Predicting Canadian residents' consumption amount through house prices*

Data analysis of NHPI and Consumption of Canada from 2000 to 2009

Shipeng Zhang

April 18, 2024

In Canada, the size and volatility of housing wealth has led many to believe that changes in housing prices have a significant impact on aggregate consumption. This study examines regional differences in housing price changes across Canada and their relationship to household spending patterns. Using forecasting models, we aim to estimate consumption levels in different regions based on NHPI data. However, limitations include potential inaccuracies in the NHPI data, assumptions about the relationship between house prices and consumption, and the model's ability to capture the full complexity of regional dynamics. Further research is needed to validate the model's predictions and explore other factors that influence consumer behavior.

*Code and data are available at: https://github.com/zero616/NHPI-Analysis

1 Introduction

In recent years, the Canadian real estate market has been the subject of extensive analysis and debate due to its significant impact on the economy and the well-being of its citizens. Canadian home prices have experienced significant volatility, raising concerns about affordability, financial stability and the broader impact on consumer consumption. Understanding the complex relationship between house prices and consumption is critical for policymakers, economists and stakeholders.

Canada's real estate market has experienced significant growth over the past few decades. Urban centers such as Toronto, Vancouver, and Montreal have become hot spots for real estate investment, driving up real estate values and reshaping the socioeconomic landscape. Historically low interest rates, demographic changes and foreign investment have fueled demand, leading to unprecedented price increases in some areas.

For many Canadians, housing is the most important component of household wealth. As property values rise, homeowners experience a wealth effect, feeling wealthier and more willing to spend money. This phenomenon has implications for consumption patterns, as increased housing wealth stimulates consumption on goods and services, thereby boosting economic growth. Conversely, falling house prices could lead to a contraction in consumer consumption, dampening economic activity.

Despite the wealth effect of rising home prices, affordability issues remain in the Canadian housing market. Soaring housing prices relative to income levels have made home ownership increasingly difficult for many Canadians, especially younger generations and immigrants. High housing costs not only strain household budgets but also limit discretionary consumption on other goods and services, potentially limiting overall consumption growth. At the same time, high rental costs force shop owners to raise rents, which in turn leads to rising prices.

Policy responses to housing market dynamics play a key role in shaping consumer behavior and broader economic outcomes. Measures aimed at cooling overheated housing markets, such as macroprudential regulation and tax policy, can influence housing affordability and household consumption decisions. Likewise, initiatives to boost the supply of affordable housing and enhance rental market stability are likely to reduce pressure on household budgets and support consumption growth.

Given the multifaceted nature of the relationship between house prices and consumption, this article aims to understand the dynamics in the Canadian context. By examining historical trends, empirical evidence, and the impact of emergencies, we seek to elucidate the interplay between housing market dynamics and consumer consumption and establish a rigorous link between the new home price index and the growth rate of Canadian consumer consumption. The linear Model shows:

$$Y = 2.4367510 + 0.6191314X + \varepsilon$$

Where:

- Y is the dependent variable (Increasing Rate of Consumption[base 181096]).
- X is the independent variable (Increasing Rate of NHPI[base 57.2]).
- ε is the error term.

Analytical and comprehensive insights, this study strives to inform policymakers and stakeholders and contribute to a nuanced understanding of housing consumption relationships in Canada.

2 Data

This paper was produced using using **R** (R Core Team 2023) utilizing the packages **tidyverse** (Wickham 2023), which made use of the following packages:

- **ggplot2** (Wickham, Chang, et al. 2023)
- **dplyr** (Wickham, François, et al. 2023)
- **janitor** (Firke 2023)
- **rmarkdown** (Allaire et al. 2023)
- **knitr** (Xie 2023)
- **lubridate** (Spinu, Grolemund, and Wickham 2023)
- **rstanarm** (Gabry and Goodrich 2024)
- **arrow**(Richardson et al. 2024)

Data :

- Detailed household final consumption expenditure, Canada, quarterly - Dataset
- URL: https://www150.statcan.gc.ca/n1/tbl/csv/36100124-fra.zip
- New housing price index, monthly - Dataset
- URL: https://www150.statcan.gc.ca/n1/tbl/csv/18100205-eng.zip

2.1 The Dataset

This dataset amalgamates information sourced from two key datasets available on the Canadian government's open platform: the "New Housing Price Index, Monthly" and the "Detailed Household Final Consumption Expenditure, Canada, Quarterly."

The New Housing Price Index (NHPI) is a monthly metric tracking variations in sales prices of newly constructed homes across time. It encompasses various housing categories, including detached houses, semi-detached houses, and townhouses. Additionally, the survey incorporates builders' assessments of the current market value of land, which are then independently indexed to create land value series. Similarly, the structural value of the properties is indexed and presented as a house series. Overall, the NHPI serves as a useful tool for gauging fluctuations within the Canadian real estate sector.

On the other hand, the Detailed Household Final Consumption Expenditure dataset provides a comprehensive summary of numerous expenditures incurred by Canadian residents for various purposes. It employs 2017 constant prices as a benchmark to eliminate the influence of inflation on growth rates.

Upon aggregating and refining the data to exclude irrelevant information, certain trends emerged. REF_DATE field denotes the specific quarter to which the data pertains, ensuring precision in analysis. Consumption figures represent the total consumption by Canadian residents during the quarter.km
NHPI encapsulates Canada's national New Housing Price Index for the same period.

