Bacon, Eggs, and Inflation: Can household groceries track inflation?*

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Canada's average inflation rate in 2022 was 6.7%, a figure not seen since the 1980s. This inflation rate reflects an increase in the cost of goods and services (determined by the consumer price index) and impacts the wallets of people across the nation. Studies show that the price of household groceries directly influences inflation expectations. This paper investigates whether the cost of groceries can track Canada's inflation rate, examining common items like bacon, eggs, chicken, milk, frozen peas, and pasta sauce. An analysis of data from Statistics Canada and the Bank of Canada reveals that the cost rate increase of common groceries often exceeds the rate of inflation, and Canadians should look elsewhere to assess the inflation rate.

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*See the GitHub repository supporting this analysis: https://github.com/seb646/groceries-and-inflation

1 Introduction

Inflation is the pervasive and sustained increase in the cost of goods and services, and it has become a significant concern for economies worldwide. Inflation is most often observed as an impact on a currency's purchasing power, but it also has far-reaching effects on the affordability of household goods. In Canada, the inflation rate is tracked by the consumer price index, or CPI, which is an amalgamation of the cost of goods and services around the country (*Price Check: Inflation in Canada* 2019). For example, if the price of energy increases, so too does the CPI, which in turn increases the rate of inflation. If the inflation rate becomes too high (or too low), it can indicate serious problems for a country's economy and has lasting financial implications for the country's population.

In 2022, Canada's average rate of inflation was 6.7% – a record high not seen since the 1980s (Orlando 2022). This reflected a rise in the price of goods and services, like energy and food, for Canadians. One of the areas where inflation rates are arguably most observable is daily grocery store purchases. In fact, one study shows that "household-level grocery price changes significantly shape[s] inflation expectations" (D'Acunto et al. 2021). It is important to note that the researchers specify expectations, rather than reality, as inflation is tracked by the larger CPI, which includes housing, energy, clothing, and other items in addition to food. Still, this perception influences how Canadians understand their country's economic situation. As food is a factor considered by the CPI, it is logical to draw a connection between the two factors.

This paper investigates whether grocery store items can track Canada's inflation rate. It uses data from Statistics Canada to measure the 5-year cost history of common grocery store items, including bacon, eggs, chicken, milk, frozen peas, and pasta sauce (*Monthly Average Retail Prices for Selected Products* 2023). It also uses data from the Bank of Canada to graph the yearly averages of inflation rates from 2017 to 2022 (*Inflation: Definitions, Graphs and Data* n.d.). By examining the percent increases in the cost of these food items, it questions and explores the existence of a relationship between the cost of food and inflation to determine whether food is a useful indicator in tracking inflation.

The estimand of this analysis is the cost rate of each selected food item from the Consumer Price Index, measured against the Bank of Canada's overall rate of inflation.

The analysis indicates that food is not a reliable metric for tracking inflation, as the cost of food often increased at rates beyond inflation during the observed period. While food cost certainly plays a role in the country's overall CPI, and thus the inflation rate, Canadians should not solely depend on the cost of food to assess the country's inflation rate.

2 Data

2.1 Measurement

The data used in this paper comes from Statistics Canada's Consumer Price Index (CPI), an index used to track "changes in consumer prices experienced by Canadians" (*Consumer Price Index Survey* 2023). The CPI is a weighted average of common household goods and services, such as food, gas, housing, etc.

Statistics Canada updates the CPI every month through a survey of "families and individuals living in urban and rural private households in Canada," excluding students living in full-time residence, people living on Indigenous reserves, and representatives of foreign nations (*Consumer Price Index Survey* 2023).

The survey completed by Canadians is sample-based, obtained from "a selection of geographical areas, representative goods and services, and types and locations of retail outlets," in order to "estimate price changes experienced by Canadians" (*Consumer Price Index Survey* 2023). Geographical distribution of the sample also "varies by product" and can be "heavily influenced by local market conditions" (*Consumer Price Index Survey* 2023).

The sample survey is mandatory for the Canadians selected to be part of the analysis. In addition to collecting responses directly from consumers, Statistics Canada also collects data from government (federal, provincial, and municipal) administrative files, other Statistics Canada surveys, and other sources.

Although Statistics Canada has a rigorous error detection system—with price collectors reporting "reasons for large or unusual price changes," "automated edit checks" on prices, and follow-up investigations for "unusual price changes"—reliability of the data is often "difficult to assess" (*Consumer Price Index Survey* 2023). The sample surveys are subject to sampling error, which is often difficult to quantify because it is "based on judgmental rather than probability sampling methods" (*Consumer Price Index Survey* 2023).

