

Economic Dynamics of Housing Prices*

Analyzing Predictors Using the New Housing Price Index

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This study examines factors influencing Canadian housing prices through the New Housing Price Index (NHPI) and key predictors: newly constructed homes, housing absorption, GDP, CPI, and interest rates. Linear regression reveals GDP and CPI as the most significant predictors, with housing absorption and interest rates playing secondary roles

1 Introduction

1.1 Overview

This study examines the factors influencing housing prices in Canada using linear regression analysis. Specifically, it investigates the relationship between the new housing price index and key predictors: newly constructed homes, housing absorption, GDP, CPI, and interest rates. By aggregating and cleaning data from Statistics Canada, this research leverages both continuous and categorical predictors, such as interest rate hikes, to model their impact on housing prices. The findings contribute to a deeper understanding of the dynamics driving housing affordability in one of Canada's largest metropolitan areas.

The estimand of this analysis is the relationship between the new housing price index and predictors like housing absorption, GDP, CPI, and interest rates. Using linear regression, we aim to quantify how these factors influence housing prices. Results indicate that GDP and CPI are the most significant predictors, highlighting the strong impact of economic trends. Housing absorption also plays a role, while interest rate hikes have a smaller effect. Understanding these drivers is crucial for policymakers to address housing affordability and market stability.

The remainder of this paper is structured as follows....

*Code and data are available at: <https://github.com/DavidFJ207/CanadianHousingAnalysis>

2 Data

2.1 Overview

We use the statistical programming language R (R Core Team 2023) to analyze housing prices in Toronto. The data for this project was sourced from Statistics Canada, including five datasets ([statscan2024?](#)). These datasets provided information on the new housing price index, housing absorption, GDP, CPI, interest rates, and construction statistics. The data spans from 1997 to 2016 and is divided quarterly, yielding 76 entries.

2.2 Measurement

2.3 Outcome Variable: New Housing Price Index

The New Housing Price Index (NHPI) tracks the prices of newly built homes in Canada. It measures whether they're increasing or decreasing. This index helps us understand the factors driving housing costs, such as economic trends, interest rates, and construction costs. By analyzing this data, policymakers, builders, and potential homebuyers can make informed decisions about the housing market.

```
# A tibble: 6 x 2
  SixMonthPeriod mean_house_price
  <date>          <dbl>
1 1997-07-01      65.4
2 1998-01-01      65.8
3 1998-07-01      66.1
4 1999-01-01      66.2
5 1999-07-01      66.7
6 2000-01-01      67.5
```

```
Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
i Please use `linewidth` instead.
```

The plot above illustrates the changes in the new housing price index across the analyzed period.

2.4 Predictor Variables

We included five main predictor variables based on our research question:

