CAN FLUCTUATION IN FOREIGN EXCHANGE RATES AND GOLD BE USED TO FORECAST REAL ESTATE RETURNS IN GREATER VANCOUVER?

by

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Abstract

This paper is focused on determining a potential relationship between foreign exchange rates and gold versus real estate returns in Greater Vancouver.

The initial idea stems from the following: Does a “cheap” Canadian Dollar mean higher investments in real estate? Significant presence of foreign investors in the real estate market has led us to believe that such a relationship exists.

We have employed several econometric methods in order to standardize the data, and the Vector Autoregressive Model to determine whether a correlation exists or not.

The results of our observations, however, do not show any obvious relationship between the compared data sets, with several exceptions.

Our most basic common link is that we all inhabit this planet. We all breathe the same air. We all cherish our children's future. And we are all mortal.

~John F. Kennedy

Nothing in the world is more dangerous than sincere ignorance and conscientious stupidity.

~Martin Luther King, Jr.

Nothing is true, everything is permitted.

~William S. Burroughs

Keywords: real estate indices, Chinese investors, foreign exchange, gold

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1.0 Introduction

Location, location, location! When it comes to real estate, nothing is more important than location. Ranked second on the BBC survey of "most popular countries" in 2013, there is no doubt Canada attracts a lot of people globally (Evans, 2013). This on some degree, explains why Canada has become one of the world's most overvalued real estate markets according to *Economist*, since when demand rises price goes up (Heaven, 2013). Amongst all the big Canadian cities, Vancouver seems to receive the most heat. When it comes to the "top 20 housing markets" in North America, Vancouver wins the crown with an absolute certainty: the average housing price in Vancouver is over $50,000 higher compared to San Francisco, which is the 2nd most popular housing market in North America (Financial Post, 2014). When one sees these results, the only rational question is why? Why do people still buy in when the market is overpriced? What is the return on Vancouver real estate market? What will the future price look like? Most interesting of all, is there one group of people (we focus our study on Chinese buyers) which pays even more in Vancouver's real estate market? While some of the questions have already been answered, the rest are what we are trying to find out in this paper.

In our paper, the term "Chinese" can refer to either Chinese investors (non-resident) or resident Chinese Canadians. They are categorized in the same group because they share the same or similar background, and are influenced by Chinese culture. Usually, Chinese Canadians have a strong tie that links them back to Chinese investors; they are often supported financially by Chinese investors.

In this paper, we start by trying to understand the general market conditions of Vancouver and foreign investors. We explored the historical reasons of why Vancouver attracts investors from abroad especially those with oriental background, such as the Chinese. We then dig further to understand the psychological rationales for Chinese investors to keep investing in real estate markets. This will help us to predict future trends in the Vancouver real estate

market and foreign investing power, since if the reasons are justified, the investment will likely continue. Furthermore, we choose several indicators that might influence real estate market such as precious metal (gold), and prominent exchange rate such as US dollar (USD) and Chinese Yuan (RMB). The limitations on potential negative regulation changes are considered as well.

After we acquired all the historical composite data of home pricing indices (HPI) and the regional HPI data, we graphed the raw data to get a general feeling of the trends and changes over time. We then took the historical data of all the indicators we decided to use: gold, RMB and USD over the same period of time. We analyzed the raw data for each indicator to understand the characteristics of each indicator and predict a correlation fit with regards to HPI. In order to verify our predictions and obtain an accurate correlation of each indicator and different HPI data, we choose to use Vector Autoregressive Model. We ran through each set of data to calculate lognormal return and first order differencing to prepare the data for the model. Additional process such as ARMA and GARCH are applied when necessary till the initial data is left with pure white noise residuals. This way our data would have the same footing and we are compared two sets of comparables with no autocorrelation within itself.

Each set of data is processed and the residuals after necessary steps were saved separately. We then ran the residuals of each chosen HPI against all indicators to check for correlations. The correlations in between of each HPI were verified as well. At last, we ran a rolling correlation against different variables to show the changes of correlation with respect to time; this will help the reader to get a better understanding of data over a longer period of time instead of looking at a specific historical moment.

Most of our expectations checked out, there weren't any strong correlations in between each HPI with regard to different indicators. The correlation might go to as much as a medium level (around ± 0.5) over one period of time, but overall, the correlation is relatively weak. The regional HPIs were strongly correlated or even close to a perfect correlation prior (at level 0.7-0.8) to 2005. However, this strong correlation quickly dropped down to zero or even negative in recent years. This tells us overall real estate market is highly unpredictable; indicators might

explain the market fluctuation over one period of time, but this may quickly turn around over the next period. Moreover, price change in one specific area in Vancouver may or may not affect the price change in another region close by. This shows that real estate market in Vancouver is highly localized and it further reduce our ability to predict the market. In addition, we found in a subset of our data that non-Chinese home owners may have a higher return on luxury homes, this further add to the mystery of Vancouver real estate market.

In the end, we have some valuable findings such as currency changes may have show an increasing correlation when 3 months time lag is applied with some regions. This added some positive value to our research.

The structure of this thesis is as follows: (i) Section II examines a number of relevant literature research and earlier empirical evidence on the factors of corporate hedging and key findings on hedging and firm value; (ii) Section III reviews the limitation of the this research, (iii) Sections IV and V present the applied methodology, data analysis and empirical results; and (iv) Section VI reports our findings and conclusions.

2.0 Literature Review

It is obvious from Fereidouni and Masron's findings that foreign investors are more likely to purchase real estate properties in countries that have a higher price (Fereidouni & Masron, 2013). This explains the continuous heat and growing price in Vancouver real estate market. According to the most recent data, the real estate price increased by 3.2% compare to last year (Financial Post, 2014). Fereidouni and Masron also pointed out in their research that foreign investors are more attracted to markets that have higher "transparency" yet with "lower financing costs" (Fereidouni & Masron, 2013). In Canada, each province has the rights to set its own property law, and the property law is rooted from the "English common-law process" (except Québec); real estate brokers and mortgage brokers are registered and regulated separately by different government bodies; moreover, the information on each property is recorded and can by access easily by the public (Valentini & Hartog, 2011). Thus, it is safe to say that Canada has a relatively well-formed real estate legal system and it is transparent for investors especially foreign investors. Furthermore, Vancouver has no legal and tax curtailments regarding foreign speculation and multiple housing purchases (McCarthy, 2011). This creates a more equal environment for foreign investors and hence more attractive to them. The low interest rate in current years after the economic crash in 2008 has further stimulated the real estate market.

2.1 What is special about Vancouver?

Vancouver is the third largest city in Canada and a major port. Given its nature and position in the country, it has unique growth properties reflected in the following: partial switching from production of goods to services and adding new and emerging service industries (advanced services) (Hutton, 1994). Vancouver is also one of the most (often times the most) livable cities of the world (McCarthy, 2011). 2.1 million residents out of 4.5 million of total BC population live in Metro Vancouver. Downtown Vancouver is being transformed from a commercial centre to real estate high-rise epicenter. "Vancouverism", an architectural style, is

characterized by slim high-rise towers, purposed for both office and residence, positioned in high-density urban area (McCarthy, 2011). The nature of the city is also changing. Vancouver is no longer a head office center, since its business base is descending in size. Residential market drives the development (McCarthy, 2011). City authorities and politicians, along with residential developers work hard on leveraging Vancouver's reputation of one of the most livable cities, in order to keep the housing prices and property taxes at high levels (McCarthy, 2011). Moreover, Chinese residents make more than 10% of the population in BC province; this is proportionally the highest across all provinces in Canada. When we examine the Chinese population portion across all large cities in Canada, Vancouver wins the race with a high number of 18.2%, nearly twice the ratio of Toronto. Hence, Vancouver is one of the best cities in Canada to study Chinese real estate buying behavior with minimal uncertainty (Chinese Canadian, 2014).

2.2 Why are Chinese investors interesting?

China's high modernization rate and its economic growth have made the middle class simultaneously eager and weary. In case of a sudden need for retreat, members of middle class will look for safe heaven around the Pacific Rim (Ley, 2010). Many Chinese investors are also known as "satellite" investors and residents. In order to protect themselves from economic and political turmoil, they tend to acquire real estate in the Greater Vancouver Area. These investors often remain either residents of China or hold on to both residencies – Canadian and Chinese (McCarthy, 2011). The most accessible countries for Chinese immigrants are Canada, USA, Australia, New Zealand and Singapore – through their student visas and immigration programs. Many residents of Hong-Kong used the ex-colonial linkage to Britain to migrate to Canada. The migrants are drawn by quality of life, educational possibilities, and personal freedoms of the western world (Ley, 2010). The city is increasingly integrating with Pacific markets and societies. Being a major port, Vancouver has regular shipping links with the Pacific Rim, which facilitates the immigration flows (Hutton, 1994). 40% of the city population is born overseas and 25% of the population was born in Asia. Consequently, it is no surprise that

Vancouver is the most concentrated residential real estate market in the world, when it comes to investors who originate from China (McCarthy, 2011).

Unlike the long lasting real estate market in Canada, the Chinese real estate market stated rather late. According to Table 1 in Rao and Zhou's research (Appendix 1), it is not hard to find out, people in China only started to view real estate as a commodity after the 1998 reforming of housing market (Rao & Zhou, 2010). This may seem like an ordinary calendar year in the Chinese history alone, yet when this is combined with another global event, there are some interesting insights. In 1997, the British handed over Hong Kong back to the Chinese government and although it proved to be a smooth transition, people in Hong Kong looked for other places and methods to transfer their money to avoid a possible economic crisis in Hong Kong (McCarthy, 2011). Meanwhile, since people from mainland China have opened their eyes for real estate market domestically, it's natural for the high-income group to seek other purchasing opportunities globally. As mentioned before, due to the deep root between Chinese immigrants and Vancouver, it is not a surprise that Great Vancouver Area has attracted so many Chinese investors since the end of last century.

2.3 Why real estate?

From a history longer than we can all remember, Chinese has always seemed to leave the impression of loving real estate investment. In fact, this impression about Chinese people is accurate. The Chinese Canadians have a much higher home ownership than Canadian average, and the rate of home owning is constantly growing (Appendix 2). The observation of high rate in Chinese Canadian home-ownership is statistically significant since by common understanding, native Canadians should be more likely than minority immigrants to own their home (Chinese Canadian, 2014). One might ask why is this so? Why do Chinese love purchasing real estate? Although it seems from the data that this affection for real estate has lasted for about two decades (Appendix 2, from 1996-2010), will this trend change? Will the Chinese alter their chase towards some other investment, such as precious metals for example? Since the change of Chinese investment on the Canadian real estate market will most likely hit the

market hard, it is essential to find out why Chinese buyer are particularly fond of investing in real estate. To better answer this question, we should take a general look at Chinese culture and its history.Despite the fact we are living in a highly modernized world, and there are many products we believe that we can no longer live without, the fundamental needs for mankind to survive are met with food. This makes land an essential asset for humans throughout history since land can be used for farming and thereby produces food to support one's family (Agriculture, 2014). This is especially true for people living in ancient China. The reliable agricultural records can be dated back in Chou dynasty which is from the time 1122 to 221 BCE (Concise Political History of China, 1995). The records indicate that many Chinese farmers' livelihood was heavily dependent on their landlords (Tauger, 2011). To be more specific, a typical landlord hires an agent to help manage different farmers that are working on his land. The harvests from the land its then handed back to the landlord and a small portion of the harvests are returned to the farmers for their surviving needs (Tauger, 2011). Although the dynasty alters across the Chinese history and the land system varies during different dynasty as well, the dependence of farmers on their landlords has always existed in the background. The high regards of land is so fundamental in Chinese history to a point that one's wealth is usually measured by the size of his land (Elvin, 1970). In addition, the unspoken dream of most farmers is:

> "…able to buy half an acre or an acre of farmland and a house, have set up a tax-paying household of their own and wish to leave their master..." (Elvin, 1970).

This clearly shows that the passion and affection that Chinese people have towards land and real estate comes with their long lasting history. Whereas although the "property rights" has been loosened in the 1980s in mainland China, land and real estate are not completely private (Katrina Mullan, 2011); thus, it is reasonable for the enthusiastic Chinese buyers, immigrated or not, to invest in the Canadian, especially Vancouver, real estate market.

2.4 Potential Regulation Threats

The Canadian government has just cancelled its "Immigrant Investor Program" (LLP) in February 2014. The amount for limit has already doubled in 2010 from its initial $400,000 to $800,000 yet the overstock cases under process are still striking (Pavlich, 2014). The Canadian government has perfectly justified reasons for its decision: first of all, the loan required to apply were much lower in Canada compared to other immigration countries such as UK, Australia and New Zealand. On top of that, Canada also offered up-front permanent residency. Secondly, immigrant investor on average pays much less tax than skilled worker, and finds much harder to blend into society due to the language barrier, etc. (Woo, 2013). However, since over 80% of the cases sent back from the cancellation of LLP are rich Chinese investors, market professionals are worried that the real estate investment from overseas will take the hit.