2.2 Data Cleaning

Table 1: Sample Table of Canada Consumtion change data (2000-2009)

REF_DATE	Prices	Seasonal.adjustment	Estimates	VALUE
2000-01	2017 constant prices	Seasonally adjusted at quarterly rates	Household final consumption expenditure	181096
2000-04	2017 constant prices	Seasonally adjusted at quarterly rates	Household final consumption expenditure	182693
2000-07	2017 constant prices	Seasonally adjusted at quarterly rates	Household final consumption expenditure	185049
2000-10	2017 constant prices	Seasonally adjusted at quarterly rates	Household final consumption expenditure	185287
2001-01	2017 constant prices	Seasonally adjusted at quarterly rates	Household final consumption expenditure	186897
2001-04	2017 constant prices	Seasonally adjusted at quarterly rates	Household final consumption expenditure	187365

Table 1 is the original data after excluding invalid information. Value represents the consumption in millions of Canadian dollars, while prices are calculated based on whether they are based on constant prices in 2017. Seasonal.adjustment represents whether seasonally adjusted at quarterly rates. And the estimator represents the type of consumption. In order to simplify the analysis, we only consider consumption at constant prices in 2017 and seasonally adjusted at quarterly rates, which can eliminate the interference of inflation on the data. In addition, we only study total consumption, not classification Research. So in data cleaning we only keep the useful parts.

Table 2: Sample Table of Canada Consumtion and NHPI change (2000-2009)

REF_DATE	GEO	New.housing.price.indexes	VALUE
2000-01	Canada	Total (house and land)	57.2
2000-01	Canada	House only	53.7
2000-01	Canada	Land only	66.8
2000-01	Atlantic Region	Total (house and land)	62.8
2000-01	Atlantic Region	House only	64.2
2000-01	Atlantic Region	Land only	58.3

Table 2 is the NHPI data set after eliminating invalid information. NHPI is classified by time, region (GEO) and NHPI. In this data set, NHPI is divided into three types: all, only houses, and only land. In order to make the analysis simple and accurate, we only Consider all NHPI values. And only consider the NHPI across Canada rather than by region when fitting the model.

Table 3: Sample Table for consumption data (2000-2009)

Ref-Date	Consumption (Million)	Increasing Rate of Consumption
2000-01	181096	0.00
2000-04	182693	0.88
2000-07	185049	2.18
2000-10	185287	2.31
2001-01	186897	3.20
2001-04	187365	3.46

Table 3 provides the consumption of all Canadian residents in the data set (millions of Canadian dollars), sorted by time. The growth rate is calculated based on consumption from 2000 to January.

Table 4: Sample Table of Canada Consumtion and NHPI change (2000-2009)

Ref-Date	Consumption (Million)	Increasing Rate of Consumption	NHPI	Increasing Rate of Consumption
2000-01	181096	0.00	57.2	0.00
2000-04	182693	0.88	57.6	0.70
2000-07	185049	2.18	57.9	1.22
2000-10	185287	2.31	58.3	1.92
2001-01	186897	3.20	58.7	2.62
2001-04	187365	3.46	59.2	3.50

Table 4 provides total consumption, consumption growth rate and NHPI value and NHPI growth rate sorted by time.

3 Model

Null hypothesis: the relationship between the quarterly national NHPI growth rate and the growth rate of Canada's total final consumption is not linear Alternative hypothesis: the relationship between the quarterly national NHPI growth rate and the growth rate of Canada's total final consumption is linear Linear regression analysis was performed to test the hypothesis and determine whether there was a statistically significant relationship between the variables. A low p-value(typically less than a chosen significance level, often 0.05) for the linear regression coefficient will provide evidence against the null hypothesis, indicating Changes in the NHPI growth rate do lead to meaningful increases in consumption by Canadian residents as a whole. On the other hand, if the p-value is high, it indicates that there is not enough evidence to reject the null hypothesis, and there may not be a significant linear relationship between the variables. Ultimately, the results of the analysis will inform whether the null hypothesis can or cannot be rejected.

3.1 Model set-up

The polynomial regression model is defined as follows:

$$Y = \beta_0 + \beta_1 X + \varepsilon$$

Where:

- Y is the dependent variable (Increasing Rate of Consumption).
- X is the independent variable (Increasing Rate of NHPI).

- β_0 and β_1 are the coefficients of the polynomial terms.
- ε is the error term.

Table 5: Linear Regression Model Summary

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	2.4367510	0.3757096	6.48573	1e-07
Increasing_Rate_NHPI	0.6191314	0.0116710	53.04849	0e+00

Table 5 shows p-value is 0.0000001, then the linear model cannot be rejected.

3.2 Model Justification

First observing the scatter plot of the data set, I believe that the relationship between the quarterly national NHPI growth rate and the growth rate of Canada's total final consumption is linear, then the linear regression model is appropriate. Compared to Bayesian models, linear models are simpler and easier to interpret. It assumes a straight-line relationship between variables, which makes it easier to understand and communicate the results. In a linear model, the coefficient represents the change in the dependent variable when the predictor variable changes by one unit. This directly explains the impact of the NHPI growth rate on the growth rate of total final consumption in Canada. Linear regression is widely used and implemented in statistical software, making it easy to apply and interpret results. If the relationship between the NHPI growth rate and Canada's total final consumption growth rate is approximately linear, then a linear model can provide an adequate fit to the data. Analytical plots of predicted and actual values can help verify whether the linear model adequately captures the relationship.

3.3 Model Prediction

Figure 1 shows the scatter plot compares the observed values of Consumption from the data set with the predicted values from the linear regression model. The dashed red line represents the line of perfect prediction (where observed equals predicted values). This plot allows us to visually assess how well the linear regression model fits the data. The points cluster closely around the dashed red line, indicating a strong fit between observed and predicted values.