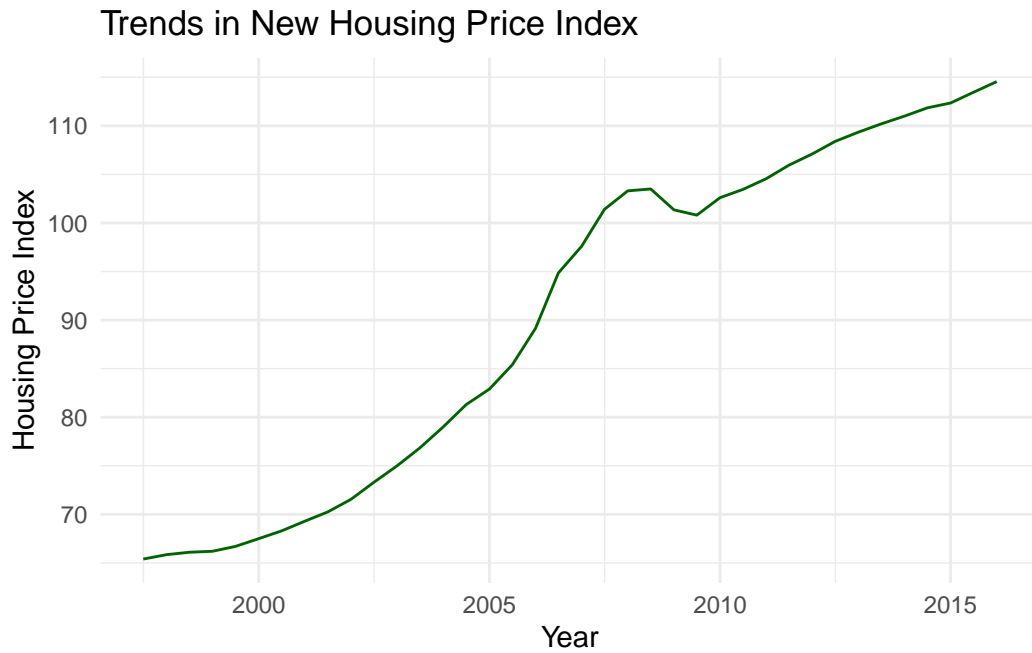


Figure 1: New Housing Price Index Over Time

2.4.1 1. Housing Availability

Number of Completed Homes: Includes all new homes at a given time.

2.4.2 2. Housing Sales

Number of Homes Sold: Represents sales volume for homes.

2.4.3 3. Gross Domestic Product

2.4.4 4. Interest Rates

Interest rate hikes were categorized by comparing rates between successive entries.

2.4.5 5. Consumer Price Index (CPI)

Interest rate hikes were categorized by comparing rates between successive entries.