Moreover, recent years, the Chinese government has more and more realized that some its rich citizens had transferred their money to overseas through investment projects, yet the Chinese government itself has not benefited from those who were allowed to "get rich first". This is particularly worry-some for stimulating the domestic economic in China, so the officials have passed regulations to limit the money transferred abroad to $50,000 per person. This news is also not very exciting for the real estate market since they are the ones need large amount of down payment for start up.

How the "negative" regulations from both countries impact the real estate market in Canada particularly in Vancouver is yet to be found out. However, in our opinion, there are other methods to immigrate to Canada and BC; moreover, the factors and historical links that have attracted Chinese immigrants in the past already exist. In addition, creative Chinese will also find other ways to transfer their money to invest into their investment of choice – the real estate market. Therefore, we are still positive with the stability and growth of the Canadian real estate market and Vancouver market.

2.5. How does gold thread into this subject?

As opposed to foreign exchange rates, we tested the correlation between the gold prices and real estate indices in Greater Vancouver. Some correlation is expected, since both of these vehicles are believed to be inflationary hedge. Higher demand for gold is associated with higher inflation and other uncertainties (Ghosh, 2004). In real estate renting, rent is usually adjusted for inflation, hence the yield follows the inflationary trends (Peyton 2011). Linking these two together, we assume correlation between gold and real estates and run a regression on their respective returns.

2.6 Understanding Foreign Exchange

The most wildly used currency for Chinese investors is probably RenMinBi (RMB), although different regions such as Hong Kong and Marco are using different currencies, but RMB still holds the major buying power for investors from Mainland China. Therefore, understanding the historical behavior of RMB exchange rate would be beneficial for our purpose of finding out the impact between Chinese investors and the real estate market in Vancouver. For a long period of time, Chinese Yuan (the basic unit of RM) is fixed on US dollars. The Chinese government has a very tight control over its currency. International corporations were not allowed to keep Chinese Yuan in their transactions. All the transactions are converted to US dollar, and then exchanged between parties of the transaction. Moreover, the exchange rate is preset by the government to ensure a favorable competitive advantage in the global market. Yuan was largely devalued after China opens its market in the late 1970s (Appendix 3). We can also see on the graph that for a very long period of time, since RMB exchange has a fixed reference on the US dollar, the graph appears to be almost a flat line (roughly from 1994 to 2005). Not until 2006 the Chinese government announced a narrow floating window for its RMB; and the currency market for RMB has started to form on the global market. It is now one of the most traded currencies internationally (Renminbi, 2014). Hence, it wouldn't be surprise that the RMB and USD behave very similarly with respect to HPI comparisons in the beginning years. Results for recent years might have more insights about the real estate market.

3.0 Limitations of the Research

There are some obvious limitations about our paper. First of all, this topic of predicting real estate prices using foreign exchange rates is fairly new and not a lot of research has done on this topic. Therefore, the literature review may not stand on a strong footing. Moreover, Housing Price Indices only maintains a monthly data for 14 years, so the span of our research is limited on that regard.

Generally speaking, we all know that two houses are not likely to be sold at the same price per square feet even though they are next to each other; the housing price may change a lot couple of blocks away. However, when we use the HPI data, only large region such as Vancouver West is considered as a whole. Details such as Kitsilano area verse UBC area were all ignored during our process. There might be some more exciting results when more detailed neighbourhood is captured and considered.

In addition, although some interesting results were present when analyzing home ownership return statistics, due to the limited data we have, further research were not able to proceed. The rationale behind why the Non-Chinese investors are willing to pay a premium on luxury homes is well worth exploring. Moreover, indirect investment such as REITS and other tools might be used home owners to offset real estate prices might worth to study as well. Further data on home owners versus their other investment portfolios will give us more insights on the matter.

4.0 Data and Methodology

4.1 Data

We obtained monthly values of home pricing indices (HPI's) in specific areas of Greater Vancouver publicly provided by REMAX, along with foreign exchange fluctuations of Chinese Yuan vs Canadian Dollar, United States Dollar and Canadian Dollar, and Gold Prices in Canadian Dollars. The observed period is from January 2000 to February 2014. For historical foreign exchange rates and gold prices, we have used the Bloomberg database.

REMAX is franchise based American real estate Company with global presence. It operates for in Canada for 20 years, and provides home pricing indices for various North American cities. For specific areas of Greater Vancouver, the HPI's start from January 2000. We have used the maximum available data set, in order to capture the most from the existing data. HPI measures pure price change of a typical property within the market. It accounts for lot size, age, number of rooms. The "typical property" concept hence captures more than average and median values do, by including the aforementioned factors (Real Estate Board of Greater Vancouver, 2012).

The problem with real estate market is that this is not a very liquid market; the best data we can find is a monthly data of price indices. However, this is not to say that the price does not change at all during the month, so a lot of the changes were unable to capture due to the illiquidity of the market and the high cost related to market research when one is trying to record the data more frequently. On the other hand, in order for HPI's monthly data to be comparable to foreign exchange data, we have used end of the month values for every cross-exchange rate and gold prices alike, for the same time window. The down side is that we purposely dropped a lot of volatilities for the constant changing prices of our indicators.

We have utilized all of the aforementioned data to get the monthly return for each respective data set. In order to get returns, natural logarithmic return is used:

$$R_t = ln(\frac{I_t}{I_{t-1}})$$

The components of the equation are as follows:

R_t – Return in the observed period

I_t – Index price at time t

I_{t-1} – Index price at time (t-1)

Log returns are used since they provide continuous compounding rate of return, and the fact that these results are much more tractable. (Tsay, 2005)

Some general properties of the data have been anticipated at the very beginning, and quantified as follows (the example is done on Vancouver Downtown HPI, and RMB_CAD exchange rate):

- Downtown HPI data has non-constant mean, is heavily auto correlated and has no constant variance, which was confirmed by ttest2, and Ljung-Box test.
- RMB_CAD exchange rate has non-constant mean, is heavily auto correlated and has no constant variance, which was confirmed by ttest2, and Ljung-Box test.

Figure 1 – Autocorrelation of HPI

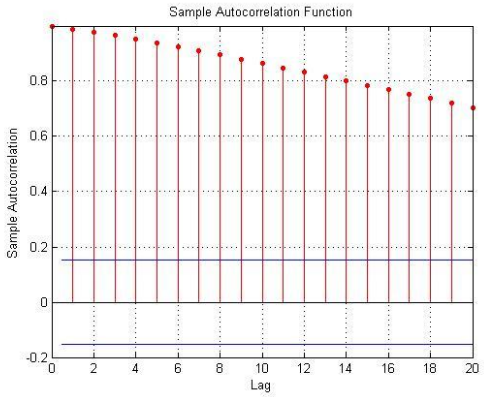
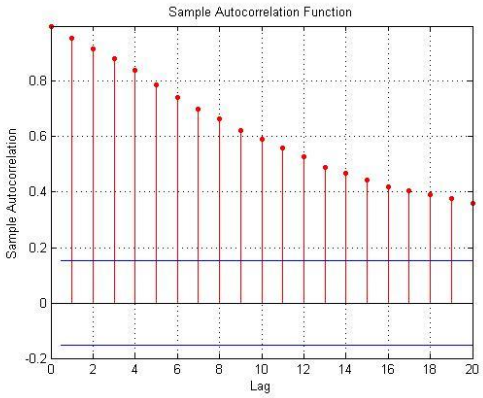


Figure 2 – Autocorrelation of RMB_CAD



In order to perform regressions on the data, the data needed to be de-trended in terms of mean and variance, and zero autocorrelation needed to be achieved. This was conducted by taking first order differentials on log returns, and (where needed) fitting an ARMA model including GARCH (if needed).

4.2 Methodology

In order to determine the cross-correlation of the data sets, the bivariate Vector Autoregressive Model is used. The model is consisted of two equations, each representing one observed data set (in this case HPI and RMB_CAD):

$$r_{1t} = \phi_{10} + \phi_{11} r_{1,t-1} + \phi_{12} r_{2,t-1} + a_{1t} ,$$
$$r_{2t} = \phi_{20} + \phi_{21} r_{1,t-1} + \phi_{22} r_{2,t-1} + a_{2t} ,$$

The first equation represents the linear dependence of the return one (in this case return on HPI) at time t on the returns of r_1 at (t-1) and return two at (t-1), thereby expressing the conditional effect of r_2, which is return on RMB_CAD, in this case.

The second equation, much like the first one, represents the conditional return of asset two, based on previous returns of assets one and two.

The ϕ coefficients represent the value of correlation coefficient of the accompanying return, which means that the output of the model is a 2X2 matrix of conditional cross-correlations of the two assets.

The correlation coefficient is an indicator which represents how two data sets are correlated with each other. The value spans from -1 to +1, thereby indicating if relation exists, and in which direction it moves. A correlation coefficient of zero indicates no correlation between two data sets. As the definition suggests the correlation coefficient is defined as follows:

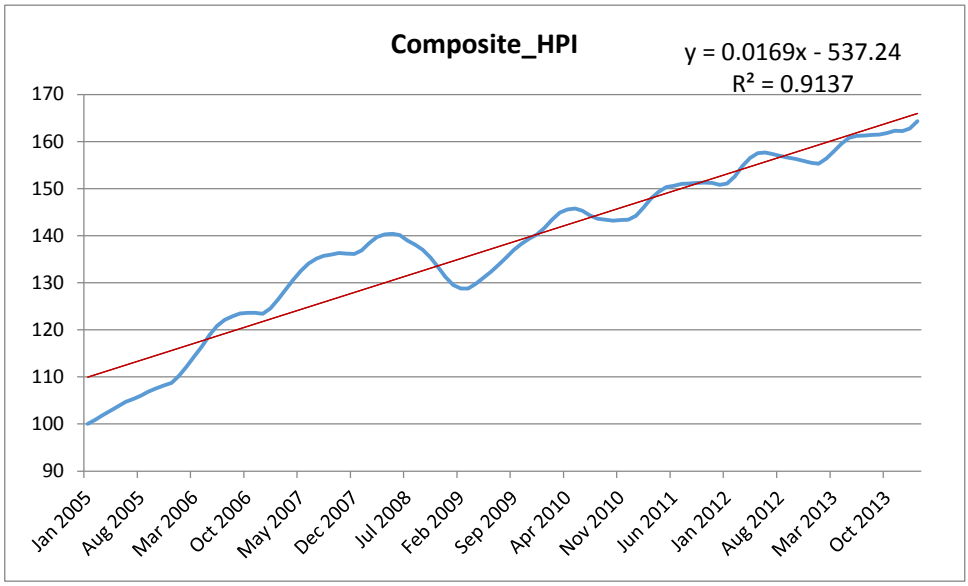
$$\rho_{ij}(l) = \frac{Cov(r_{it}, r_{j,t-l})}{std(r_{it}) * std(r_{j,t-l})}$$

This represents the correlation coefficient between returns r_{it} and $r_{j,t-l}$. It divides the covariance between the two returns with the product of their respective standard deviations.

5.0 Analysis of the Vancouver Real Estate Market

5.1 Analyzing the House Price Index (HPI) data

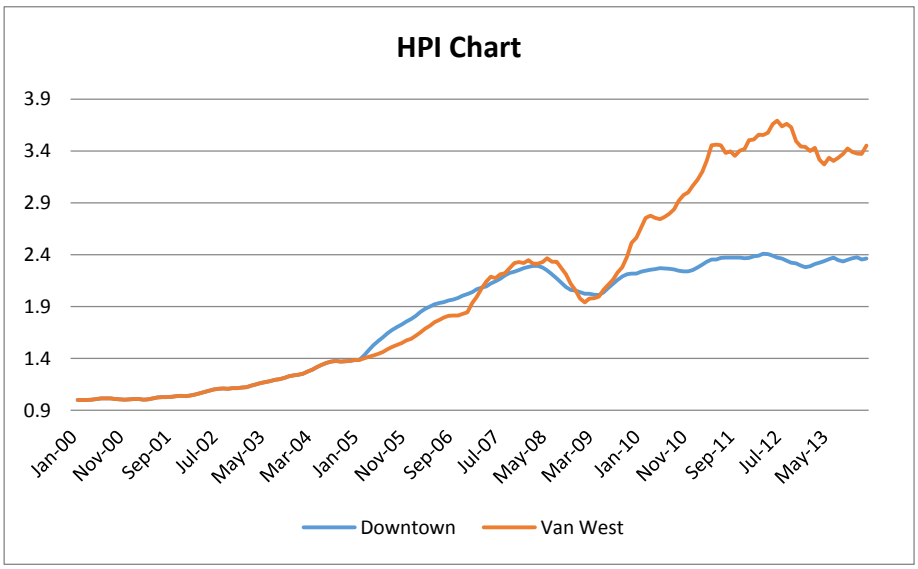
We first took a look the general return of HPI data. We analyzed the composite HPI of Greater Vancouver data since 2005. The upward trend is very clear. It has a strong linear correlation when we fit a linear line to the HPI composed return. We can see that over 90% of the data is explained. When we take a closer look to HPI in different locations within Great Vancouver Area; it is not hard to realize that price indexes across various locations took a big hit in 2008 and early 2009 when the housing market crisis occurred in US. Fortunately, the market was able to recover very quickly, by early 2010; majority of the locations had recovered to their historical level before the crisis. Then we move on to a subset of $1 million up transactions occurred in 2011 to 2013, we find that it seems that the real estate market is slowing down since in 2011 there were over 10,000 transactions over $1 million occurred, and this figure quickly dropped down to merely over 8,000 in 2010, and even lower in 2013. However, when we zoom out to a longer historical period, we can see on the composed HPI graph, the changes in the market is only a normal fluctuation, not a major downturn as occurred in 2008.