The Bank of Canada, which calculates and posts metrics on the country's inflation rates, uses Statistics Canada's Consumer Price Index for their calculation and thus follows identical measurement guidelines (*Inflation: Definitions, Graphs and Data* n.d.).

2.2 Data Analysis

This paper uses data from both Statistics Canada's Consumer Price Index (CPI) and the Bank of Canada's Inflation Rate measurements.

Within the CPI, the paper specifically examines 6 variables representing different food items: bacon (per 500 grams), eggs (per 1 dozen), chicken breasts (per kilogram), milk (per 2 liters), frozen peas (per 750 grams), and pasta sauce (per 650 milliliters). These 6 food items were

selected as a representation of various food types and groups, allowing an analysis of meats, dairy, frozen goods, and shelf-stable food. The CPI displays a price of each food item by month of a given year, and was subsequently cleaned to find the average of a given year. Limitations in the history of the data only allow for analysis from 2017 up to 2022. Once the data was cleaned, a cost rate (the difference in price of a given year against the previous year) was calculated to show the change in price in order to measure the food item against inflation. It is important to note that, since the data only extends to 2017, a cost rate analysis from the years 2018 to 2022.

The rate of inflation measurements similarly recorded data month-to-month and required cleaning to show the yearly average. Although the inflation rate data set provided a far more robust history, only the years 2017 to 2022 were included in this analysis as inflation was only used as a comparison against food cost rates.

3 Results

3.1 Bacon (per 500 grams)

The cost of bacon fluctuated significantly over the analyzed time period. On average, the cost of bacon increased by 5.39% while the inflation rate increased by 3.04%. The highest price increase was between 2020 and 2021, which saw an increase 12.97% from $5.86 to $6.62. Prior to 2021, the cost increase of bacon fell within a roughly 1% margin of the inflation rate, although after 2020 the cost increased at a rate far greater than inflation.
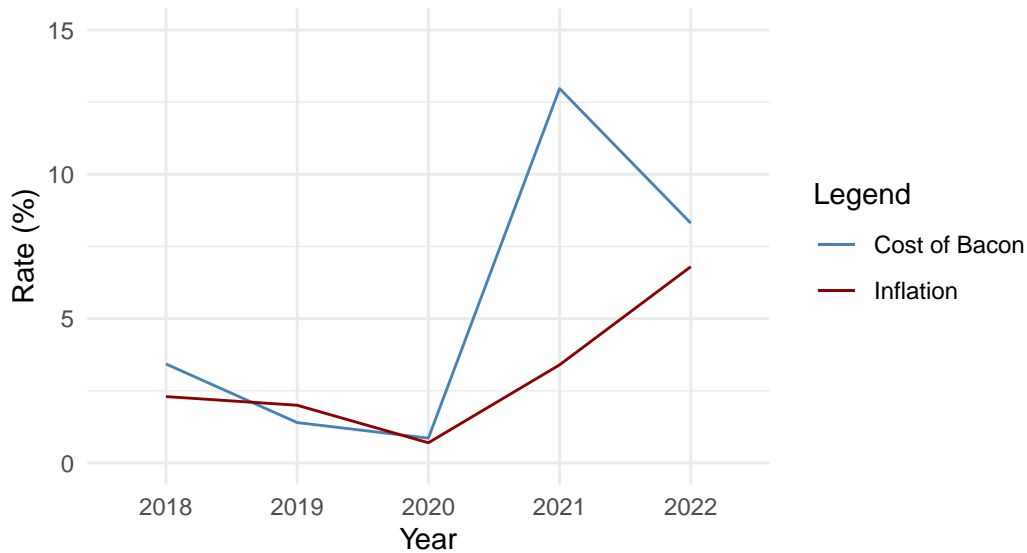

Figure 1: Cost of Bacon Rate vs. Inflation Rate, graph (since 2018)

Figure 1 graphs the cost rate of bacon against the rate of inflation between 2018 and 2022. This graph assists in visualizing the differences between the two rates, highlighting the significant increase in 2021 compared to the relatively stable rates of the three prior years. The graph also shows that, in 2022, the cost rate lowered significantly and may indicate an eventual return to previous levels (where bacon remained in consistent margins with inflation).

Year	Bacon Cost	Bacon Cost Rate	Inflation Rate
2018	$5.73	3.43%	2.3%
2019	$5.81	1.4%	2%
2020	$5.86	0.86%	0.7%
2021	$6.62	12.97%	3.4%
2022	$7.17	8.31%	6.8%

Figure 2: Cost of Bacon Rate vs. Inflation Rate, data (since 2018)

Figure 2 shows a breakdown of the data by year, comparing the raw cost (in $CAD), the cost rate, and the inflation rate.