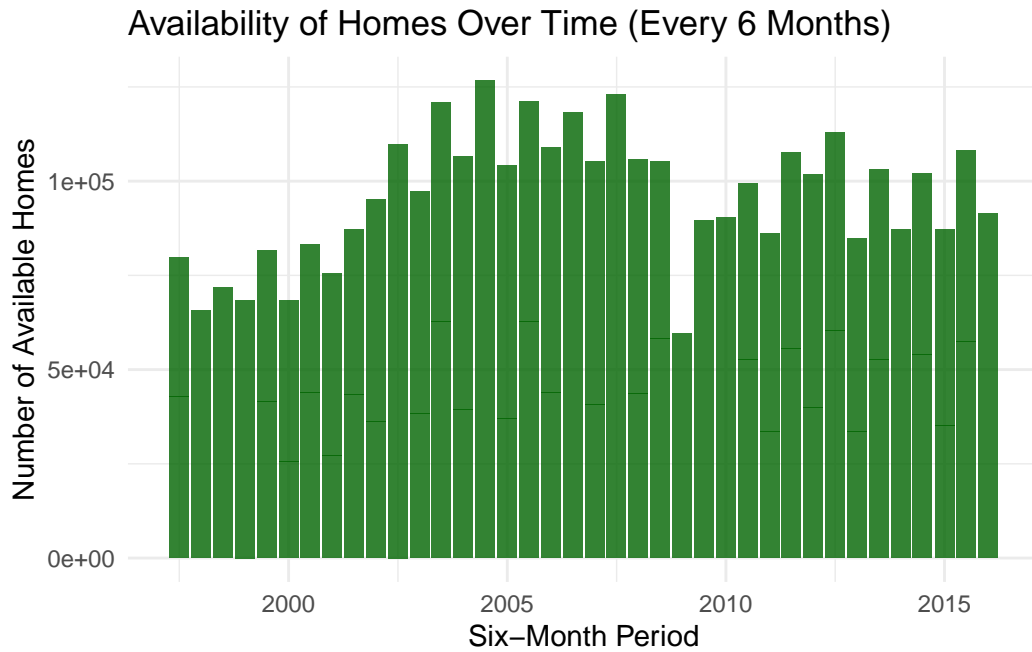


Figure 2: Distribution of Available Homes by Six-Month Period

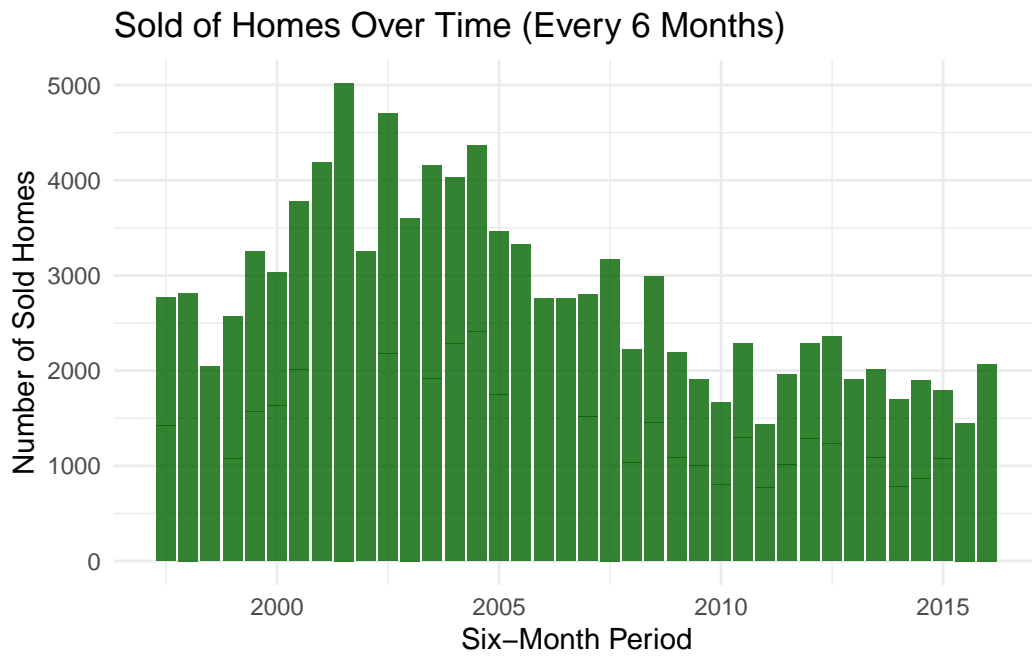


Figure 3: Distribution of sold Homes by Six-Month Period

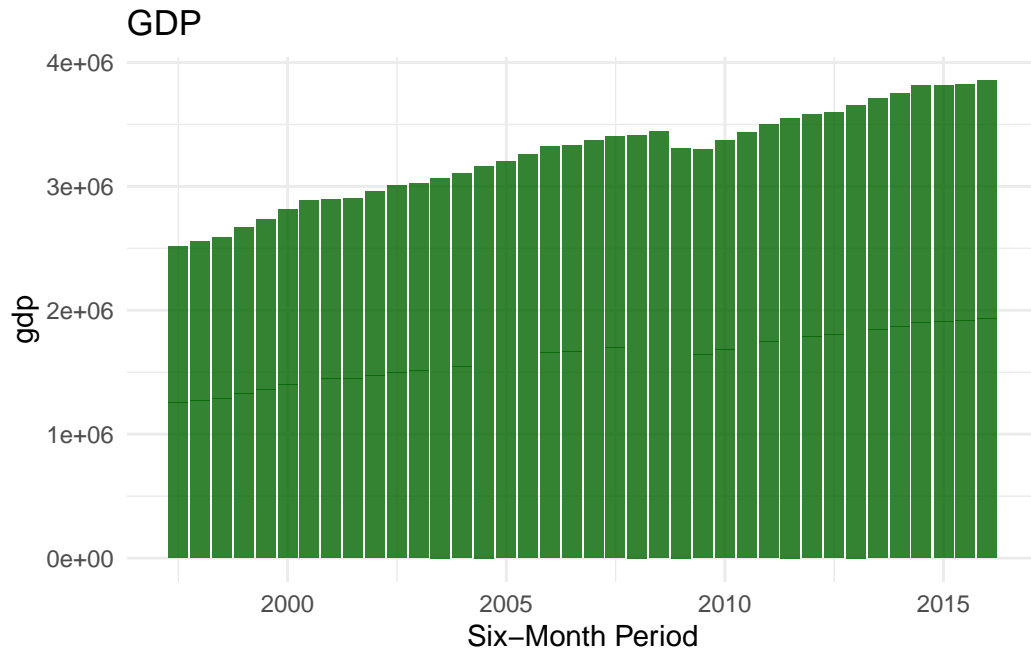


Figure 4: Gross Domestic Product

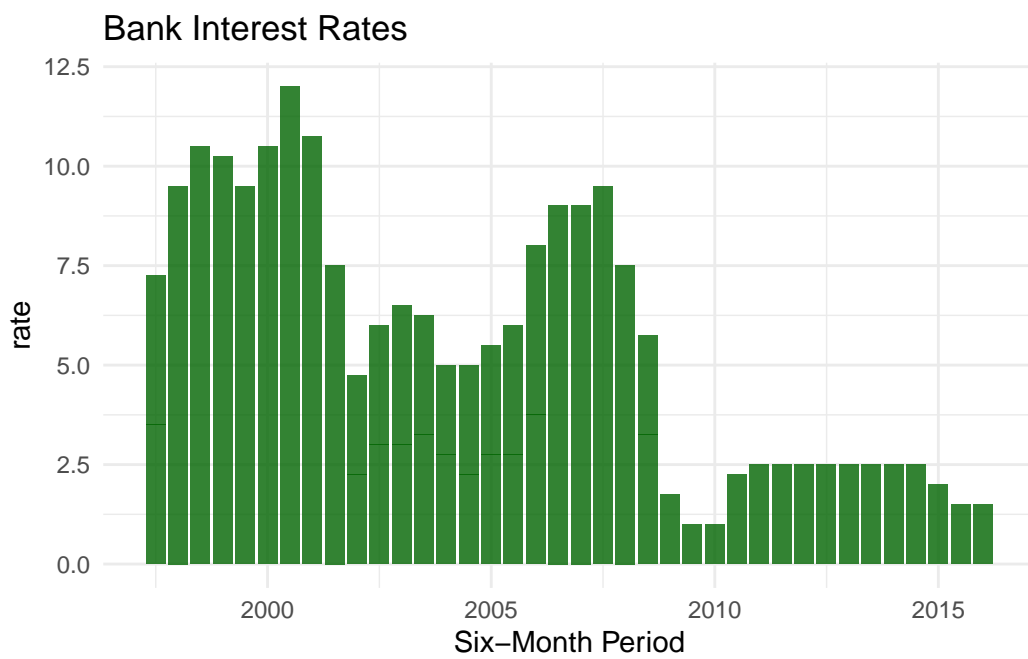


Figure 5: Interest Rate Trends and Hikes

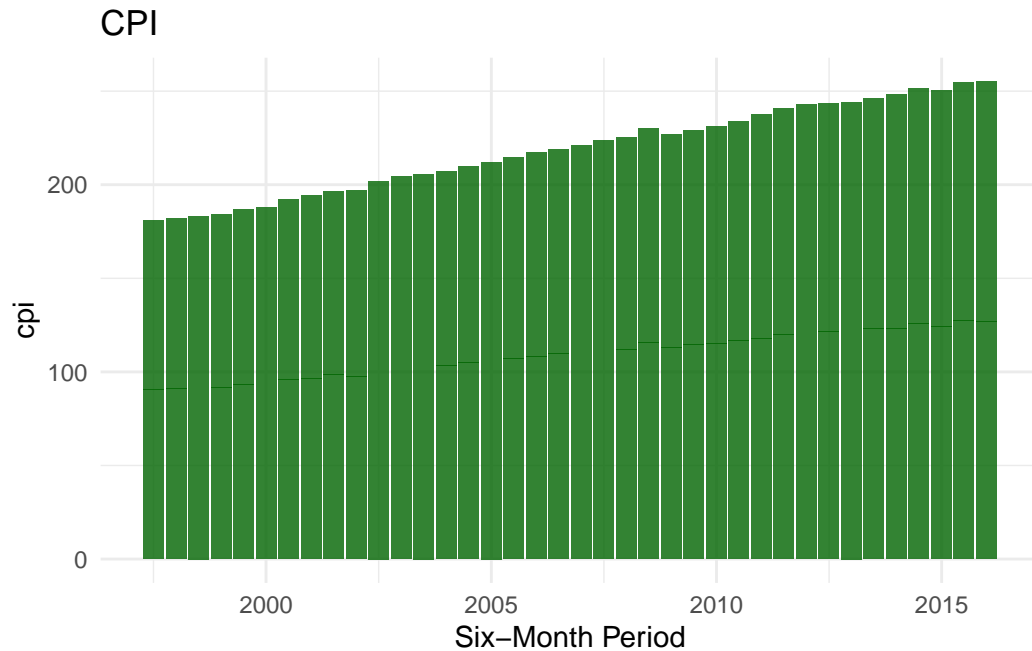


Figure 6: CPI

2.5 Summary

The data has been prepared for analysis through cleaning, transformation, and visualization. Each variable has been integrated into a cohesive dataset that will allow us to investigate how supply, demand, and economic factors impact housing prices in Canada.

3 Model

3.0.0.1 Goal of the Model

We want to predict house prices based on economic factors like interest rates, GDP, and absorption (a measure of market activity). To do this, we created a mathematical model that looks at the relationships between these factors and house prices, ensuring it's both accurate and easy to interpret.

3.0.1 Exploration and Refinement

1. Exploring the Data:

We looked at the relationships between each factor and house prices using scatterplots.

For example:

- **Interest Rate:** A clear negative relationship—higher rates are linked to lower house prices.
- **GDP and CPI:** Both show strong positive relationships with house prices.
- **Absorption:** Also negatively linked to house prices, but with more variability.