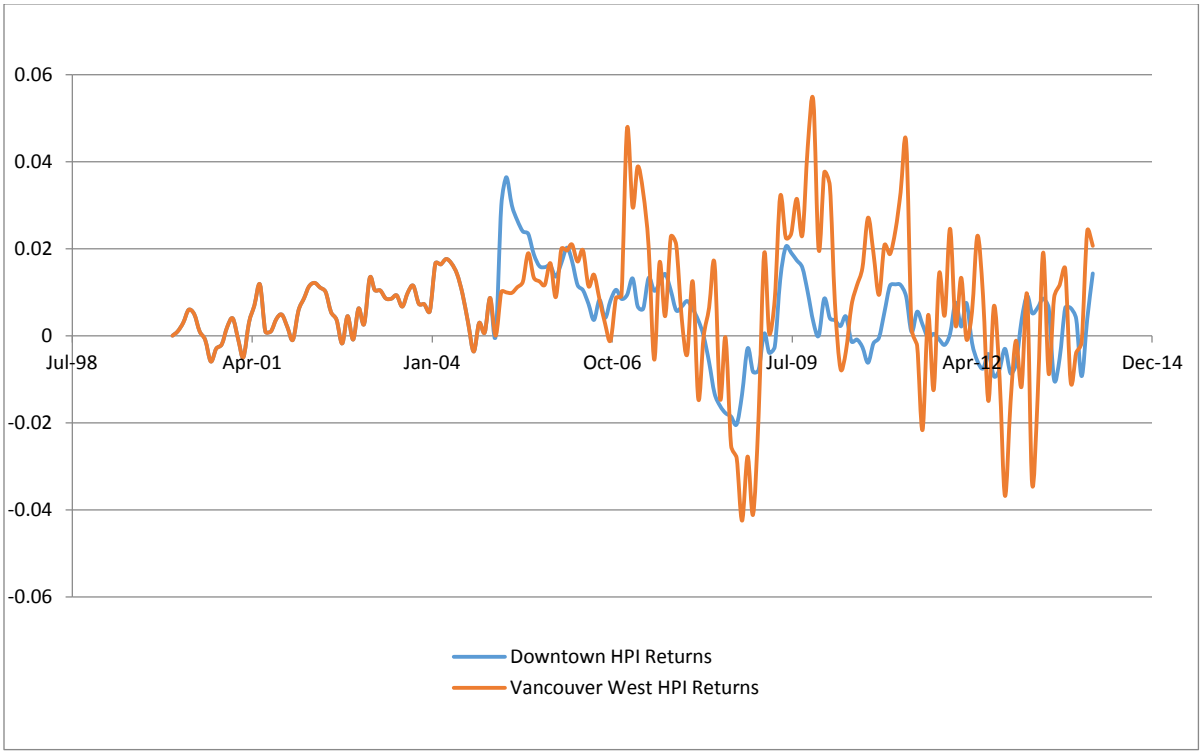
Moreover, we find that the $1 million transactions seem to concentrate in three major locations across Vancouver, Vancouver West, West Vancouver, and Richmond (listed from most

transactions to least transactions), so we decided take a closer look to these locations for further analysis, we also add Downtown area to the picture since it is viewed as a "good location" in Vancouver traditionally.

It is very obvious that prior to beginning of 2008, all locations had a steep growth curve. It seems that the graph of the prices merged into one line till around January 2005 (Appendix 5). The differences of the prices in various locations start to show after the crisis of 2009. We can clearly observe the characteristic of difference markets in Vancouver. For example, as the graph below, Downtown Vancouver market is much more flat. Although the housing price did recover after the crisis of 2009, but it did not exceed too much compare to the historical level. The growth is still somewhat noticeable, but it is also very flat, and we don't really see the overall economical conditions reflect on the graph. On the other hand, the Vancouver West real estate market views a serious growth since 2009. The difference in price of an average house between Downtown and Vancouver West has achieved as much as 100% by 2013. We can also see that the Vancouver West market is impacted more heavily according to the changes of the general market conditions. In fact, those two are the most interesting locations amongst the five locations we selected: Downtown market views the most flat return after 2009, whereas Vancouver West views the most dramatic growth.



Month to month log-returns of Downtown HPI and Vancouver West HPI



The characteristics of Downtown and Vancouver markets are made even more obvious when we transfer the data from HPI to log-returns. We can see that the return was perfectly correlated till sometime 2005; however, after 2005, Vancouver West starts to have a much higher volatility than Downtown market.

The price from other three locations also showed some valuable results too. The Richmond market went side by side with Vancouver West till the beginning of 2011, and then it took a hit and start declining in mid 2012. By the end of 2013, the Richmond market settled at 50% lower compared to Vancouver West market (Appendix 6). On the other hand, Vancouver East and West Vancouver markets are highly correlated; the graphs are very well aligned for the last thirteen years (Appendix 7).

5.2 Analyzing factors that might explain real estate market growth

5.2.1 Gold

Gold is a precious metal, and it is traditionally viewed as a good investment against currency inflation. It is interesting to find out when people are getting wealthier than before, will they invest in Gold or real state, or both? In addition, will the price of gold impact the real estate market?

By simply looking at the gold price changes for the past fifteen years, we can see a strong upward trend just like in the real estate market (Appendix 8). However, gold price was not affected by the housing market crisis in 2008; the price of gold actually went up during that period of time. This proves that people do invest in gold when the housing market and general economy is unstable, thus driving up the price in 2008. Moreover, since the trend looks generally the same, we expect a correlation in between gold price and the return of real estate market. Yet, since the return of downtown is more flat than other locations, we do expect a weaker link when regressing gold price against Downtown real estate return.

5.2.2 Foreign Currency Exchange

As mentioned before, Canada has a diversified population from different ethnic backgrounds. Canadian real estate market has an obvious advantage in attracting foreign investment. Hence, understanding foreign currency changes over time and the impact on the real estate market would be beneficial. We have chosen two foreign currencies to compare against the Canadian dollar. One is the Chinese Yuan (RMB) and the other is the US dollar (USD). Since the Chinese residents are the visible minority with the highest house ownership in Canada (Chinese Canadian, 2014), it is important to look into their purchasing power. Moreover, since USD is still widely used in the international market, this would be a good indicator for other foreign investment in Canada.

Generally speaking, the RMB exchange showed no obvious trend over the last fifteen years since it was heavily controlled for the most part of this time span (Renminbi, 2014). It started at around 5.5 Yuan per one Canadian dollar in the end of 20th century, and it ended at

about the same price in late 2013 (Appendix 9). The exchange did fluctuate over time, but it does not look similar as the real estate market. We thus expect no general correlation in between of RMB and the Vancouver real estate market. Furthermore, viewing the USD exchange, we can see a very weak trend from the end of 1990s till current (Appendix 10), but since the trend is not comparable to those of real estate market, we do not expect strong correlation as well.

5.3 Regression Results

Most of our expectation checked out, there is barely any link between downtown real estate market against all the factors.

Downtown Vancouver HPI shows insignificant correlation with Gold, RMB_CAD, and USD_CAD. On top of that very few regression results represent remotely statistically significant indicator, and none of them has a t-statistic value greater than 2 or -2. The ones with t-statistic values between 1 and two, however, are accompanied by high standard error value.

Vancouver West HPI shows 0.24 correlation with gold returns at time (t-2), with t-statistic of 1.4 and high standard error. Other values are similar to ones we got for Downtown Vancouver, meaning that no correlation can be derived.

Richmond HPI shows strong correlation of 0.52 with gold returns at time (t-2), with statistically significant t-statistic value of 3.04, and relatively high standard error. Additionally, the index shows low correlation of 0.129 and 0.156 with RMB_CAD and USD_CAD respectively, at (t-1), with low statistical significance of 1.61 and 1.49 respectively.

West Vancouver HPI indicates correlation with gold prices of 0.28 and 0.25 at (t-2), and (t-3) respectively, with low statistical significance of 1.57 and 1.43, and relatively high standard errors. Additionally, the index shows negative correlation of 0.21 with USD_CAD at (t-3), which statistically significant (t-statistic=-2.06), but it has relatively high standard error.

Additionally, another regression has been conducted: Composite Greater Vancouver HPI against RMB_CAD from 2008 to 2014. Due to limited HPI data points, these results should be

taken with reserve. Nevertheless, the regression shows significant correlation of returns on HPI with returns on RMB_CAD at (t-1), and significant negative correlation at (t-3). The results are statistically significant. However, the standard error has a high value.

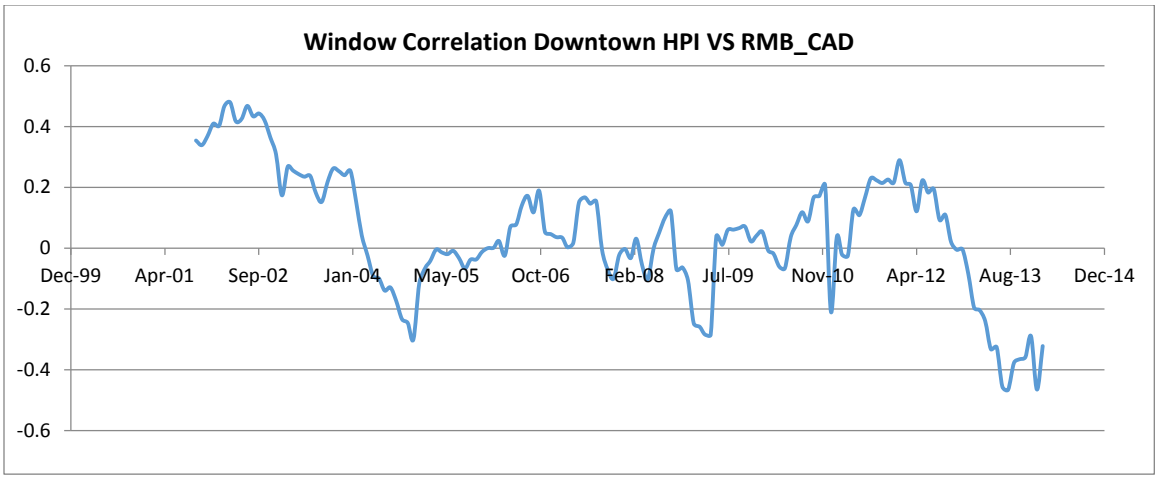
AR(1) Autoregression Matrix:	
-0.146083	0.271278
0.225084	-0.140627
AR(2) Autoregression Matrix:	
0.225706	-0.0386525
-0.118858	-0.0123324
AR(3) Autoregression Matrix:	
0.272509	-0.28177
0.275536	0.00253608

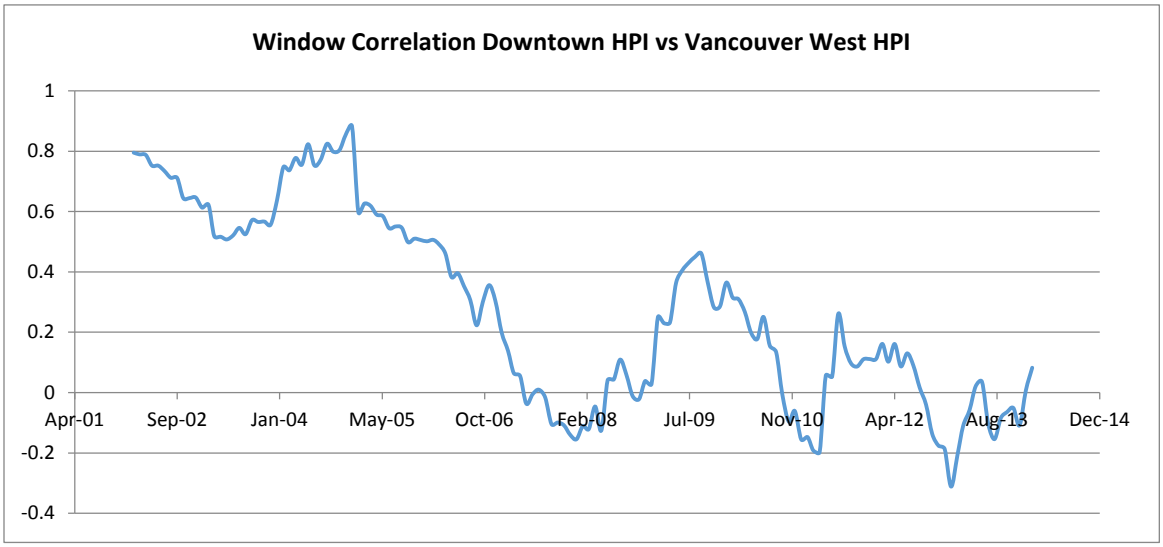
5.4 Window correlation of the data

As stated in the Methodology section, the relationship between the regression residuals is further explained by correlation coefficient in order to have more intuitive results. Static correlation coefficient is presented with every regression result, and dynamic (or window) correlation is used to further clarify the results by showing how the correlation changes through time. In order to have representable results, and given the limitations of the HPI data, every point of the window correlation represents correlation coefficient between the two data sets within the 20 months period.