In the given time period, bacon was not a reliable metric for monitoring inflation due to the drastic increase in 2021, along with the still relatively high increase in 2022. Because of this, bacon should not be used to track inflation but may prove to be a reliable indicator in the future.

3.2 Eggs (per 1 dozen)

The increase of the cost of eggs remained above the rate of inflation, by statistically significant margins, over the analyzed time period. On average, the cost of eggs increased by 6.66% while the inflation rate increased by 3.04%, showing increases more than double inflation. The highest price increase was between 2019 and 2020, which saw an increase 9.41% from $3.4 to $3.72. Due to the relatively low cost of eggs, a price increase in the single digits typically amounts to less-visible changes year-over-year. When viewing the increase over a greater period of time, this change is more visible.
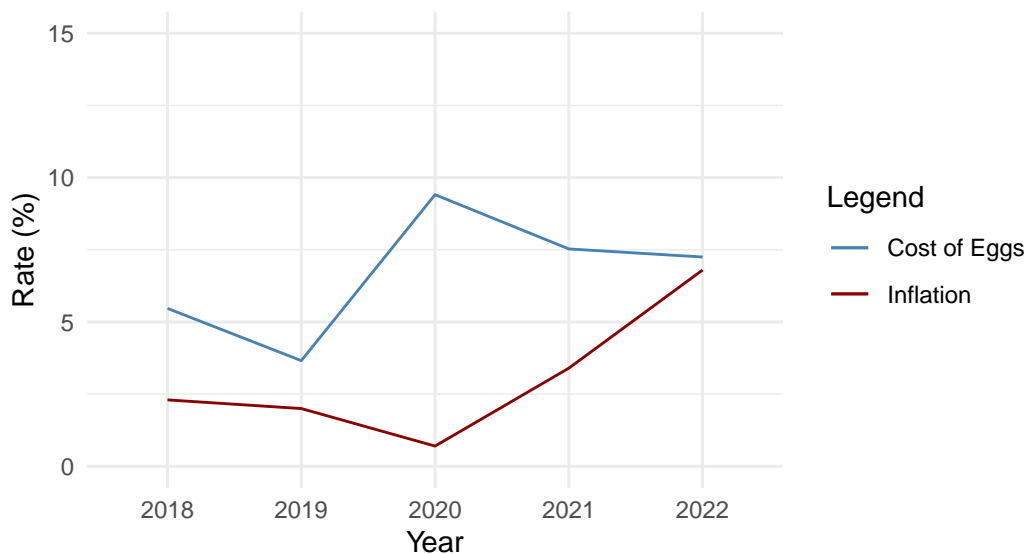

Figure 3: Cost of Eggs Rate vs. Inflation Rate, graph (since 2018)

Figure 3 graphs the cost rate of eggs against the rate of inflation between 2018 and 2022. This graph assists in visualizing the differences between the two rates, highlighting the consistently high cost increases when compared to inflation. The graph also shows that, in 2022, the cost rate lowered significantly to within 0.45%.

Figure 4 shows a breakdown of the data by year, comparing the raw cost (in $CAD), the cost rate, and the inflation rate.

Year	Eggs Cost	Eggs Cost Rate	Inflation Rate
2018	$3.28	5.47%	2.3%
2019	$3.4	3.66%	2%
2020	$3.72	9.41%	0.7%
2021	$4	7.53%	3.4%
2022	$4.29	7.25%	6.8%

Figure 4: Cost of Eggs Rate vs. Inflation Rate, data (since 2018)

In the given time period, eggs were not a reliable metric for monitoring inflation due to its consistent high increases comparative to inflation. The relatively low cost of eggs also makes this difference far less visible over the short term. Because of these factors, eggs should not be used to track inflation.

