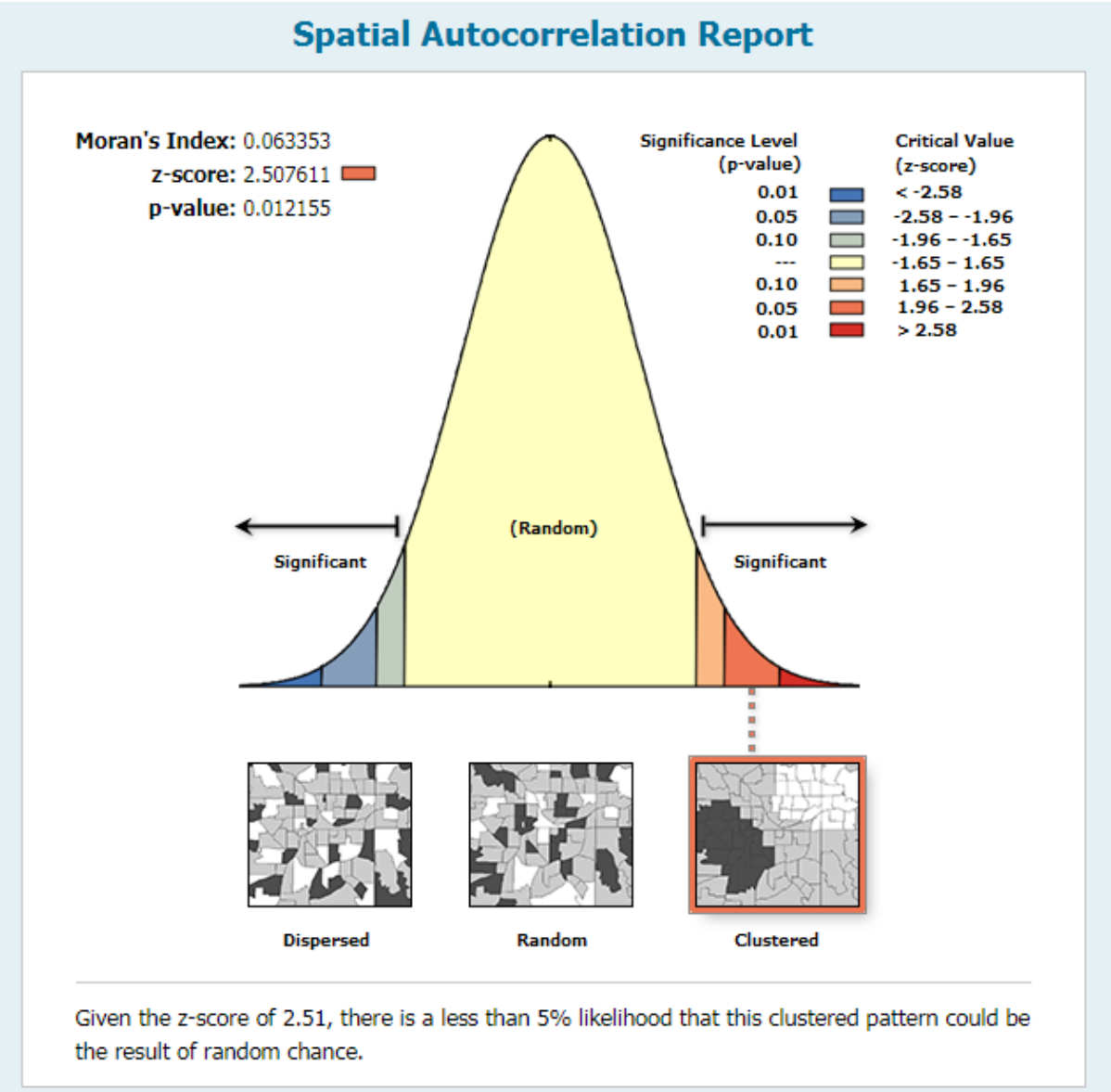
[28] Education includes any university certificate, diploma or degree above Bachelor-level degrees.

Appendix D Spatial Autocorrelation in ArcGIS

Example Spatial Autocorrelation Report (Moran's I) from ArcGIS

The report is for the test estimated for price changes in 2017 Q2 across 17 municipalities.

The Z-score higher than 1.65 means that there is significant spatial clustering in the sample.