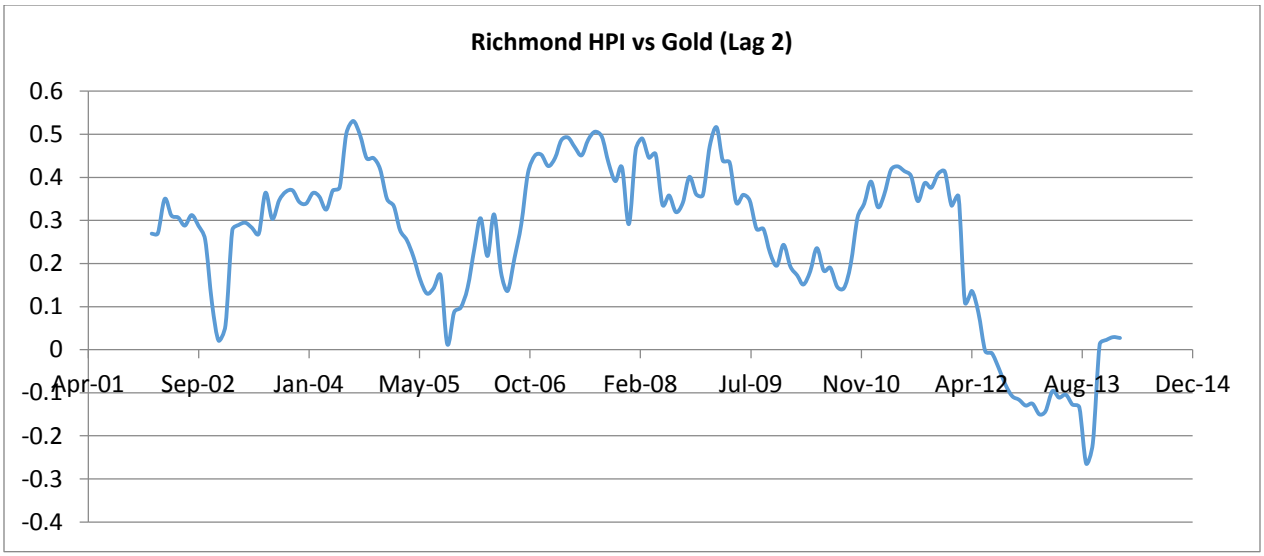
In order to test this approach, dynamic correlation was run on the residuals of S&P500 and S&P/TSX, given the known correlation of these two indices. Monthly returns from January 2000 to February 2014 were used to test this relationship. As expected, the results do show high correlation between the two indices, and how this correlation changes through time (Appendix 11).

The following graphs show window correlation of Downtown HPI residuals vs RMB_CAD residuals, and Downtown HPI residuals and Vancouver West HPI residuals:





On the other hand, we found that gold is positively correlated at lag 2 with locations such as Richmond and West Vancouver (Appendix 12). The static correlation at lag 2 between Richmond and gold price is 0.24; it is a good sign if this correlation is stable across the whole period. However, when we did the window correlations to verify the results, we find that the correlation with gold does not hold all the time at lag 2.



As we can see on the graph above, although gold price is positively correlated with Richmond HPI for the most part, this correlation did drop to almost -0.3 in 2003. Moreover, the correlation changes heavily over time, so gold price may not be a strong enough indicator to predict Richmond housing price.

5.5 Analyzing the subset of $2 million up transactions in 2012

We obtained this subset of data from CBRE Vancouver. The ownership list was purchased and transferred into a 0-1 data type, then passed to us. The Chinese owners here are those who have Chinese ethnic background, and maintained a Chinese last name.

We further analyzed a subset of data; all the transactions took place in year 2012, and the sales price of each transaction is at least $2 million dollars. Just by simply looking at the data, it is really interesting to find out that all those expensive properties are concentrated in a handful of area within Great Vancouver region. Those areas are Surrey, Vancouver West and West Vancouver. Popular areas or areas known to be pricy such as downtown Vancouver actually do not have properties over 2 million dollars or at least the ownership is not changing as frequently as other areas. When we examine the data more carefully, it is not hard to find out that within the 2070 transactions we have; 1737 transactions of properties are located in Vancouver West area, this makes to about 84% of transactions. Furthermore, within these

Vancouver West transactions, only about 380 are brought by Chinese owners, which is just under 22%. This is not surprising since Chinese are a visible minority in Great Vancouver; the population is more concentrated in places such as Richmond or Metrotown. We can conclude from the first glance of the data that $2 million+ transactions in 2012 are concentrated in three major areas: Surrey, Vancouver West and West Vancouver, with a great majority of the transactions occurring in Vancouver West, Amongst those transactions, most are conducted by non-Chinese owners.

We then performed more detailed analysis on the data. Return was calculated according to the first two sales dates. Since Vancouver West (VW) is the dominant region in our data, the regional analysis does not show significant difference. The average return after adjustment[1] is around 26.3% and the average holding period in between of the two sales dates is about 6.7 years. However, the median of the return is only 12.2% whereas the median for holding period is only over 4 years. This shows that the data is quite skewed and the longer the holding period the higher the return tends to be, this finding is consistent with common understanding.

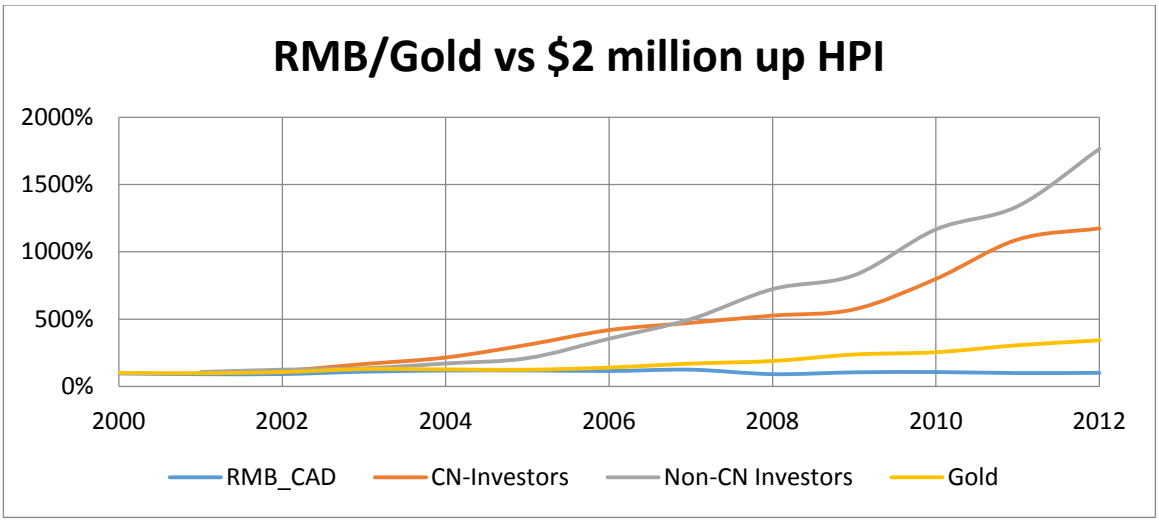
More interestingly, when we break the data down into Chinese owners and Non-Chinese owners, we see a very different result than we initially anticipated. First of all, as mentioned before, people of Chinese background are very passionate about real estate due to historical reasons and they also has a much higher home ownership rate compare to people from other ethnic backgrounds. One good guess about Chinese real estate purchasing behavior would be that they are much likely to pay a higher price since their true affection of houses. Moreover, they might even trade more frequently than others since they are constantly chasing their dream home. Surprisingly enough, none of the guesses were checked out. The average return on Chinese buyers of real estate is only about 21.4% this is significantly lower than the overall average. Non-Chinese buys has the highest return which comes up to 28.3%. To make this an even more interesting case, the average holding periods for Chinese owners are one year longer than the average yet the average holding periods for Non-Chinese owners are about 5 months shorter than the average. Hence, Chinese buyers generate a much lower return

[1] We have filleted out the empty data and eliminated the data with a return over 1000%; this contains the top 11 transactions. We have also removed the bottom 11 transaction to cut down both tails.

on real estate with a much longer holding period, and those of other ethnic groups trade more often and earns a higher return; this finding defeats the common understanding of longer holding period higher return. There might be a lot of interesting reasons behind this, more Chinese buyers may be better at bargaining, so they can buy their houses at more reasonable price, thus the low return. It could also be that the houses are not as well maintained than other owners, so it is priced lower compare to other houses (graph of the annualized return is showed below). Furthermore, it would be beneficial to find out which group pays the highest premium on the real estate market. However, due to the privacy protection we do not have access to more detailed data to further explore.

	Average Return	Holding Period (in years)	Median Return	Holding Period (in years)
Chinese investors (22%)	21.4%	7.8	11.9%	4.8
Non-Chinese investors (78%)	28.3%	6.3	12.6%	4.0

To further explore the data, we optimized the use of sales date3 and its sales price. We were able to calculated the annual return each year for both Chinese investors and non-Chinese investors from 2000-2012. Due to the scarcity of our data, the average returns for each year is heavily skewed; therefore we chose to use the median return as the return for each year. We then transformed this to two HPI indices and adjusted the gold price and RMB for them to be comparable. The graph for the RMB and gold price verses $2 million up homes price indices is showing as below.



We can see that the curve for Chinese investors is generally below the Non-Chinese investors, and the deviation is enlarging in later years. Moreover, both Chinese and Non-Chinese HPIs are well above the indices for gold and RMB; this may make sense to certain extend but the difference is quite unreasonable. Such high growth in HPI indices may be because the luxury market for housing market is just picking up in recent years. Other reasons might be that some houses were re-built on the original land and large value was added due to the new building. On the other hand, we do feel that part of this growth was due to the limited data we had, and the return was largely skewed to begin with.

In general, our findings for Chinese investors are still valuable. They do behave distinctively different than those who come from a difference background. Yet a much larger data sample is needed before any decisive conclusion can be drawn.

6.0 Findings and Conclusions

In this paper, we are aim to understand the history and reality of Vancouver real estate market. We aim to understand not only the present and what appears to be the fact but also the fundamental and physiological reasons for foreign investors to invest in real estate market especially Great Vancouver market. We also try to analyze couple of indicators that logically make sense to have an influence on real estate markets. Precious metal such as gold is important since historically commodity and real estate are both believed to be alternative investments compared to the liquid market. Exchange rates especially US dollar and Chinese Yuan would help us understand the international market as a whole as well as Chinese investors' specific buying power in the Vancouver market.

In this paper we tested our hypothesis of correlation between home pricing indices in Greater Vancouver and two foreign exchange rates and gold. The research process is constrained by insufficient data points for more thorough and in depth conclusions.

Although the compared raw data visually leaves the impression of high correlation, the actual econometric treatment of the data has proven otherwise. Most of the observed foreign exchange fluctuations have significant correlation with real estate market returns. According to this, a "cheaper" Canadian Dollar does not represent a decision trigger for real estate investors from China and United States.

In some very limited instances, based on this research, foreign exchange can be used as a variable element for forecasting of home prices with a 3 months lag. Interestingly, gold prices are positively correlated with real estate returns (especially with a 2 months lag) in some cases according to our research. This partially aligns with general assumption that real estates and gold are attractive inflation hedging instruments.

Furthermore, luxury homes seem to show a much faster price change than the general price change in gold or RMB. Both Chinese and non-Chinese home owners generate a decent return over the period we examined. However, resident Chinese home owners, although having a higher home ownership rate than people from other ethnic backgrounds, they may not give

you the highest real estate returns when dealing with them. They are also less likely to purchase luxury homes according to our results.

We believe that our research and its results are still fruitful. It is very obvious to us that the real estate market especially in the region of Great Vancouver Area is getter more and more difficult to predict. The once perfectly correlated HPI returns in different regions inside Vancouver Area have diverse heavily in recent years. This on one hand proves that real estate markets really have its beauty to hedge cash markets. However, one's return on real estate market may not be very predictable.

Further research can be done with respect to indirect real estate investing and the impact on real estate market; other exchange rate with regard to pricing predictions; and further explore on home owners' investment portfolios to better understand their investment behaviors. This will help explaining why premium is paid amongst some group but not others. With additional indicators, longer time span and access to more detailed data future research may be able to give us more valuable results and help predicting housing prices in Great Vancouver Area or other regions.