3.3 Chicken Breasts (per kilogram)

The cost of chicken fluctuated significantly over the analyzed time period, falling either below or above the year's inflation rate by statistically significant margins. On average, the cost of eggs increased by 4.28% while the inflation rate increased by 3.04%, showing increases more than double inflation. The highest price increase was between 2021 and 2022, which saw an increase 13.01% from $12.84 to $14.51. The relatively high cost of chicken makes cost changes far more visible to consumers, thus having a significant influence on the perception of inflation.
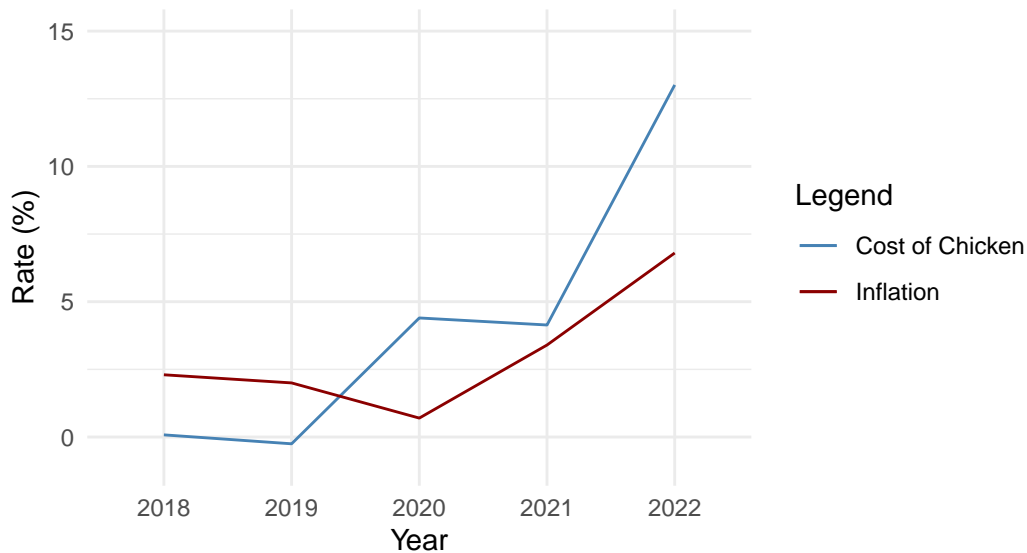

Figure 5: Cost of Chicken Rate vs. Inflation Rate, graph (since 2018)

Figure 5 graphs the cost rate of chicken against the rate of inflation between 2018 and 2022. This graph assists in visualizing the differences between the two rates, highlighting the drastic cost fluctuations when compared to inflation. The graph also shows that, prior to 2020, chicken breasts appeared relatively inflation-resistant increasing at 0.08% in 2018 and lowering in price by 0.25% in 2019. In 2022, however, the cost of chicken increased significantly by 13.01%, a rate almost double that of inflation.

Year	Chicken Cost	Chicken Cost Rate	Inflation Rate
2018	$11.84	0.08%	2.3%
2019	$11.81	-0.25%	2%
2020	$12.33	4.4%	0.7%
2021	$12.84	4.14%	3.4%
2022	$14.51	13.01%	6.8%

Figure 6: Cost of Chicken Rate vs. Inflation Rate, data (since 2018)

Figure 6 shows a breakdown of the data by year, comparing the raw cost (in $CAD), the cost rate, and the inflation rate.

In the given time period, chicken breasts were not a reliable metric for monitoring inflation due to its drastic cost fluctuations compared to inflation. With the cost falling below and then rising well above inflation rates, the cost of chicken breasts were far too inconsistent to reliably track inflation. Although the price of chicken makes differences visible enough for consumers to recognize, the sporadic increases do not suggest any relationship between the two metrics.

3.4 Milk (per 2 litres)

The cost of milk generally increased at a rate parallel to inflation. On average, the cost of eggs increased by 3.49% while the inflation rate increased by 3.04%. The most significant price increase—an outlier in this dataset due to the COVID-19 pandemic—was between 2019 and 2020, which saw an increase 3.83% from $4.18 to $4.34. Although this was the most numerically significant increase, it was not the highest as the cost increased by 6.94% from 2021 to 2022—although this price increase roughly matched the inflation rate of 6.8%.
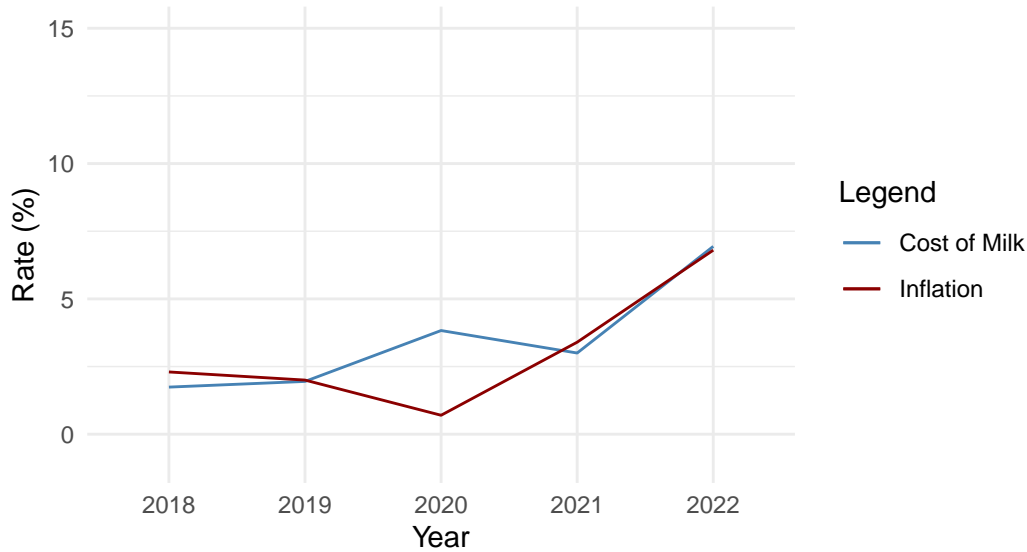
Figure 7: Cost of Milk Rate vs. Inflation Rate, graph (since 2018)