To ensure these factors don't overlap too much in their information (a problem called "multicollinearity"), we used a tool called the **Variance Inflation Factor (VIF)**. This told us that GDP and CPI were too similar to both be useful, so we removed CPI to simplify the model.

2. Checking Assumptions:

For our model to work well, it needs to satisfy certain assumptions:

- **Linearity:** The relationships between factors and house prices should follow straight lines.
- **Consistent Variance:** The errors in our predictions (residuals) should spread out evenly.
- **Normal Distribution:** The residuals should follow a bell-shaped curve.

We checked these assumptions using plots: - **Residuals vs. Fitted:** Showed some patterns, suggesting the need for possible tweaks. - **Scale-Location Plot:** Slight inconsistencies in error spread, indicating minor heteroscedasticity (unequal spread of errors). - **Normal Q-Q Plot:** Mostly aligned with expectations, except for a few extreme points (outliers).

3. Refining the Model:

We used step-by-step selection to find the most important factors. The final model kept:

- **Interest Rate:** Lower rates are linked to higher house prices.
- **GDP:** A major positive influence.
- **Absorption:** Significant but negatively linked, meaning more market activity tends to reduce prices.

We removed **construction** because it wasn't contributing much.

3.0.2 Final Model Performance

1. Key Insights:

- The model explains **95.4%** of the variation in house prices, showing it's highly accurate.
- It performs well on both the training and test data, proving it's reliable for predicting unseen scenarios.

2. Metrics:

- **RMSE** (typical error): 3.61
- **MAE** (average error): 3.07
- **R²** (accuracy): 95.76%

4 Results

Our results are summarized in `?@tbl-modelresults`.

Table 1: Summary of NHPI Model Results

Factor	Effect_on_NHPI	Interpretation
Bank Interest Rate	-0.62 per 1% increase	Higher interest rates make mortgages more expensive, reducing demand for new homes.
GDP	+0.0000778 per unit increase	Economic growth slightly increases NHPI as higher income and better financial security encourage people to buy homes, driving up prices.
Housing Absorption	-0.00603 per unit increase	Higher absorption suggests competitive pricing or increased supply, which can lead to lower prices.

Model Performance

The R-squared value of the model is 0.9576, indicating that 95.76% of the variation in NHPI is explained by the model.

Our analysis reveals key insights into how economic factors influence the New Housing Price Index (NHPI). A 1% increase in bank interest rates leads to a 0.62-point decrease in the NHPI, highlighting the significant role of borrowing costs in shaping housing affordability. Higher interest rates make mortgages more expensive, reducing demand for new homes as fewer buyers can afford them. Consequently, builders may lower prices to attract buyers, which is reflected in the NHPI. This finding underscores the strong connection between interest rates and housing market dynamics.

Economic growth, measured through Gross Domestic Product (GDP), has a positive but small effect on housing prices. A one-unit increase in GDP results in a 0.0000778-point rise in the NHPI, indicating that as the economy strengthens, demand for housing grows. Higher incomes and better financial security encourage people to buy homes, driving up prices. Additionally, increased economic activity often raises construction costs, further contributing to higher housing prices. While the individual effect of GDP changes is small, cumulative economic growth can have a noticeable impact on housing markets.

Interestingly, housing absorption, which tracks how many new houses are sold, shows a slightly negative relationship with the NHPI. For each additional house sold, the NHPI decreases by 0.00603. This suggests that when houses sell quickly, builders may reduce prices to maintain competitive sales or manage high supply levels. While high absorption indicates a busy housing market, it may not always lead to higher prices. Instead, it reflects the interplay between

supply, demand, and pricing strategies in the new housing market. These findings collectively provide a nuanced understanding of the factors driving changes in housing prices.

5 Discussion

5.1 Diverse Opinions on Housing Affordability

The issue of housing affordability has sparked widespread debate, with individuals and organizations proposing various solutions to address the crisis. Some advocate for increasing housing supply, while others emphasize controlling demand through policy measures. This paper aims to contribute to the discourse by identifying impactful solutions based on data-driven insights. By analyzing the relationships between key economic factors and the New Housing Price Index (NHPI), this study sheds light on effective levers to improve housing affordability.