8.0 Appendix

Appendix 1:

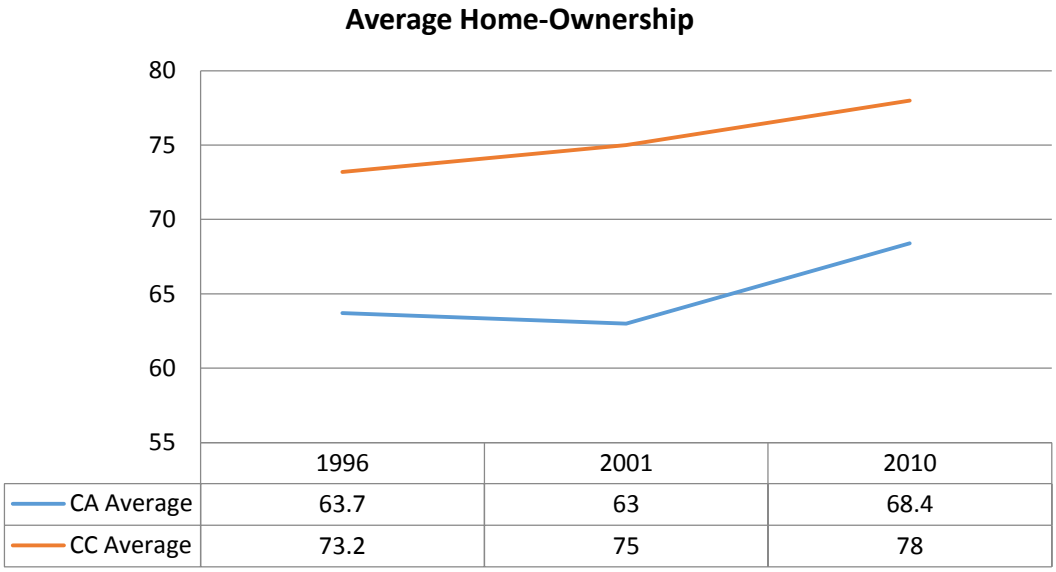
Table 1

Milestones in the Development of China's Real Estate Market

Year	Development
1988	Constitution changed to permit transfer of state-owned land-use rights
1992	Start of public housing sales in major cities
1995	Regulations on sale and resale of real estate issued
1998	Abolition of all state-allocated housing, establishment of residential mortgages
2002	All sale of government land required to be by public auction, tender, or listing
2005	National administrative control measures to cool down overheating sector
2007 (2d half)	Real estate market downturn started with policy tightening
2008Q4	Unwinding of tightening measures to revive market

Source: Rao, X., & Zhou, Y. (2010, March–April). China's Real Estate Market Mid-Term Correction and Long-Term Growth. *The Chinese Economy, 43*(2), 23–32. doi:10.2753/CES1097-1475430202

Appendix 2:

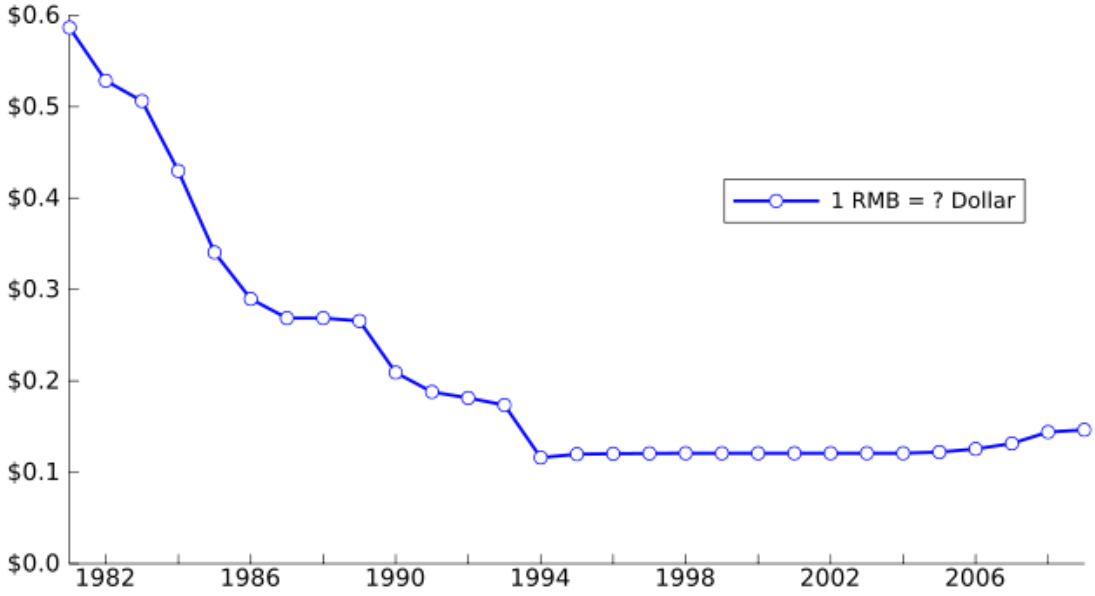


	1996	2001	2010
CA Average	63.7	63	68.4
CC Average	73.2	75	78

Note: CA Average: Canadian Average; CC Average: Chinese Canadian Average
Measurements in percentage

Source: *Chinese Canadian*. (2014, March 15). Retrieved March 16, 2014, from Wikipedia: http://en.wikipedia.org/wiki/Chinese_Canadian

Appendix 3:



Source: *Renminbi*. (2014, April 3). Retrieved April 6, 2014, from Wikipedia: http://en.wikipedia.org/wiki/Renminbi#International_use

Appendix 4:
Matlab scripts

A – Data Standardization

```
%% clean all the data and close all the figure
clc
clear all
close all
format compact

%%Author: Zarko Kolaric & Lei Yang
%Student ID: 301084642
%date: Jan 28, 2014

%%P1 (a) Test for constant mean.
data = xlsread('RMB_CAD','Monthly RMB_CAD','B15:B184');
%startDate=datenum('01.2000','mmyyyy');
%endDate = datenum('02.2014','mm.yyyy');
%Date=datenum(startDate:endDate);

logData=log(data);
Diff=diff(logData);

figure(1)
plot(Diff);

%% Check for CONSTANT MEAN
L=round(length(Diff)/2);
mean1      = Diff(1:L);
mean2      = Diff(L+1:end);
H=ttest2(mean1,mean2)

if H == 0
  disp(['HPI Means are Equal.']);
else
  disp(['HPI Means are NOT Equal.']);
end
disp(' ');

%% Check for Autocorrelation and GARCH Effects
if lbqtest(Diff) == 0
  disp(['Diff-Log Return of HPI passes the Ljung-Box test for autocorrelation.']);
else
  disp(['Diff-Log Return of HPI FAILS the Ljung-Box test for autocorrelation.']);
end
disp(' ');
if lbqtest(Diff.^2) == 0
  disp(['Squared Diff-Log Return of HPI passes the Ljung-Box test for conditional heteroscedasticity, indicating no
GARCH Effects.']);
```

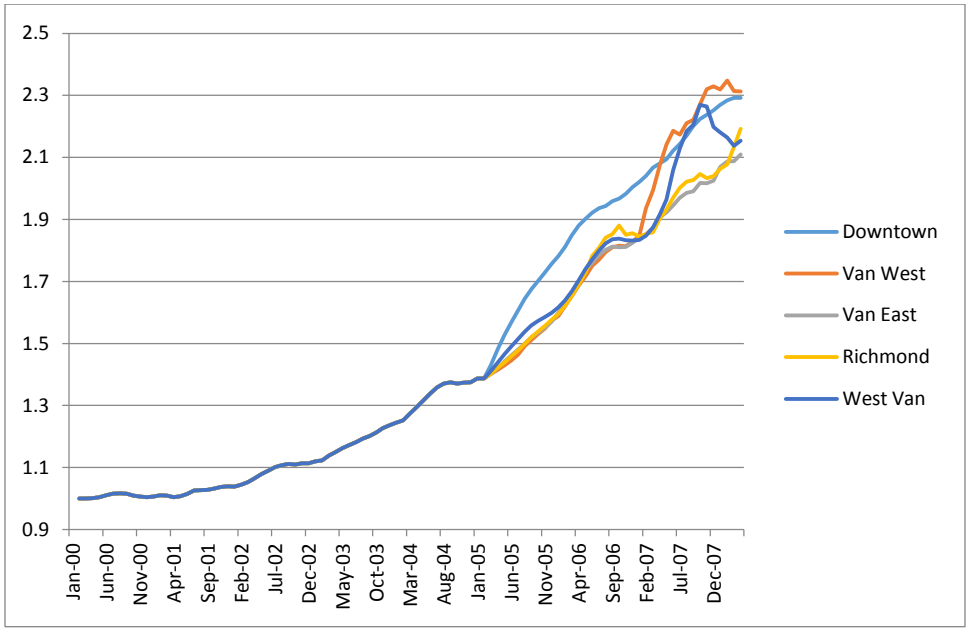
```
else
  disp(['Squared Diff-Log Return of HPI FAILS the Ljung-Box test for conditional heteroscedasticity, indicating
PRESENCE of GARCH Effects.']);
end
disp(' ');

figure(2);
autocorr(Diff);
%%
% Fit an ARMA(p,q) model to the data, for p = 0,1,2,3,4 and q = 0,1,2,3,4
% and pick the model with the lowest BIC value

bestFit = 0;
bestBIC = Inf;
BIC = zeros(3,3);

for p = 0:2
   for q = 0:2
      if (p==0) && (q==0)
         BIC(p+1,q+1) = Inf;
      else
         currentModel = arima(p,0,q);
         [currentFit,~,currentLogL] = estimate(currentModel,Diff,'print',false);
         [currentAIC,currentBIC] = aicbic(currentLogL,p+q+1,length(Diff));
         if currentBIC < bestBIC
            bestFit = currentFit;
            bestBIC = currentBIC;
         end
         BIC(p+1,q+1) = currentBIC;
      end
   end
end
disp(['Based on the BIC criterion, the ARMA model picked is: ']);
bestFit

%% Calculate the model residuals and check for GARCH effects
residuals = infer(bestFit,Diff);

% %% HPI Manual ARMA Fit
%
% %%select models for HPI
% p=2;
% q=1;
% model  = arima(p,0,q);
% fit    = estimate(model, Diff, 'print', false);
% model  = arima('AR', fit.AR, 'MA', fit.MA, ...
%              'Constant', fit.Constant, ...
%              'Variance', fit.Variance);
% residuals      = infer(model, Diff(max(p,q)+1:end), 'Y0', Diff(1:max(p,q)));

if lbqtest(residuals) == 0
```

```
  disp(['Model Residuals (ARMA) passes the Ljung-Box test for serial autocorrelation, indicating no GARCH
effects.']);
else
  disp(['Model Residuals (ARMA) fails the Ljung-Box test for serial autocorrelation, indicating the presence of
GARCH effects.']);
end

if lbqtest(residuals.^2) == 0
  disp(['Squared Model Residuals (ARMA) passes the Ljung-Box test for serial autocorrelation, indicating no GARCH
effects.']);
else
  disp(['Squared Model Residuals (ARMA) fails the Ljung-Box test for serial autocorrelation, indicating the presence
of GARCH effects.']);
end

%% HPI - Fit an ARMA(p,q) model with a GARCH(1,1) model

% Specify model to fit.  R and M corresponds to Autoregressive model order
% of ARMA(R,M).  P and Q corresponds to model order of GARCH(P,Q).
spec = garchset('R', bestFit.P, 'M', bestFit.Q,'P',1,'Q',1);
[Coeff,Errors,LLF,Innovations,Sigmas,Summary] = garchfit(spec,residuals);

% Verify that the standardized innovations are white noise, using the Ljung-Box test
std_innovations = Innovations./Sigmas;

if lbqtest(std_innovations) == 0
  disp(['Standardized HPI Residuals from GARCH model pass the Ljung-Box test for serial autocorrelation, indicating
that it is white noise.']);
else
  disp(['Standardized HPI Residuals from GARCH model fail the Ljung-Box test for serial autocorrelation, indicating
that it is not white noise.']);
end

if lbqtest(std_innovations.^2) == 0
  disp(['Squared Standardized HPI Residuals from GARCH model pass the Ljung-Box test for serial autocorrelation,
indicating constant volatility.']);
else
  disp(['Squared Standardized HPI Residuals from GARCH model fail the Ljung-Box test for serial autocorrelation,
indicating non-constant volatility.']);
end

%%
DT=std_innovations;
save DT.mat DT;
```