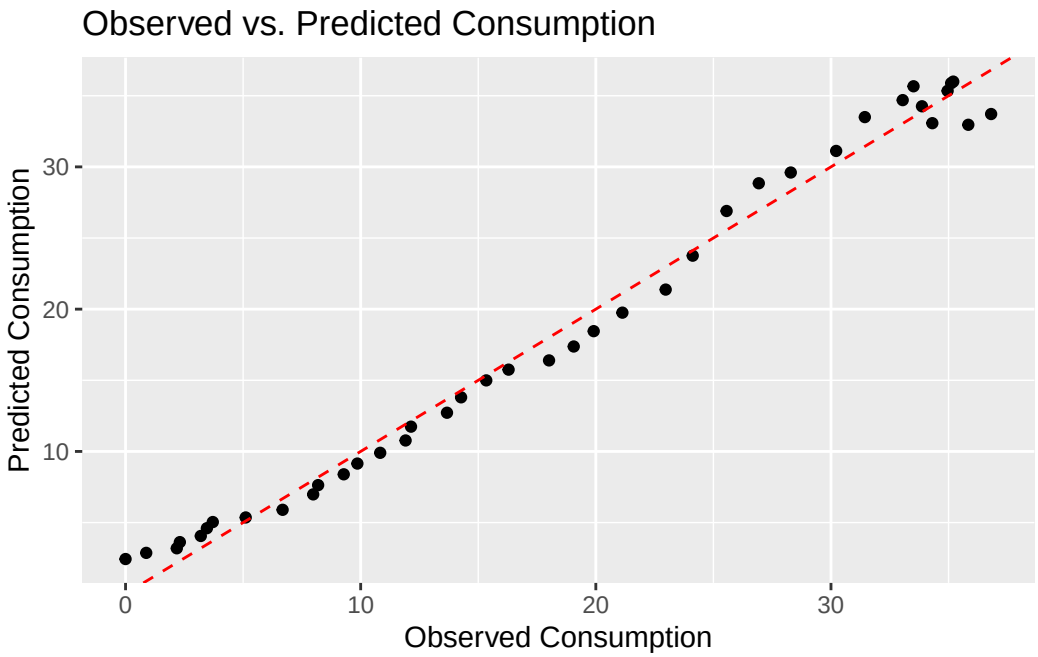

Figure 1: Linear Regression Model Prediction

4 Results

This research used a linear regression model to investigate the association between xxxxxxxx. As shown in Table 2, the estimated intercept produced by the model is 2.4367510, indicating that the expected value of the underlying consumption growth rate when the NHPI growth rate is zero is 2.4367510. The model also shows a statistically significant regression coefficient of 0.6191314, indicating that there is a significant linear relationship between the NHPI growth rate and the consumption growth rate. These findings indicate that as the NHPI growth rate increases, it is predicted that the consumption growth rate for the quarter will increase by approximately 0.6191314 percentage points, retaining all other variables. This shows that as the NHPI continues to grow, the final consumption of Canadian residents also continues to increase. Figure 2 illustrates the relationship between NHPI growth rate and consumption growth rate, where the number of data points with NHPI growth rate on the x-axis and consumption growth rate on the y-axis of the scatterplot shows a clear upward slope. The fitted regression line represents the overall trend of the data, where the slope indicates that the consumption growth rate increases as the NHPI growth rate increases.