5.1.1 Insights from Interest Rates

One of the most significant findings from this analysis is the strong influence of bank interest rates on housing prices. A 1% increase in interest rates results in a 0.62-point decrease in the NHPI. This relationship highlights the pivotal role of monetary policy in shaping housing markets. Higher interest rates make mortgages more expensive, reducing buyers' purchasing power and cooling demand. Consequently, builders may lower prices to attract the shrinking pool of potential buyers.

This finding aligns with the idea that controlling demand through interest rate adjustments can mitigate rapid price increases. Policymakers can leverage this mechanism to manage housing affordability, particularly in overheated markets. However, the broader economic implications of raising interest rates, such as slowing economic growth or increasing borrowing costs for businesses, must also be considered.

5.2 Economic Growth and Housing Demand

Economic growth, measured through Gross Domestic Product (GDP), plays a smaller but still notable role in housing prices. A 1-unit increase in GDP corresponds to a 0.0000778-point rise in the NHPI. While the individual effect of GDP changes is modest, sustained economic expansion can cumulatively impact housing markets.

5.2.1 The Interplay Between Growth and Demand

As the economy grows, incomes tend to rise, and job security improves, encouraging more people to enter the housing market. This increased demand can drive up prices, especially in high-demand areas with limited housing supply. Additionally, economic growth often leads to higher construction costs, which builders pass on to buyers, further inflating prices.

The data underscores the importance of aligning housing policies with economic conditions. For instance, governments can invest in affordable housing initiatives during periods of economic growth to balance market dynamics. Additionally, encouraging private-sector investment in housing projects can help increase supply and stabilize prices.

5.3 Housing Absorption and Market Dynamic}

Housing absorption, or the rate at which new homes are sold, exhibits a counterintuitive yet significant relationship with the NHPI. For every additional house sold, the NHPI decreases by 0.00603. This finding suggests that a busy housing market, characterized by high absorption rates, does not always result in higher prices. Instead, it may reflect increased supply or competitive pricing strategies by builders.

5.3.1 Implications for Supply-Side Strategies

This result challenges the conventional assumption that higher sales volumes drive up prices. In reality, when builders face high demand, they may respond by rapidly increasing supply to capitalize on market conditions. However, this increased supply can also lead to price stabilization or even slight decreases as builders compete to sell homes. Policies encouraging efficient and scalable housing production can leverage this dynamic to improve affordability.

Additionally, monitoring absorption rates can provide valuable insights into market trends. For example, a sudden increase in absorption rates might signal an oversupply risk, prompting policymakers to adjust incentives or regulations to maintain market balance.

5.4 Weaknesses and Next Steps

While this study provides valuable insights, it is not without limitations. One key weakness is the reliance on aggregated data, which may mask regional disparities in housing affordability. For example, housing market dynamics in metropolitan areas like Toronto may differ significantly from those in smaller cities or rural areas. Future research should incorporate more granular data to capture these regional variations.

5.4.1 Incorporating Additional Predictors

Another limitation is the exclusion of certain factors that may influence housing prices, such as population growth, zoning regulations, and international investment trends. Including these variables in future models could provide a more comprehensive understanding of the factors driving affordability.

5.4.2 Addressing Policy Implications

Finally, the study emphasizes the need for coordinated policy interventions. While interest rate adjustments, economic growth management, and supply-side strategies can individually impact affordability, their combined effects may yield the most significant results. Policymakers should consider integrated approaches that balance demand- and supply-side measures to achieve long-term housing affordability.

5.5 Conclusion

This paper highlights the complexity of addressing housing affordability through a data-driven lens. By analyzing the NHPI and its key predictors, it provides actionable insights into the economic factors shaping housing markets. The findings underscore the importance of interest rate policies, economic growth alignment, and efficient housing production in making homes more affordable. Moving forward, a multi-faceted approach that incorporates regional disparities and additional predictors will be crucial for developing sustainable solutions to the housing crisis.

A Appendix

A.1 Appendix: Methodological Exploration of Data Collection and Sampling

This Appendix explores the methodologies used in the collection and analysis of the datasets utilized in this study, particularly focusing on the reliability and representativeness of the New Housing Price Index (NHPI) and associated economic indicators. By examining the methods of data collection, sampling techniques, and potential biases, we aim to contextualize our findings within the broader field of housing market analysis.

A.1.1 Data Collection Methodology

The New Housing Price Index (NHPI) is collected through monthly builder surveys that track the prices of new single, semi-detached, and townhomes across 27 Canadian cities. Builders report separate prices for the house and land to ensure consistency, and adjustments are made for changes in quality, like size or features, to measure “pure” price changes. However, the exclusion of custom-built homes and limited regional coverage may underrepresent certain housing trends. This structured approach ensures reliable data for understanding housing market dynamics.