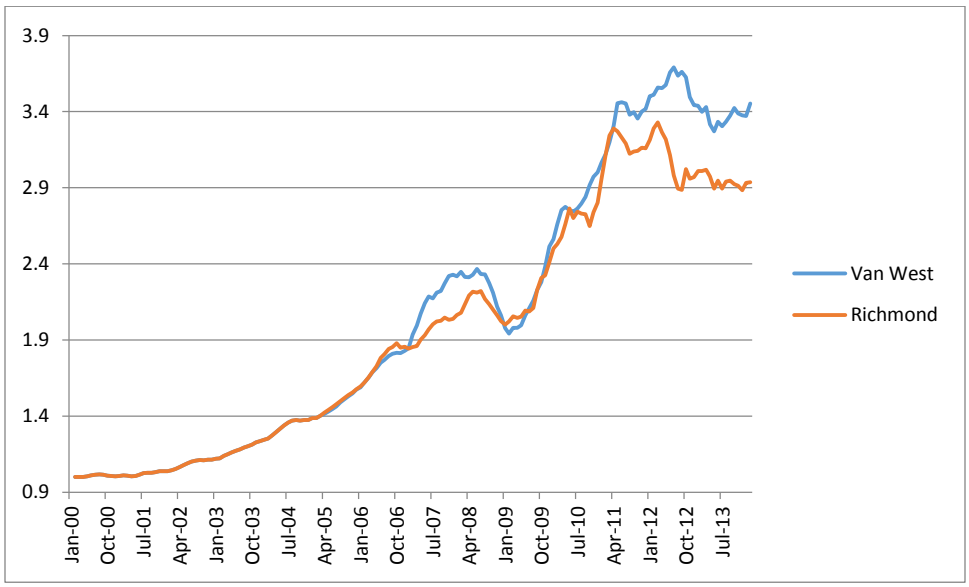
B – VAR Model

```
%% clean all the data and close all the figures
clc
clear all
close all
format compact
%%

load('RichmondHPI.mat');
load('Gold_CAD.mat');

if length(DT) > length(goldRes)
   DT = DT(length(DT) - length(goldRes) + 1:end);
else
   longer = goldRes;
   goldRes = goldRes(length(goldRes) - length(DT) + 1:end);
end


disp('Correlation between the data is = ')
corr(DT,goldRes)

[xcorrcoeff, lag]= xcov(DT,goldRes,6,'coef')

%DT=DT*10;
goldRes=goldRes*10;


figure(3);
subplot(2,1,1);
plot(DT);
subplot(2,1,2);
plot(goldRes);


%% Estimate VAR using vgxvarx (Matlab function)
disp(' ')
disp('VAR Fitting using Matlab vgxvarx:')
n=2;  %number of time series
A=[DT, goldRes];
%A = [residuals, diffGold];
nAR=3; %AR lags
Constant=true;
Spec = vgxset('n',n,'nAR',nAR,'Constant',Constant);
[EstSpec,EstStdErrors,LLF,W] = vgxvarx(Spec,A);
vgxdisp(EstSpec)
disp(' ')
vgxdisp(EstSpec,EstStdErrors)
```

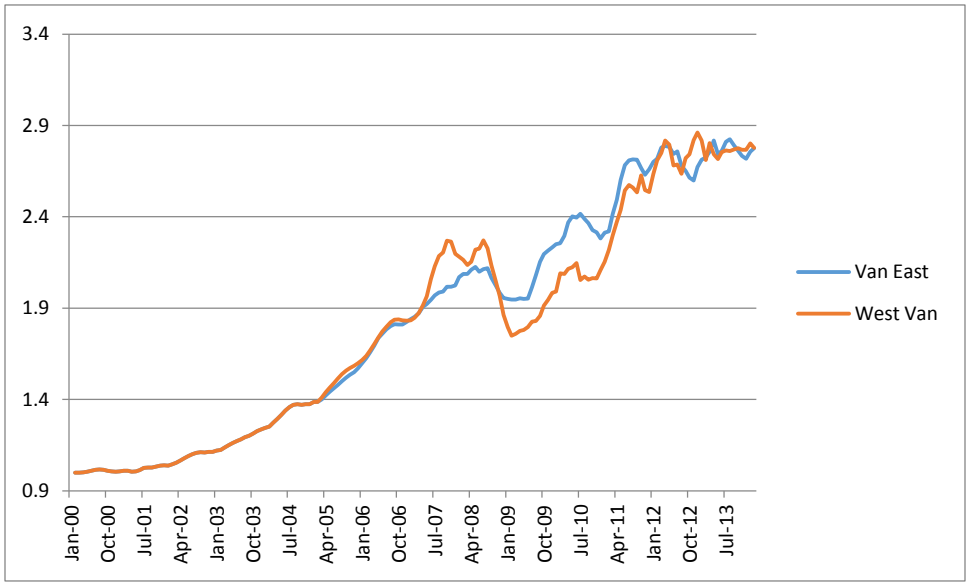
Appendix 5:



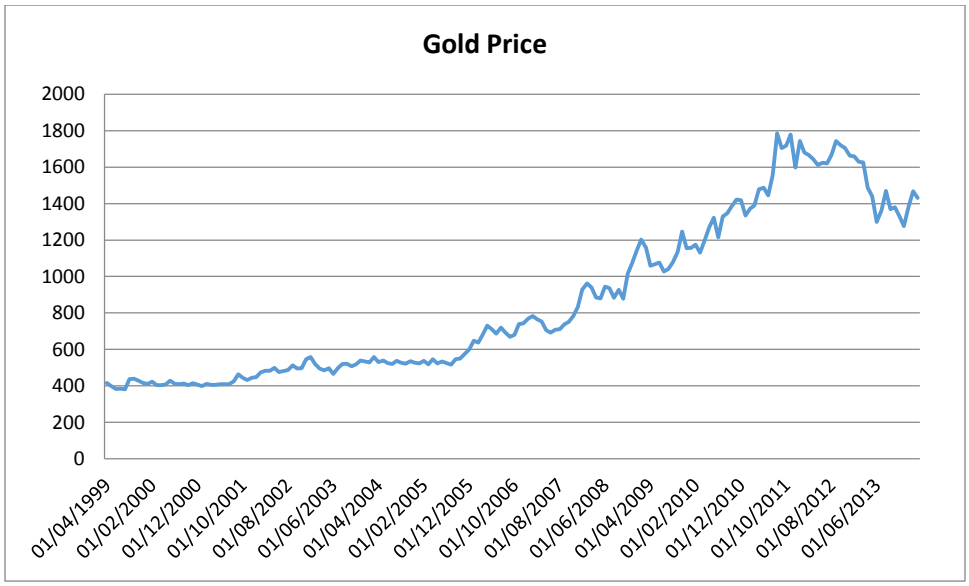
Appendix 6:



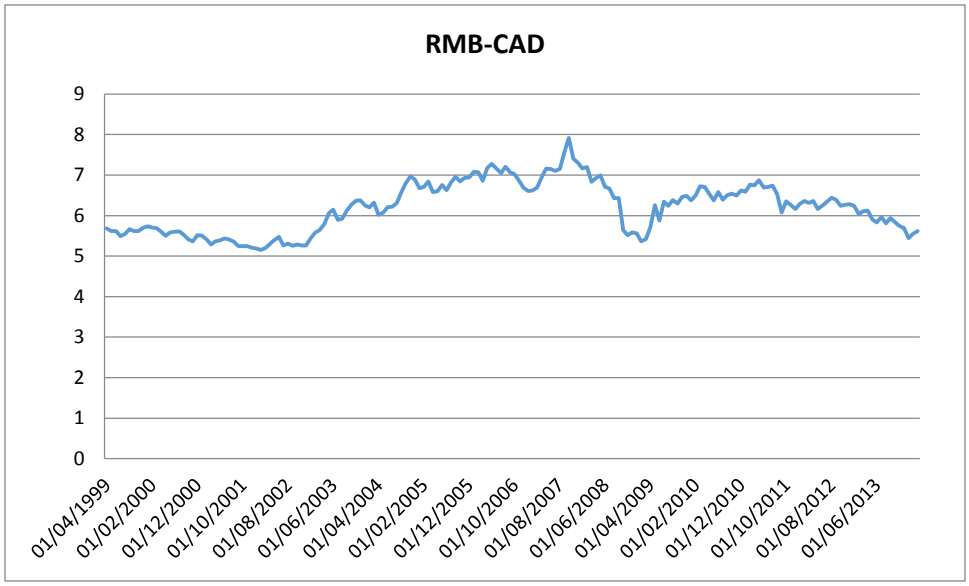
Appendix 7:



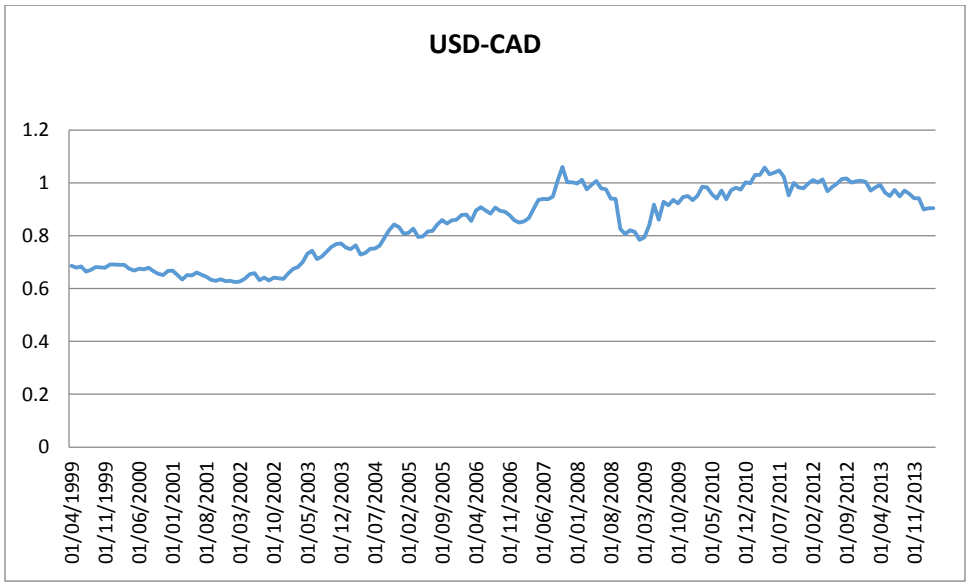
Appendix 8:



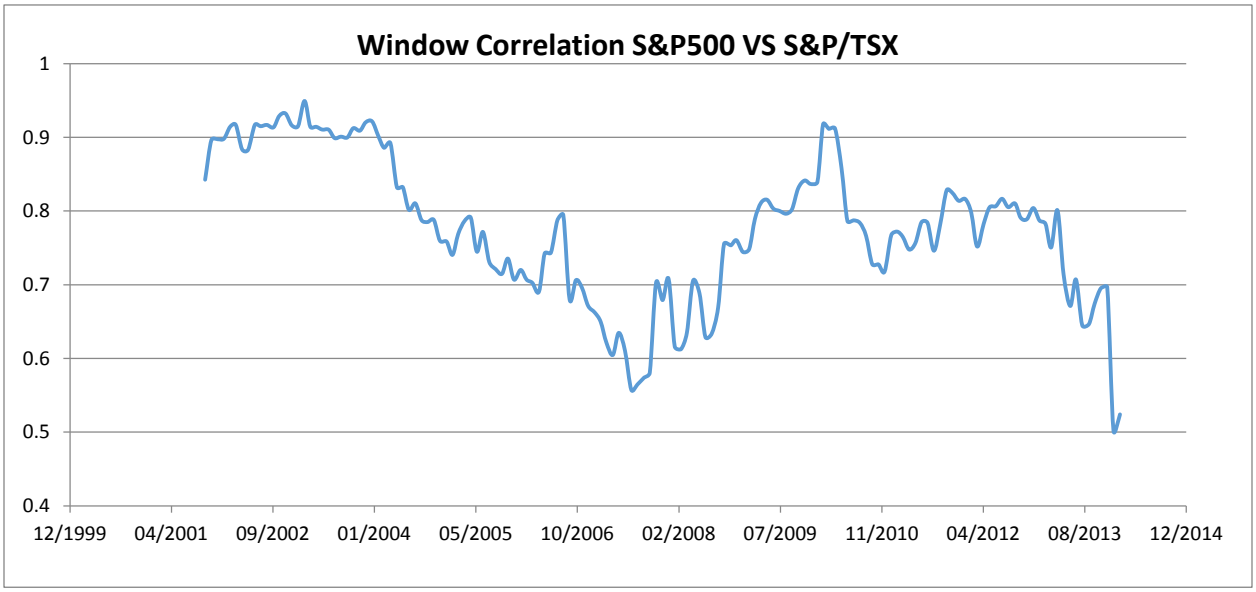
Appendix 9:



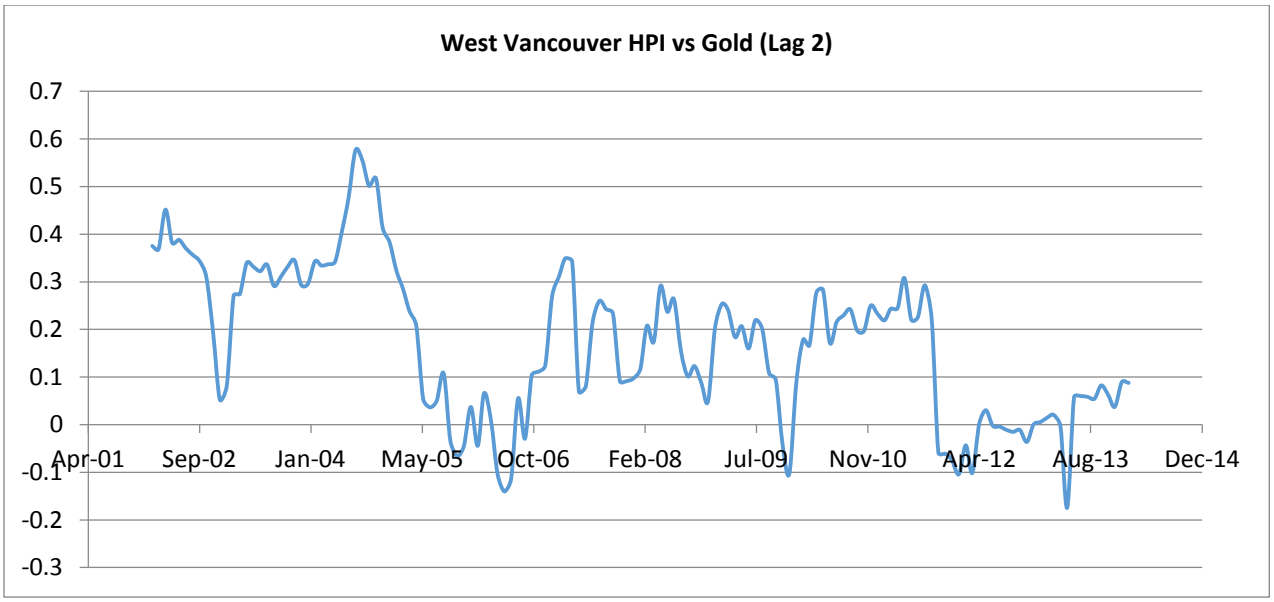
Appendix 10:



Appendix 11:



Appendix 12:



Appendix 12: Regression Results

Dowtown

VS Gold

ans =

-0.02

xcorrcoeff =

-0.033
0.0137
0.0304
-0.037
-0.046
-0.01
-0.02
0.0034
0.0211
-0.059
-0.051
0.0261
0.0738

lag =

-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6

VAR Fitting using Matlab vgxvarx:

Model : 2-D VAR(3) with Additive Constant
Conditional mean is AR-stable and is MA-invertible
a Constant:
0.0005
0.008
AR(1) Autoregression Matrix:
0.0446151 0.00091298
-0.0110689 -0.0487671
AR(2) Autoregression Matrix:
-0.0260606 0.0206865
-0.0441338 -0.0732413
AR(3) Autoregression Matrix:
-0.0176348 -0.0732505
-0.0322972 0.0290651
Q Innovations Covariance:
0.00272954 -3.8807e-05
-3.8807e-05 0.0020521

Model : 2-D VAR(3) with Additive Constant
Conditional mean is AR-stable and is MA-invertible
Standard errors without DoF adjustment (maximum likelihood)

Parameter	Value	Std. Error	t-Statistic
a(1)	0.000539508	0.00418293	0.128978
a(2)	0.00796602	0.00362689	2.19638
AR(1)(1,1)	0.0446151	0.0778645	0.572985
(1,2)	0.00091298	0.0892102	0.010234
(2,1)	-0.0110689	0.0675139	-0.163951
(2,2)	-0.0487671	0.0773514	-0.630461
AR(2)(1,1)	-0.0260606	0.0789839	-0.329948
(1,2)	0.0206865	0.089873	0.230175
(2,1)	-0.0441338	0.0684845	-0.644435
(2,2)	-0.0732413	0.0779261	-0.939881
AR(3)(1,1)	-0.0176348	0.0807305	-0.218441
(1,2)	-0.0732505	0.0903498	-0.810743
(2,1)	-0.0322972	0.069999	-0.461396
(2,2)	0.0290651	0.0783395	0.371015
Q(1,1)	0.00272954		
Q(2,1)	-3.8807e-05		
Q(2,2)	0.0020521		

VS RMBCAD

ans =

0.032

xcorrcoeff =

0.2119
0.0778
0.0115
0.1151
0.0448
0.1286
0.032
0.0029
0.1011
-0.063
0.0626
0.1326
0.094

lag =

-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6

VAR Fitting using Matlab vgxvarx:

Model : 2-D VAR(3) with Additive Constant
Conditional mean is AR-stable and is MA-invertible
a Constant:
0.0016
0.0085
AR(1) Autoregression Matrix:
0.046959 -0.000290834
0.242506 0.0128459
AR(2) Autoregression Matrix:
-0.0298259 0.0574193
0.0737771 -0.0698609
AR(3) Autoregression Matrix:
-0.0198417 -0.0379942
0.240801 0.0318517
Q Innovations Covariance:
0.269732 0.0199768
0.0199768 0.940068

Model : 2-D VAR(3) with Additive Constant
Conditional mean is AR-stable and is MA-invertible
Standard errors without DoF adjustment (maximum likelihood)

Parameter	Value	Std. Error	t-Statistic
a(1)	0.00160299	0.040094	0.0399808
a(2)	0.00853233	0.0748419	0.114005
AR(1)(1,1)	0.046959	0.077821	0.603423
(1,2)	-0.000290834	0.0410626	-0.00708271
(2,1)	0.242506	0.145265	1.6694
(2,2)	0.0128459	0.0766499	0.167591
AR(2)(1,1)	-0.0298259	0.079069	-0.377213
(1,2)	0.0574193	0.0413847	1.38745
(2,1)	0.0737771	0.147595	0.499862
(2,2)	-0.0698609	0.0772512	-0.904334
AR(3)(1,1)	-0.0198417	0.0805354	-0.246372
(1,2)	-0.0379942	0.0415185	-0.915115
(2,1)	0.240801	0.150332	1.60179
(2,2)	0.0318517	0.0775009	0.410985
Q(1,1)	0.269732		
Q(2,1)	0.0199768		
Q(2,2)	0.940068		

VS USDCAD

ans =

0.0069

xcorrcoeff =

0.2159
8.60E-02
1.00E-03
0.1066
0.0532
0.1011
0.0069
-0.0083
0.0593
-0.049
0.0755
0.1232
0.0856

lag =

-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6

VAR Fitting using Matlab vgxvarx:

Model : 2-D VAR(3) with Additive Constant
Conditional mean is AR-stable and is MA-invertible
a Constant:
#######
0.0004
AR(1) Autoregression Matrix:
0.0443442 -0.00646072
0.10547 -0.0194269
AR(2) Autoregression Matrix:
-0.0249714 0.061156
0.052096 -0.040748
AR(3) Autoregression Matrix:
-0.0131224 -0.0515928
0.119305 -0.0396313
Q Innovations Covariance:
0.000692343 3.81578e-06
3.81578e-06 0.000686551

Model : 2-D VAR(3) with Additive Constant
Conditional mean is AR-stable and is MA-invertible
Standard errors without DoF adjustment (maximum likelihood)

Parameter	Value	Std. Error	t-Statistic
a(1)	-2.09318e-05	0.00205039	-0.0102087
a(2)	0.000396566	0.00204179	0.194224
AR(1)(1,1)	0.0443442	0.0785667	0.564415
(1,2)	-0.00646072	0.0776234	-0.0832316
(2,1)	0.10547	0.0782374	1.34808
(2,2)	-0.0194269	0.077298	-0.251324
AR(2)(1,1)	-0.0249714	0.0799268	-0.312428
(1,2)	0.061156	0.0781962	0.782084
(2,1)	0.052096	0.0795918	0.65454
(2,2)	-0.040748	0.0778684	-0.523292
AR(3)(1,1)	-0.0131224	0.0815132	-0.160984
(1,2)	-0.0515928	0.078172	-0.65999
(2,1)	0.119305	0.0811715	1.46979
(2,2)	-0.0396313	0.0778443	-0.50911
Q(1,1)	0.000692343		
Q(2,1)	3.81578e-06		
Q(2,2)	0.000686551		

Vancouver West

VS Gold	VS RMBCAD	VS USDCAD
Correlation between the data is =	**Correlation between the data is =**	**Correlation between the data is =**
0.061	**0.12**	**0.13**
xcorrcoeff =	**xcorrcoeff =**	**xcorrcoeff =**
0.1008	-0.041	-0.092
-0.074	-0.008	-0.029
0.0286	0.0616	0.0299
0.0969	0.1457	0.1656
-0.168	0.2656	0.2342
-0.033	0.0643	0.0571
0.061	**0.12**	**0.13**
0.0046	-0.013	-0.039
0.138	0.0703	0.094
-0.057	-0.025	-0.017
0.0408	0.0053	0.0383
0.0123	0.1157	0.1084
-0.004	0.0925	0.069
lag =	**lag =**	**lag =**
-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6	-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6	-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6
VAR Fitting using Matlab vgxvarx:	**VAR Fitting using Matlab vgxvarx:**	**VAR Fitting using Matlab vgxvarx:**
Model : 2-D VAR(3) with Additive Constant	Model : 2-D VAR(3) with Additive Constant	Model : 2-D VAR(3) with Additive Constant
Conditional mean is AR-stable and is MA-invertible	Conditional mean is AR-stable and is MA-invertible	Conditional mean is AR-stable and is MA-invertible
a Constant:	a Constant:	a Constant:
######	0.0153	0.0001
0.0078	0.0112	0.0003
AR(1) Autoregression Matrix:	AR(1) Autoregression Matrix:	AR(1) Autoregression Matrix:
-0.00176414 0.0103445	-0.00637072 -0.0140778	-0.00125967 -0.0148782
-0.0352998 -0.0288136	0.0621929 -0.0411951	0.172186 -0.0784487
AR(2) Autoregression Matrix:	AR(2) Autoregression Matrix:	AR(2) Autoregression Matrix:
0.0200765 0.16783	0.0178203 0.0803628	0.0145935 0.0392209
-0.139251 -0.0562167	0.260224 -0.0967954	0.619622 -0.0774378
AR(3) Autoregression Matrix:	AR(3) Autoregression Matrix:	AR(3) Autoregression Matrix:
-0.00928867 -0.0597477	-0.0174777 -0.028956	-0.0147099 -0.0064014
0.0720833 0.0420708	0.149947 0.0278432	0.491053 -0.0583294
Q Innovations Covariance:	Q Innovations Covariance:	Q Innovations Covariance:
0.0029682 0.000194727	1.20681 0.134879	0.000120142 3.85281e-05
0.000194727 0.00200419	0.134879 0.882944	3.85281e-05 0.000637992
Model : 2-D VAR(3) with Additive Constant	Model : 2-D VAR(3) with Additive Constant	Model : 2-D VAR(3) with Additive Constant
Conditional mean is AR-stable and is MA-invertible	Conditional mean is AR-stable and is MA-invertible	Conditional mean is AR-stable and is MA-invertible
Standard errors without DoF adjustment (maximum likelihood)	Standard errors without DoF adjustment (maximum likelihood)	Standard errors without DoF adjustment (maximum likelihood)
Parameter Value Std. Error t-Statistic	Parameter Value Std. Error t-Statistic	Parameter Value Std. Error t-Statistic
a(1) 2.55248e-05 0.0044191 0.00577602	a(1) 0.0152946 0.085819 0.178219	a(1) 0.000147546 0.000856239 0.172319
a(2) 0.00782683 0.00363126 2.15541	a(2) 0.0112174 0.0734057 0.152814	a(2) 0.000255422 0.00197313 0.12945
AR(1)(1,1) -0.00176414 0.0786483 -0.0224307	AR(1)(1,1) -0.00637072 0.0790154 -0.0806264	AR(1)(1,1) -0.00125967 0.0791458 -0.0159159
(1,2) 0.0103445 0.0952508 0.108603	(1,2) -0.0140778 0.0906883 -0.155233	(1,2) -0.0148782 0.0334985 -0.444145
(2,1) -0.0352998 0.0646267 -0.546211	(2,1) 0.0621929 0.0675862 0.920201	(2,1) 0.172186 0.182384 0.944084
(2,2) -0.0288136 0.0782693 -0.368135	(2,2) -0.0411951 0.0775707 -0.531065	(2,2) -0.0784487 0.0771942 -1.01625
AR(2)(1,1) 0.0200765 0.0778718 0.257815	AR(2)(1,1) 0.0178203 0.0792141 0.224964	AR(2)(1,1) 0.0145935 0.0791824 0.184303
(1,2) 0.16783 0.0944153 1.77757	(1,2) 0.0803628 0.0883407 0.909691	(1,2) 0.0392209 0.0328994 1.19215
(2,1) -0.139251 0.0639887 -2.17619	(2,1) 0.260224 0.0677562 3.84059	(2,1) 0.619622 0.182463 3.39577
(2,2) -0.0562167 0.0775827 -0.724604	(2,2) -0.0967954 0.0755627 -1.28099	(2,2) -0.0774378 0.0758136 -1.02142
AR(3)(1,1) -0.00928867 0.0791893 -0.117297	AR(3)(1,1) -0.0174777 0.082448 -0.211985	AR(3)(1,1) -0.0147099 0.0817189 -0.180007
(1,2) -0.0597477 0.0957625 -0.623915	(1,2) -0.028956 0.0887787 -0.32616	(1,2) -0.0064014 0.0330552 -0.193658
(2,1) 0.0720833 0.0650713 1.10776	(2,1) 0.149947 0.0705223 2.12623	(2,1) 0.491053 0.188314 2.60763
(2,2) 0.0420708 0.0786898 0.534641	(2,2) 0.0278432 0.0759373 0.36666	(2,2) -0.0583294 0.0761727 -0.765752
Q(1,1) 0.0029682	Q(1,1) 1.20681	Q(1,1) 0.000120142
Q(2,1) 0.000194727	Q(2,1) 0.134879	Q(2,1) 3.85281e-05
Q(2,2) 0.00200419	Q(2,2) 0.882944	Q(2,2) 0.000637992