Input Feature Class:	MetroVan_qrt_pr_chg_17q2
Input Field:	CHG_17_Q2
Conceptualization:	INVERSE_DISTANCE
Distance Method:	EUCLIDEAN

Appendix E Metro Vancouver Monthly Price Cross-correlations

Cross-correlation Table for All Non-Central Municipalities with Central Prices (with Lags)

	T-0 Vancouver West	T-0 West Vancouver	T-1 Vancouver West	T-1 West Vancouver	T-2 Vancouver West	T-2 West Vancouver	T-3 Vancouver West	T-3 West Vancouver	T-4 Vancouver West	T-4 West Vancouver
Abbotsford	0.04	-0.06	0.09	0.11	-0.05	0.04	0.07	-0.02	-0.02	0.06
Burnaby	0.01	0.11	0.11	0.10	-0.02	-0.08	0.14	0.13	-0.03	-0.16
Coquitlam	0.16	0.04	0.00	0.16	0.12	-0.06	-0.09	0.03	0.25	0.01
Delta North	-0.21	-0.05	0.25	0.05	0.01	0.11	0.05	-0.06	-0.13	0.13
Delta South	-0.04	0.10	0.09	0.05	-0.07	-0.10	0.02	0.01	-0.02	-0.10
Langley	0.09	0.16	0.08	-0.15	0.00	0.23	0.11	-0.11	-0.04	0.05
Maple Ridge	0.01	0.01	-0.03	0.10	0.06	-0.05	0.02	0.07	0.12	-0.07
Mission	0.10	0.01	0.07	0.12	0.02	-0.18	0.04	0.25	-0.04	-0.19
New Westminster	-0.11	0.19	0.08	-0.08	-0.02	0.06	0.02	0.01	-0.09	-0.03
North Vancouver	-0.05	-0.02	0.17	-0.02	0.13	0.19	-0.10	-0.13	0.01	0.07
Pitt Meadows	-0.18	0.15	0.19	-0.17	-0.02	0.13	-0.03	0.00	0.06	-0.02
Port Coquitlam	-0.01	0.04	0.19	-0.12	-0.09	0.28	0.05	-0.04	-0.04	-0.10
Port Moody	-0.15	0.11	0.03	-0.01	0.14	-0.04	-0.07	0.00	0.08	0.08
Richmond	0.15	0.09	0.14	-0.08	-0.04	0.04	0.12	0.04	-0.03	0.04
Sunshine Coast	-0.09	0.11	0.06	-0.11	0.07	0.08	-0.15	-0.01	0.16	0.06
Surrey Center	0.13	0.05	-0.09	0.00	0.14	0.12	-0.11	-0.05	0.17	0.09
Surrey Cloverdale	0.12	0.07	0.04	0.09	-0.02	-0.09	0.20	0.12	-0.11	0.00
Surrey North	0.23	0.17	-0.14	-0.04	0.00	0.07	0.18	-0.02	-0.17	-0.04
Vancouver East	-0.06	0.10	0.34	0.12	-0.18	0.03	0.27	-0.02	-0.09	0.01
White Rock - S Surrey	0.14	0.15	-0.09	-0.05	0.19	0.15	-0.08	-0.07	0.07	-0.12
T-0 Vancouver West		0.11	-0.34	0.10	-0.12	0.02	0.10	-0.11	0.05	0.04
T-0 West Vancouver	0.11		-0.16	-0.45	0.11	0.08	0.15	-0.12	-0.22	0.06

Summary stats

(without central regions with each other – the last two lines of the previous table excluded)

	ABS T-0 Vancouver West	ABS T-0 West Vancouver	ABS T-1 Vancouver West	ABS T-1 West Vancouver	ABS T-2 Vancouver West	ABS T-2 West Vancouver	ABS T-3 Vancouver West	ABS T-3 West Vancouver	ABS T-4 Vancouver West	ABS T-4 West Vancouver
MEAN	0.10	0.09	0.11	0.09	0.07	0.11	0.10	0.06	0.09	0.07
MEDIAN	0.10	0.10	0.09	0.09	0.05	0.08	0.08	0.04	0.08	0.06
MIN	0.01	0.01	0.00	0.00	0.00	0.03	0.02	0.00	0.01	0.00
MAX	0.23	0.19	0.34	0.17	0.19	0.28	0.27	0.25	0.25	0.19

Source: author's original analysis.

Appendix F Metro Vancouver Municipality Neighbors

Neighbor Spatial Weights Matrix

Edge & Corner	Abbotsford	Burnaby	Coquitlam	Delta North	Langley	Maple Ridge & PM	Mission	North Vanc	Port Coq	Richmond	Surrey Center	Surrey Clov	Surrey North	Vanc East	Vanc West	West Vanc	White Rock - S Surrey
Abbotsford	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
Burnaby	0	0	1	0	0	0	0	1	0	1	0	0	0	1	0	0	0
Coquitlam	0	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0
Delta North	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0
Langley	1	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	1
Maple Ridge	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
Mission	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
North Vancouver	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
Port Coquitlam	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Richmond	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0
Surrey Center	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0
Surrey Cloverdale	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	1
Surrey North	0	0	1	1	1	1	0	0	1	0	1	1	0	0	0	0	0
Vancouver East	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0
Vancouver West	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	1	0
West Vancouver	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
White Rock - S Surrey	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
SUM	3	4	3	3	5	7	2	4	2	4	3	4	6	4	4	2	2

Source: author's original work.