Other economic indicators, such as GDP, CPI, and interest rates, are derived from a mix of data sources including Statistics Canada surveys, government administrative records, and financial institutions. GDP data relies on monthly estimates projected from annual Supply and Use Tables using indicators like real output and employment. CPI is collected through surveys of retail prices across various goods and services to measure inflation, while interest rates are monitored directly from financial markets and reported by institutions. Aggregation processes, like deflation and index chaining, ensure consistency and accuracy, while no direct sampling is used for interest rate data.

The NHPI survey employs a multi-stage sampling approach, ensuring consistent coverage across 27 Canadian cities by focusing on builders with significant market activity. This method aligns with the principles of stratified sampling by stratifying builders geographically to represent regional trends. A key strength of this approach is its ability to maintain consistency over time by tracking prices for comparable house models. However, the exclusion of custom-built homes and regions with lower construction activity limits the dataset’s comprehensiveness, potentially underrepresenting smaller markets and unique housing segments.

A.1.2 Sampling Considerations

The NHPI targets new single, semi-detached, and townhomes in 27 Canadian cities, focusing on regions with significant construction activity. This population of interest is not fully representative of the entire housing market, as it excludes rural areas and custom-built homes.

Custom-built homes often differ significantly in design and cost, and their exclusion may result in an incomplete understanding of housing price trends. Furthermore, by prioritizing urban areas with higher construction activity, the NHPI may overemphasize trends in larger markets while underrepresenting housing dynamics in smaller or rural regions.

The NHPI employs a multi-stage sampling approach, with stratification by city to ensure geographic representation. Builders are selected based on their residential building permit values, ensuring that the sample reflects active market participants. While this stratified method enhances consistency and reliability, potential biases remain. For instance, reliance on self-reported data from builders may introduce inaccuracies, and the exclusion of lower-activity regions could skew national estimates. Although adjustments such as weighting are applied to improve representativeness, the dataset's urban focus limits its ability to capture the diversity of housing trends across Canada.

A.1.3 Bias and Measurement Errors

The NHPI data is susceptible to several biases and errors that could affect the validity of analysis. Builder surveys may introduce bias, as builders might have incentives to report lower prices to appear competitive or overreport quality adjustments to justify price changes. While inflation and cost change adjustments are applied to maintain data consistency, their robustness depends on the accuracy of the reported data, leaving room for error. Economic indicators like CPI and GDP, which involve complex calculations and data integration, may face issues such as data lags or misclassification of economic activities, potentially impacting their reliability as explanatory variables. Additionally, the NHPI's urban-focused sampling could lead to sampling bias, skewing conclusions toward trends in larger markets and underrepresenting rural housing dynamics. Mitigating these biases requires stricter validation processes for builder-reported data, cross-verification with independent market surveys, and more inclusive sampling strategies that account for diverse market conditions.

A.1.4 Simulation of Idealized Data

```
Rows: 76 Columns: 7
-- Column specification -----
Delimiter: ","
chr (1): REF_DATE
dbl (6): house_price, rate, gdp, cpi, construction, absorption

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
Rows: 1000 Columns: 6
-- Column specification -----
Delimiter: ","
```

```
dbl (6): house_price, construction, absorption, gdp, cpi, rate
```

```
i Use `spec()` to retrieve the full column specification for this data.
```

```
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
Rows: 76
```

```
Columns: 7
```

```
$ REF_DATE      <chr> "1997-07", "1997-10", "1998-01", "1998-04", "1998-07", "1~  
$ house_price   <dbl> 65.4, 65.4, 65.8, 65.9, 66.1, 66.1, 66.1, 66.3, 66.5, 66.~  
$ rate         <dbl> 3.50, 3.75, 4.50, 5.00, 5.00, 5.50, 5.25, 5.00, 4.75, 4.7~  
$ gdp          <dbl> 1256378, 1265026, 1271935, 1289440, 1284777, 1304826, 132~  
$ cpi          <dbl> 90.5, 90.6, 90.9, 91.0, 91.4, 91.6, 91.5, 92.5, 93.1, 93.~  
$ construction <dbl> 42859, 36904, 23578, 42093, 37395, 34373, 23376, 44936, 4~  
$ absorption    <dbl> 1420, 1352, 1419, 1395, 850, 1193, 1076, 1498, 1570, 1682~
```

```
Rows: 1,000
```

```
Columns: 6
```

```
$ house_price   <dbl> 230.6800, 237.9640, 214.1158, 262.7312, 204.2651, 252.691~  
$ construction <dbl> 182.0098, 197.9676, 110.8919, 143.8789, 149.8608, 288.835~  
$ absorption    <dbl> 183.75241, 166.29576, 211.22489, 260.25338, 155.13478, 17~  
$ gdp          <dbl> 2.770917, 3.021973, 1.812786, 2.017697, 2.581891, 1.49396~  
$ cpi          <dbl> 125.1009, 126.0262, 101.6433, 112.4302, 108.2651, 130.129~  
$ rate         <dbl> 3.408445, 2.868344, 2.138966, 3.000523, 3.481520, 2.99507~
```