Richmond

VS Gold	VS RMBCAD	VS USDCAD
Correlation between the data is =	**Correlation between the data is =**	**Correlation between the data is =**
0.064	**0.117**	**0.15**
xcorrcoeff =	**xcorrcoeff =**	**xcorrcoeff =**
0.0896	-0.002	-0.029
0.0176	-0.042	-0.063
-0.13	0.0251	0.0058
-0.041	0.1919	0.1936
-0.012	0.0755	0.0716
-0.055	0.0277	0.0139
0.064	**0.117**	**0.15**
0.0153	0.1218	0.1199
0.2363	-0.058	-0.083
0.041	-0.043	-0.038
-0.039	0.0846	0.1001
0.1419	0.1454	0.094
0.0019	0.0387	-0.016
lag =	lag =	lag =
-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6	-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6	-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6
VAR Fitting using Matlab vgxvarx:	VAR Fitting using Matlab vgxvarx:	VAR Fitting using Matlab vgxvarx:
Model : 2-D VAR(3) with Additive Constant	Model : 2-D VAR(3) with Additive Constant	Model : 2-D VAR(3) with Additive Constant
Conditional mean is AR-stable and is MA-invertible	Conditional mean is AR-stable and is MA-invertible	Conditional mean is AR-stable and is MA-invertible
a Constant:	a Constant:	a Constant:
-0.053	-0.001	-7E-04
0.0779	0.0128	0.009
AR(1) Autoregression Matrix:	AR(1) Autoregression Matrix:	AR(1) Autoregression Matrix:
0.00611073 0.0710517	0.0147252 0.115583	0.0125273 0.138416
-0.0292294 -0.0363543	0.0354147 0.00702371	0.0136068 -0.0258528
AR(2) Autoregression Matrix:	AR(2) Autoregression Matrix:	AR(2) Autoregression Matrix:
-0.0240433 0.569333	0.00261813 -0.0697045	0.0101714 -0.114901
-0.00315242 -0.0687438	0.0731136 -0.0714037	0.0642459 -0.0495995
AR(3) Autoregression Matrix:	AR(3) Autoregression Matrix:	AR(3) Autoregression Matrix:
0.120062 0.102411	0.106826 -0.0500815	0.108583 -0.0669871
-0.0227458 0.0592162	0.185957 0.0270552	0.16112 -0.0668768
Q Innovations Covariance:	Q Innovations Covariance:	Q Innovations Covariance:
0.962656 0.039819	1.00918 0.0944394	1.00628 0.101795
0.039819 0.206781	0.0944394 0.944442	0.101795 0.60787

Model : 2-D VAR(3) with Additive Constant	Model : 2-D VAR(3) with Additive Constant	Model : 2-D VAR(3) with Additive Constant
Conditional mean is AR-stable and is MA-invertible	Conditional mean is AR-stable and is MA-invertible	Conditional mean is AR-stable and is MA-invertible
Standard errors without DoF adjustment (maximum likelihood)	Standard errors without DoF adjustment (maximum likelihood)	Standard errors without DoF adjustment (maximum likelihood)
Parameter Value Std. Error t-Statistic	Parameter Value Std. Error t-Statistic	Parameter Value Std. Error t-Statistic
a(1) -0.0526167 0.07966 -0.660516	a(1) -0.00102624 0.0784818 -0.0130762	a(1) -0.000692124 0.0783666 -0.00883188
a(2) 0.0778694 0.0369199 2.10915	a(2) 0.0128453 0.0759229 0.169189	a(2) 0.0089866 0.0609083 0.147543
AR(1)(1,1) 0.00611073 0.0776626 0.0786831	AR(1)(1,1) 0.0147252 0.0780943 0.188557	AR(1)(1,1) 0.0125273 0.0784719 0.15964
(1,2) 0.0710517 0.169251 0.419802	(1,2) 0.115583 0.0797976 1.44846	(1,2) 0.138416 0.0934381 1.39198
(2,1) -0.0292294 0.0359941 -0.812059	(2,1) 0.0354147 0.0755479 0.468771	(2,1) 0.0136068 0.0609901 0.223098
(2,2) -0.0363543 0.0784424 -0.463452	(2,2) 0.00702371 0.0771958 0.0909857	(2,2) -0.0258528 0.0772855 -0.33451
AR(2)(1,1) -0.0240433 0.0753964 -0.318892	AR(2)(1,1) 0.00261813 0.077999 0.0335663	AR(2)(1,1) 0.0101714 0.0782315 0.130017
(1,2) 0.569333 0.170418 3.3408	(1,2) -0.0697045 0.0811407 -0.859057	(1,2) -0.114901 0.100984 -1.13781
(2,1) -0.00315242 0.0349439 -0.0902137	(2,1) 0.0731136 0.0754558 0.96896	(2,1) 0.0642459 0.0608033 1.05662
(2,2) -0.0687438 0.0789833 -0.870359	(2,2) -0.0714037 0.0784951 -0.909659	(2,2) -0.0495995 0.0784874 -0.631942
AR(3)(1,1) 0.120062 0.0756556 1.58695	AR(3)(1,1) 0.106826 0.0778873 1.37155	AR(3)(1,1) 0.108583 0.0780713 1.39082
(1,2) 0.102411 0.176218 0.581161	(1,2) -0.0500815 0.0813765 -0.615429	(1,2) -0.0669871 0.101359 -0.66089
(2,1) -0.0227458 0.035064 -0.648694	(2,1) 0.185957 0.0753477 2.46798	(2,1) 0.16112 0.0606788 2.65529
(2,2) 0.0592162 0.0816713 0.725056	(2,2) 0.0270552 0.0787232 0.343675	(2,2) -0.0668768 0.0787784 -0.848924
Q(1,1) 0.962656	Q(1,1) 1.00918	Q(1,1) 1.00628
Q(2,1) 0.039819	Q(2,1) 0.0944394	Q(2,1) 0.101795
Q(2,2) 0.206781	Q(2,2) 0.944442	Q(2,2) 0.60787

West Vancouver

VS Gold	VS RMBCAD	VS USDCAD
Correlation between the data is =	**Correlation between the data is =**	**Correlation between the data is =**
-0.07	**0.034**	**0.053**
xcorrcoeff =	**xcorrcoeff =**	**xcorrcoeff =**
-0.029	-0.05	-0.082
-0.026	0.1752	0.124
-0.114	0.0202	-0.024
0.0137	0.0969	0.1162
-0.112	0.1456	0.1489
-0.025	0.1215	0.1602
-0.07	**0.034**	**0.053**
0.1188	0.0011	-0.007
0.1564	0.0155	0.024
0.0554	-0.16	-0.186
0.0037	-0.013	-8E-04
0.0129	0.1095	0.0853
-0.061	0.0352	0.0386
lag =	**lag =**	**lag =**
-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6	-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6	-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6
VAR Fitting using Matlab vgxvarx:	**VAR Fitting using Matlab vgxvarx:**	**VAR Fitting using Matlab vgxvarx:**
Model : 2-D VAR(3) with Additive Constant	Model : 2-D VAR(3) with Additive Constant	Model : 2-D VAR(3) with Additive Constant
Conditional mean is AR-stable and is MA-invertible	Conditional mean is AR-stable and is MA-invertible	Conditional mean is AR-stable and is MA-invertible
a Constant:	a Constant:	a Constant:
-0.049	0.013	0.013
0.1597	0.0065	0.0046
AR(1) Autoregression Matrix:	AR(1) Autoregression Matrix:	AR(1) Autoregression Matrix:
-0.0345751 0.143036	-0.00904466 0.00382956	-0.00664595 -0.000335602
-0.0261847 -0.0422933	0.120305 -0.0110137	0.173741 -0.0635024
AR(2) Autoregression Matrix:	AR(2) Autoregression Matrix:	AR(2) Autoregression Matrix:
-0.0167664 0.195085	-0.0205911 0.03142	-0.0219864 0.0341116
-0.110953 -0.0709606	0.145009 -0.0702278	0.169146 -0.0616256
AR(3) Autoregression Matrix:	AR(3) Autoregression Matrix:	AR(3) Autoregression Matrix:
-0.0326917 0.0894563	-0.0596826 -0.170374	-0.0570763 -0.182112
0.00844441 0.0582263	0.108908 0.0520392	0.149315 -0.0369094
Q Innovations Covariance:	Q Innovations Covariance:	Q Innovations Covariance:
1.01697 -0.0578882	1.03704 0.0553909	1.02754 0.0661889
-0.0578882 0.819121	0.0553909 0.938818	0.0661889 1.05551
Model : 2-D VAR(3) with Additive Constant	Model : 2-D VAR(3) with Additive Constant	Model : 2-D VAR(3) with Additive Constant
Conditional mean is AR-stable and is MA-invertible	Conditional mean is AR-stable and is MA-invertible	Conditional mean is AR-stable and is MA-invertible
Standard errors without DoF adjustment (maximum likelihood)	Standard errors without DoF adjustment (maximum likelihood)	Standard errors without DoF adjustment (maximum likelihood)
Parameter Value Std. Error t-Statistic	Parameter Value Std. Error t-Statistic	Parameter Value Std. Error t-Statistic
a(1) -0.0486747 0.0818372 -0.594774	a(1) 0.0129725 0.0795649 0.163042	a(1) 0.0129807 0.0791961 0.163906
a(2) 0.159667 0.0734466 2.17392	a(2) 0.00649498 0.0757033 0.0857952	a(2) 0.00460061 0.0802665 0.0573167
AR(1)(1,1) -0.0345751 0.0779369 -0.443629	AR(1)(1,1) -0.00904466 0.0769799 -0.117494	AR(1)(1,1) -0.00664595 0.0767181 -0.0866281
(1,2) 0.143036 0.0874724 1.63521	(1,2) 0.00382956 0.0816342 0.0469113	(1,2) -0.000335602 0.076365 -0.00439471
(2,1) -0.0261847 0.0699462 -0.374355	(2,1) 0.120305 0.0732438 1.64253	(2,1) 0.173741 0.077755 2.23446
(2,2) -0.0422933 0.078504 -0.53874	(2,2) -0.0110137 0.0776723 -0.141797	(2,2) -0.0635024 0.0773971 -0.820475
AR(2)(1,1) -0.0167664 0.0772942 -0.216916	AR(2)(1,1) -0.0205911 0.0781124 -0.263608	AR(2)(1,1) -0.0219864 0.078214 -0.281106
(1,2) 0.195085 0.0880535 2.21553	(1,2) 0.03142 0.0820237 0.38306	(1,2) 0.0341116 0.076532 0.445717
(2,1) -0.110953 0.0693694 -1.59945	(2,1) 0.145009 0.0743214 1.95111	(2,1) 0.169146 0.0792711 2.13376
(2,2) -0.0709606 0.0790255 -0.897946	(2,2) -0.0702278 0.0780428 -0.899862	(2,2) -0.0616256 0.0775664 -0.794488
AR(3)(1,1) -0.0326917 0.078126 -0.418448	AR(3)(1,1) -0.0596826 0.0798036 -0.747868	AR(3)(1,1) -0.0570763 0.0801576 -0.712052
(1,2) 0.0894563 0.0893909 1.00073	(1,2) -0.170374 0.0811976 -2.09827	(1,2) -0.182112 0.0752251 -2.42089
(2,1) 0.00844441 0.0701159 0.120435	(2,1) 0.108908 0.0759305 1.43432	(2,1) 0.149315 0.0812409 1.83793
(2,2) 0.0582263 0.0802258 0.72578	(2,2) 0.0520392 0.0772568 0.673587	(2,2) -0.0369094 0.0762419 -0.484109
Q(1,1) 1.01697	Q(1,1) 1.03704	Q(1,1) 1.02754
Q(2,1) -0.0578882	Q(2,1) 0.0553909	Q(2,1) 0.0661889
Q(2,2) 0.819121	Q(2,2) 0.938818	Q(2,2) 1.05551

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