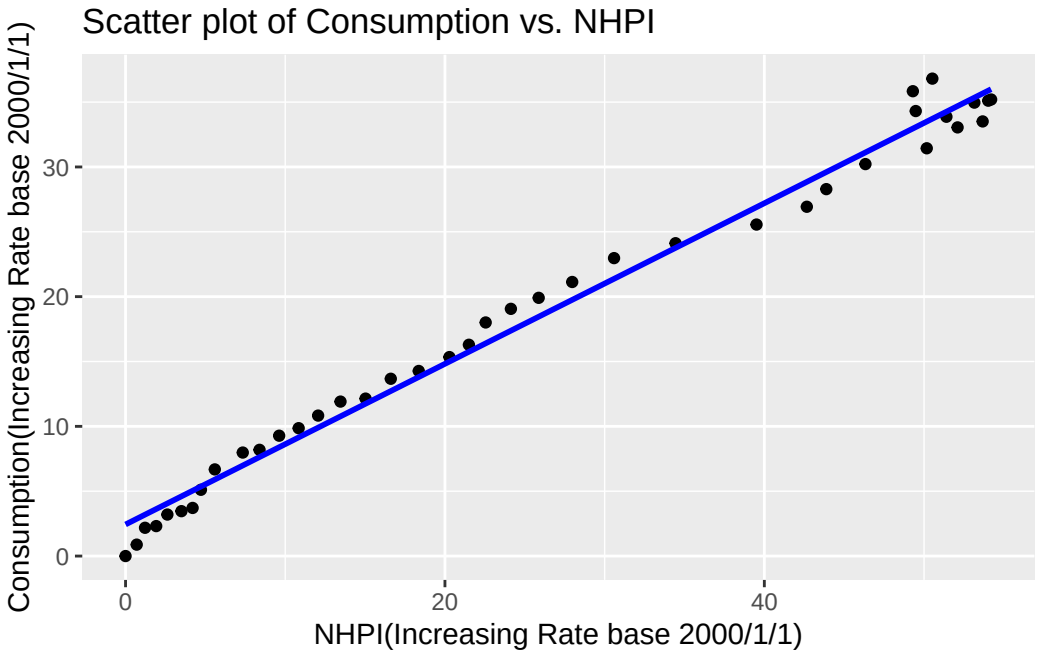

Figure 2: Scatter plot of Consumption vs. NHPI

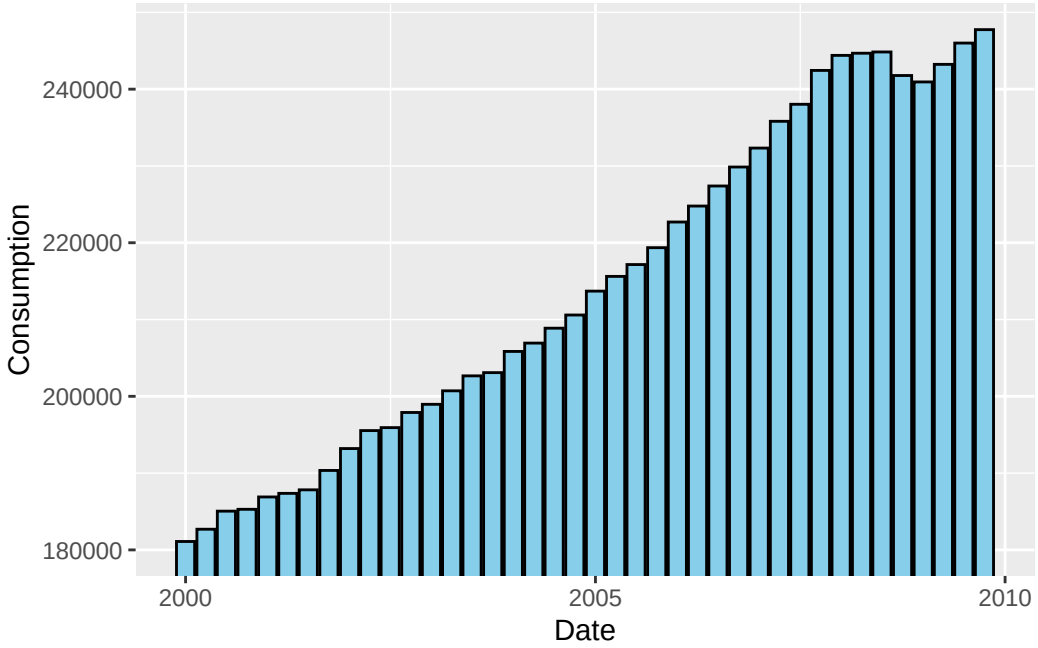

Figure 3: Consumption Over Time

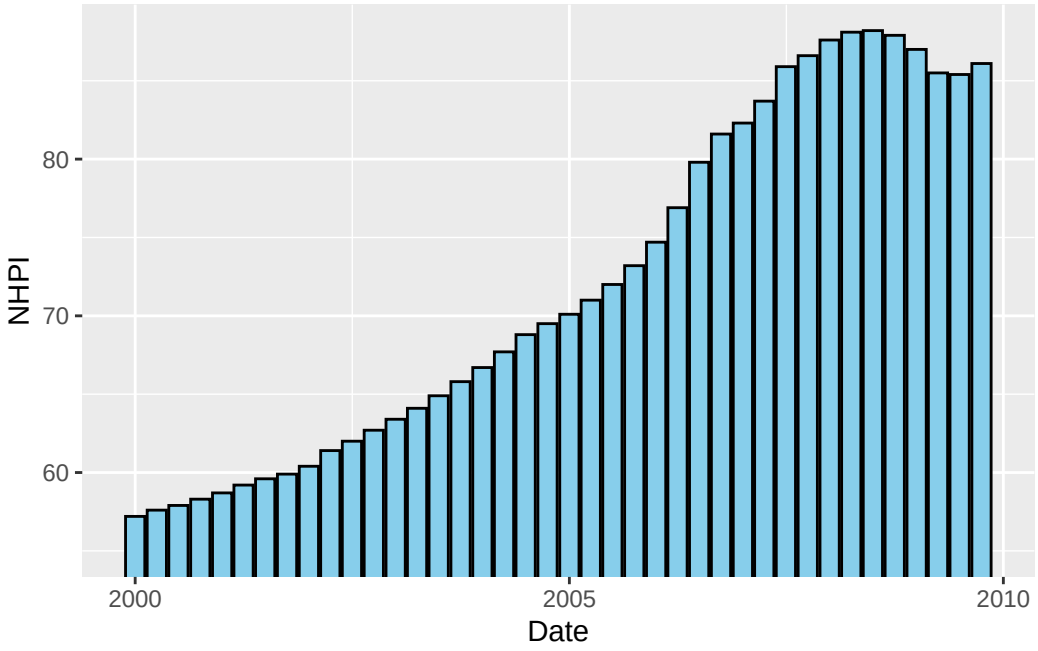

Figure 4: NHPI Over Time

5 Discussion

5.1 House Prices and Consumer consumption Trends

After analyzes historical trends in the New House Price Index (NHPI) in Figure 4 and fluctuations in household consumer consumption which in Figure 3. There is a significant correlation between the two. The first point to focus on is the wealth effect, where homeowners typically experience an increase in wealth when house prices rise. Increased wealth can boost consumer confidence and discretionary consumption as homeowners feel more financially secure. Conversely, falling home prices may lead to less consumer consumption as homeowners feel less wealthy. Second, fluctuations in the housing market, such as changes in housing affordability, mortgage rates, and housing supply and demand dynamics, may affect the NHPI and consumer consumption. For example, low mortgage rates may stimulate demand for housing, causing home prices to rise and increasing consumer consumption on related goods and services (e.g., home furnishings, renovations). Consumer Sentiment: Consumer sentiment and perceptions of future economic prospects can influence consumption decisions. Positive sentiment may lead to increased consumer consumption, including housing-related expenditures, while negative sentiment may have the opposite effect. For older homeowners, rising house prices will stimulate an increase in consumer consumption. For young renters, rising house prices will lead to an increase in rents, and high rents will lead to a decrease in consumer consumption.