The simulation was designed to generate an idealized dataset representing potential housing market trends under different economic conditions, including broader geographic diversity and adjusted predictor distributions. Compared to the observed data, the simulated dataset shows higher variability in predictors like absorption and construction, reflecting hypothetical rural inclusion and varying economic environments. For instance, simulated values for GDP and CPI exhibit a wider range, which may capture conditions not fully represented in the observed urban-focused data. The results suggest that observed data may underrepresent variability in house prices associated with broader economic factors, potentially leading to an overestimation of price stability. These findings highlight the importance of addressing gaps in geographic and economic coverage, with implications for more comprehensive housing policies and market analyses.

A.1.5 Literature Connections

A.1.6 7. Conclusion

This Appendix emphasizes the strengths and limitations of the NHPI and related economic indicators in analyzing housing trends. While the NHPI provides a reliable measure of urban

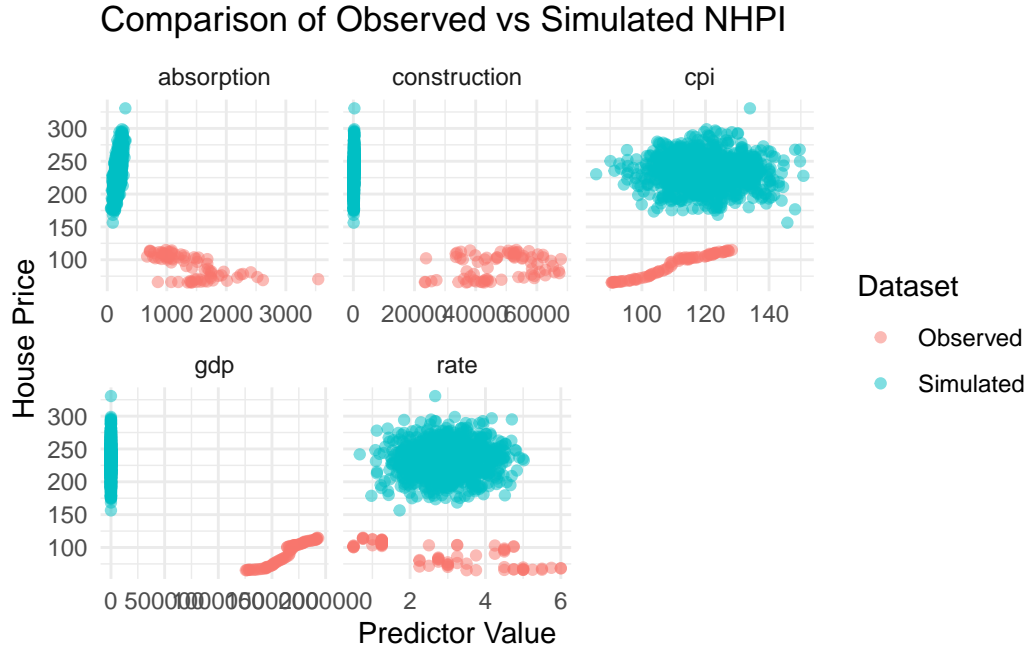


Figure 7: Simulated Data

housing markets, its exclusion of rural areas and custom-built homes limits its representativeness at the national level. Simulations revealed greater variability in an idealized dataset, suggesting that observed data may underrepresent broader economic conditions and housing trends. These insights underscore the importance of cautious interpretation when drawing conclusions from urban-focused datasets and highlight the value of incorporating additional data sources to improve representativeness and robustness in housing market analysis.

B Model details

References

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