5.2 Regional Differences

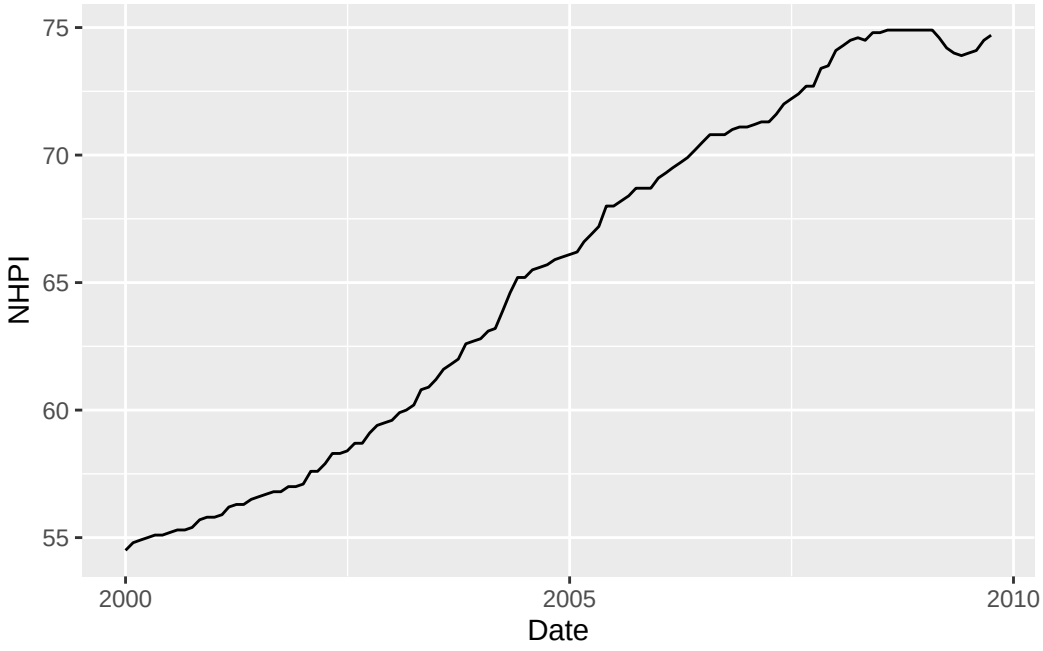

Figure 5: NHPI of Toronto Over Time

Studying how housing prices vary across different regions in Canada can offer valuable insights into local housing market dynamics and their impact on household spending habits. Analyzing historical housing price data across provinces and cities allows us to pinpoint areas with significant fluctuations in the National House Price Index (NHPI) over time. For instance, examining NHPI changes in Toronto, Vancouver, and Regina reveals distinct trends. Figure 5 shows the NHPI changes in Toronto. Figure 6 shows the NHPI changes in Vancouver. Figure 7 shows the NHPI changes in Regina. Comparing these trends, we observe that major cities with dense populations tend to experience more pronounced fluctuations in NHPI, while smaller towns with fewer inhabitants tend to have steadier curves. This variance may stem from the concentration of urban populations. Unfortunately, the Canadian government dataset lacks consumption data for provinces and cities. However, by leveraging the Vancouver we've developed and incorporating NHPI data from different regions, we can estimate consumption levels across various areas.

Figure 8 shows the Predict Consumption changes in Toronto. Figure 9 x shows the Predict Consumption changes in Vancouver. Figure 10 x shows the Predict Consumption changes in Regina.

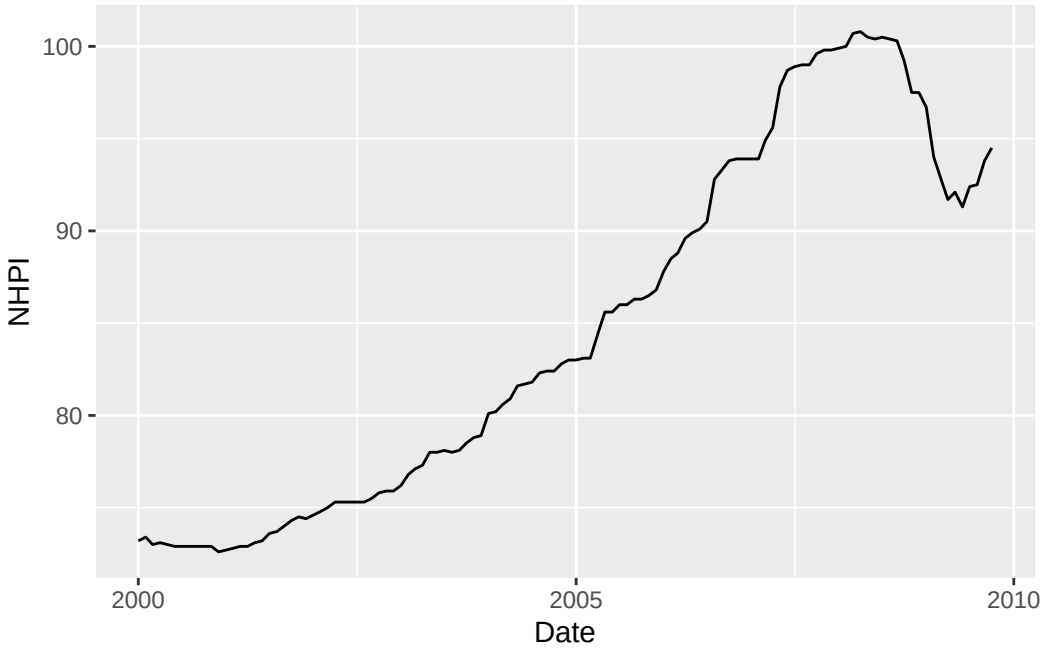

Figure 6: NHPI of Vancouver Over Time

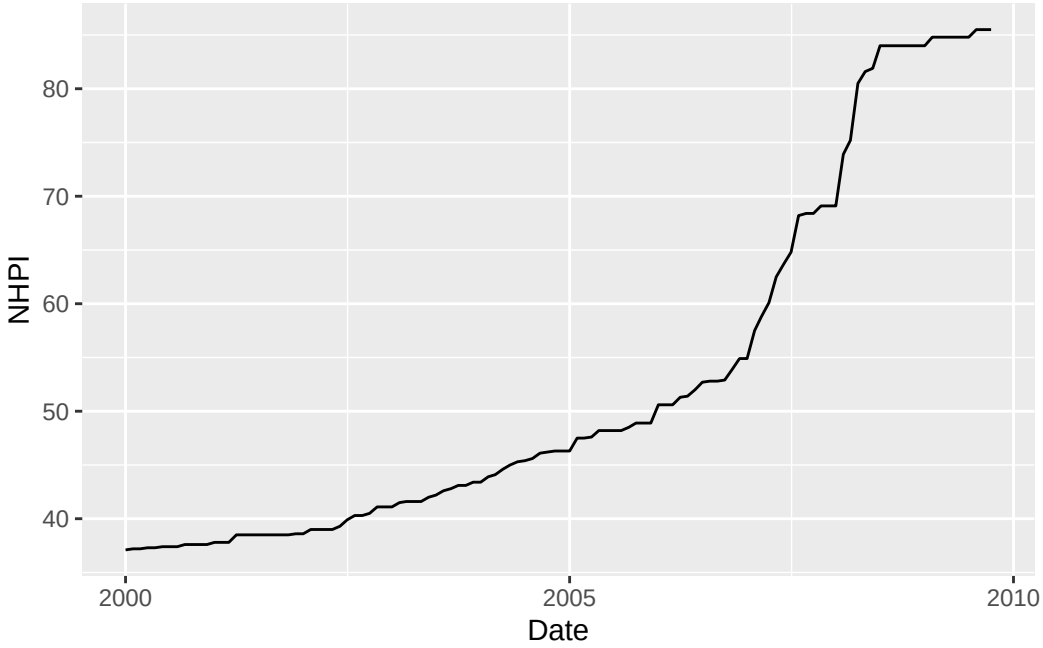

Figure 7: NHPI of Regina Over Time

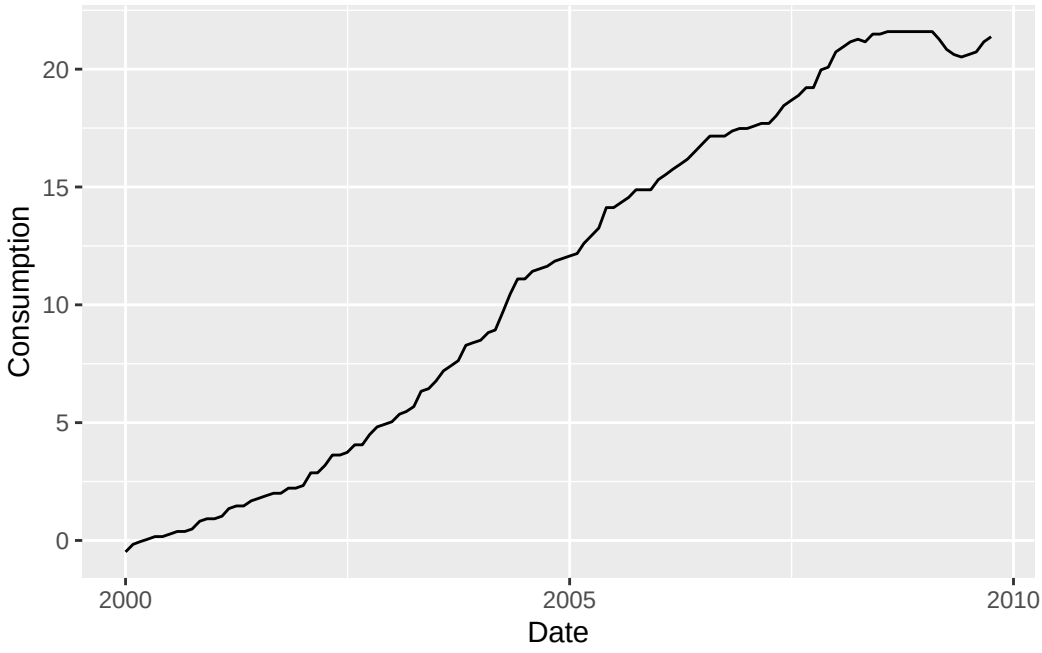

Figure 8: Predict Consumption of Toronto Over Time

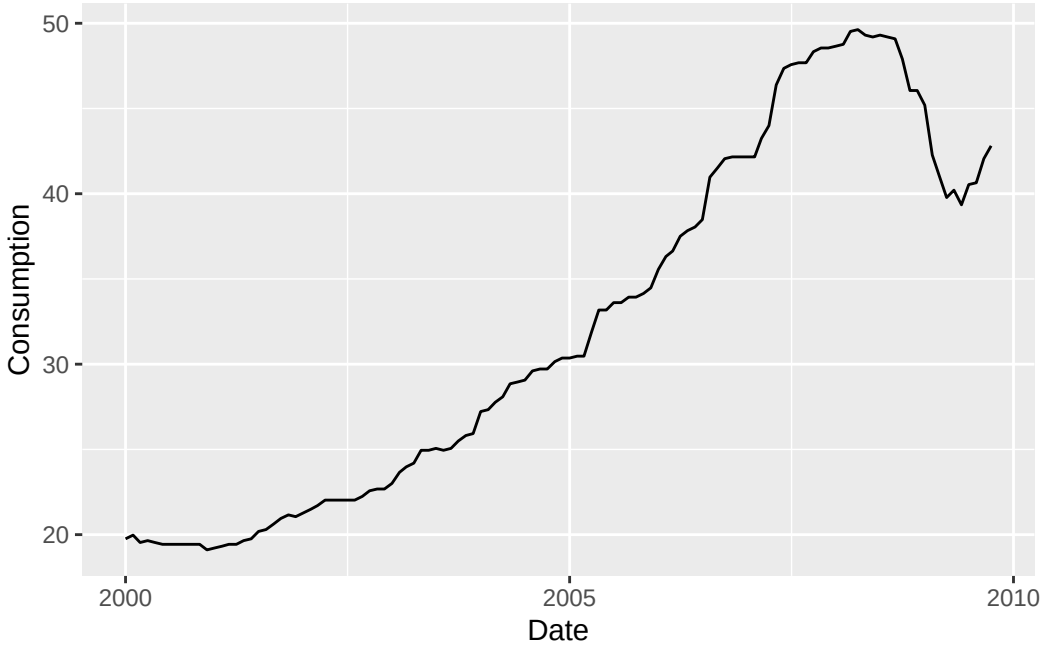

Figure 9: Predict Consumption of Vancouver Over Time

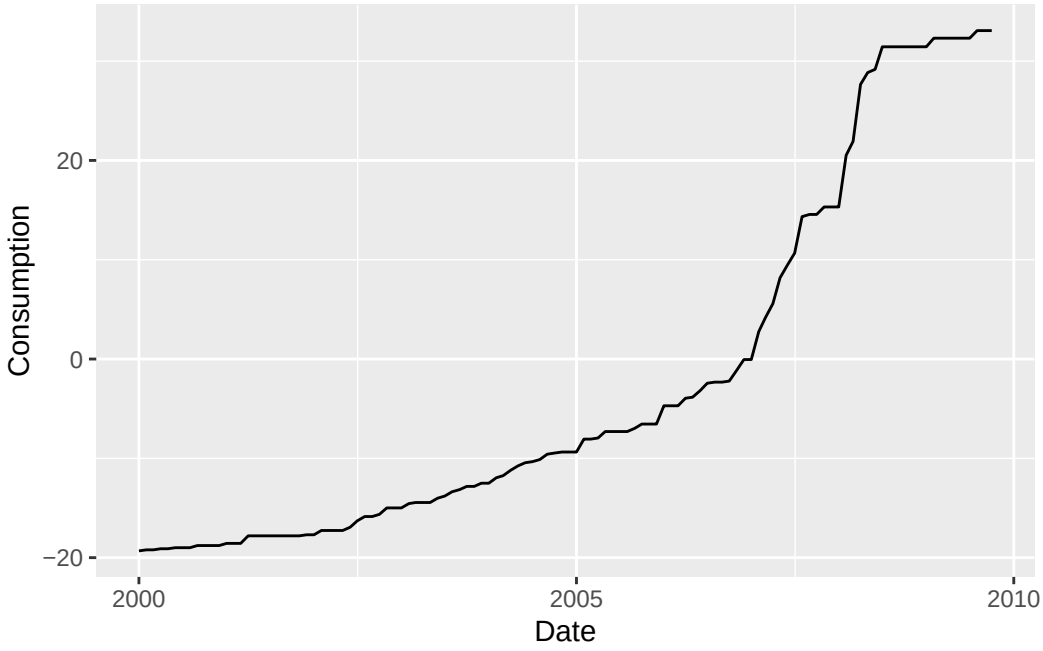

Figure 10: Predict Consumption of Regina Over Time

5.3 The Long-term Outlook

Assessing the long-term outlook for the Canadian housing market and household consumer consumption requires consideration of a range of key drivers and potential challenges that could influence future trends. Housing supply and demand dynamics include housing construction rates, land supply, zoning regulations, and housing affordability, which interact with demand-side factors to determine housing market equilibrium. Imbalances in housing supply and demand can lead to price volatility, affordability challenges and potential housing market corrections. Government policies and regulatory measures, such as housing subsidies, tax incentives, mortgage rules and land use regulations, can influence housing market dynamics and consumer consumption. Changes in government policy may introduce new incentives or restrictions that impact housing affordability and household finances. Developments in financial markets, including mortgage conditions, credit availability and mortgage rates, can affect housing market activity and consumer borrowing behavior. Changes in lending standards, interest rate policies and mortgage market liquidity may affect housing affordability and household debt levels. In the long term, technological advances and innovations in home construction, real estate transactions, and consumer finance can reshape housing markets and consumer consumption patterns. Digital platforms, fintech solutions and sustainable housing technologies may influence consumer preferences and market dynamics. Assessing the long-term outlook for the Canadian housing market and household consumer consumption requires consideration of the complex interplay of these factors and their potential impact on future trends. By moni-

toring key drivers and understanding potential challenges, policymakers, industry stakeholders and investors can better anticipate and adapt to changing market conditions and consumer preferences.

5.4 Next steps and weaknesses

This article lays the foundation for a more detailed study of the factors influencing final consumption of Canadian residents. Since there is no regional consumption data, it is impossible to confirm the impact of excessive fluctuations in housing prices on consumption data. The next step would involve utilizing the model we've constructed to predict consumption levels in different regions based on NHPI data. This would entail feeding NHPI data from various regions into the model and generating predictions for consumption amounts in those regions. By doing so, we can gain insights into how housing price changes influence household spending patterns across Canada.

However, it's essential to acknowledge the weaknesses and limitations of this approach. One potential weakness is the assumption that NHPI changes directly correlate with changes in household spending patterns. While housing prices certainly impact consumer behavior, other factors such as income levels, employment rates, and economic policies also play significant roles.

Additionally, the model's accuracy may be affected by the quality and reliability of the NHPI data, as well as the assumptions and variables incorporated into the model itself. It's crucial to validate the model's predictions against real-world consumption data to assess its effectiveness and identify any potential biases or inaccuracies.

Furthermore, the model may not capture the full complexity of regional differences in housing markets and consumer behavior. Factors such as cultural preferences, demographic trends, and local economic conditions could influence consumption patterns in ways that aren't fully accounted for in the model.

Overall, while using NHPI data to predict consumption levels is a promising approach, it's important to interpret the results with caution and consider the broader context and potential limitations of the model.

References

Allaire, JJ, Yihui Xie, Christophe Dervieux, Jonathan McPherson, Javier Luraschi, Kevin Ushey, Aron Atkins, et al. 2023. *Rmarkdown: Dynamic Documents for r*. https://github.com/rstudio/rmarkdown.

Brilleman, SL, MJ Crowther, M Moreno-Betancur, J Buros Novik, and R Wolfe. 2018. "Joint Longitudinal and Time-to-Event Models via Stan." https://github.com/stan-dev/stancon_talks/.

Firke, Sam. 2023. *Janitor: Simple Tools for Examining and Cleaning Dirty Data*. https://github.com/sfirke/janitor.

Gabry, Jonah, and Ben Goodrich. 2024. *Rstanarm: Bayesian Applied Regression Modeling via Stan*. https://mc-stan.org/rstanarm/.

Grolemund, Garrett, and Hadley Wickham. 2011. "Dates and Times Made Easy with lubridate." *Journal of Statistical Software* 40 (3): 1–25. https://www.jstatsoft.org/v40/i03/.

R Core Team. 2023. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Richardson, Neal, Ian Cook, Nic Crane, Dewey Dunnington, Romain François, Jonathan Keane, Dragoș Moldovan-Grünfeld, Jeroen Ooms, Jacob Wujciak-Jens, and Apache Arrow. 2024. *Arrow: Integration to Apache 'Arrow'*. https://github.com/apache/arrow/.

Spinu, Vitalie, Garrett Grolemund, and Hadley Wickham. 2023. *Lubridate: Make Dealing with Dates a Little Easier*. https://lubridate.tidyverse.org.

Wickham, Hadley. 2016. *Ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York. https://ggplot2.tidyverse.org.

———. 2023. *Tidyverse: Easily Install and Load the Tidyverse*. https://tidyverse.tidyverse.org.

Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D'Agostino McGowan, Romain François, Garrett Grolemund, et al. 2019. "Welcome to the tidyverse." *Journal of Open Source Software* 4 (43): 1686. https://doi.org/10.21105/joss.01686.

Wickham, Hadley, Winston Chang, Lionel Henry, Thomas Lin Pedersen, Kohske Takahashi, Claus Wilke, Kara Woo, Hiroaki Yutani, and Dewey Dunnington. 2023. *Ggplot2: Create Elegant Data Visualisations Using the Grammar of Graphics*. https://ggplot2.tidyverse.org.

Wickham, Hadley, Romain François, Lionel Henry, Kirill Müller, and Davis Vaughan. 2023. *Dplyr: A Grammar of Data Manipulation*. https://dplyr.tidyverse.org.

Xie, Yihui. 2014. "Knitr: A Comprehensive Tool for Reproducible Research in R." In *Implementing Reproducible Computational Research*, edited by Victoria Stodden, Friedrich Leisch, and Roger D. Peng. Chapman; Hall/CRC.

———. 2015. *Dynamic Documents with R and Knitr*. 2nd ed. Boca Raton, Florida: Chapman; Hall/CRC. https://yihui.org/knitr/.

———. 2023. *Knitr: A General-Purpose Package for Dynamic Report Generation in r*. https://yihui.org/knitr/.

Xie, Yihui, J. J. Allaire, and Garrett Grolemund. 2018. *R Markdown: The Definitive Guide*. Boca Raton, Florida: Chapman; Hall/CRC. https://bookdown.org/yihui/rmarkdown.

Xie, Yihui, Christophe Dervieux, and Emily Riederer. 2020. *R Markdown Cookbook*. Boca Raton, Florida: Chapman; Hall/CRC. https://bookdown.org/yihui/rmarkdown-cookbook.