Figure 7 graphs the cost rate of milk against the rate of inflation between 2018 and 2022. This graph assists in visualizing the differences between the two rates, highlighting the similarities between the rates. The graph also shows that, prior to and after 2020, milk remained relatively consisted when compared to yearly inflation rates.

Year	Milk Cost	Milk Cost Rate	Inflation Rate
2018	$4.1	1.74%	2.3%
2019	$4.18	1.95%	2%
2020	$4.34	3.83%	0.7%
2021	$4.47	3%	3.4%
2022	$4.78	6.94%	6.8%

Figure 8: Cost of Milk Rate vs. Inflation Rate, data (since 2018)

Figure 8 shows a breakdown of the data by year, comparing the raw cost (in $CAD), the cost rate, and the inflation rate.

In the given time period, milk appeared to be a reliable metric for tracking inflation rates in Canada. With the cost remaining relatively stable between $4 and $5, the increase is small but noticeable. Throughout the observed period, excluding the year 2020, the cost increase of milk remained within less than a 1% margin when compared to interest rates and thus may prove to be a reliable grocery store item for generally tracking inflation.

3.5 Frozen Peas (per 750 grams)

The cost of frozen peas consistently increased at rates low enough to suggest inflation-resistance. On average, the cost of frozen peas increased by 2.59% in the observed period while the inflation rate rose by 3.04%. The cost did not increase between 2017 and 2018, leading to a possible market adjustment of 4.63% in 2019. Generally, aside from the year 2020, which influenced costs across the industry, the cost of frozen peas remained below interest rates.
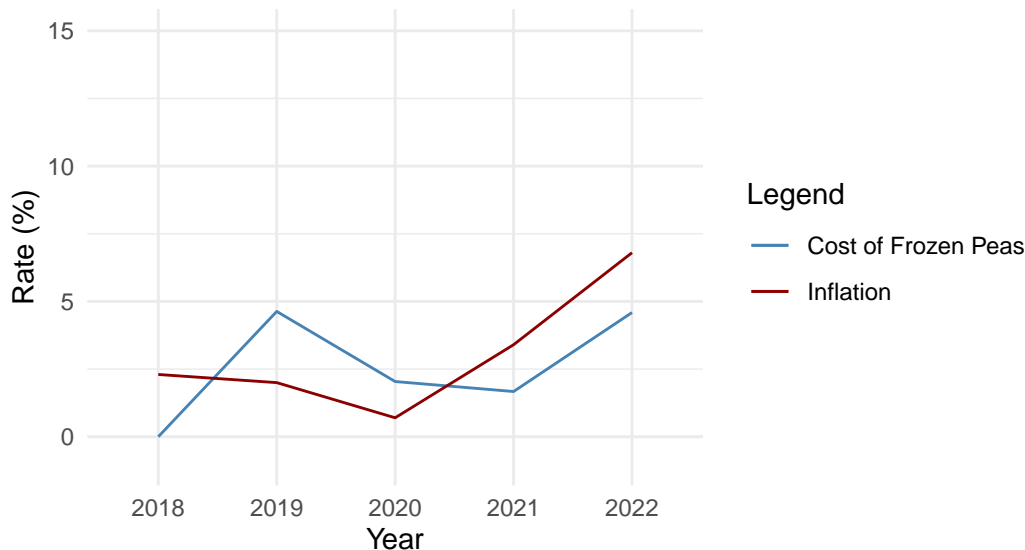

Figure 9: Cost of Frozen Peas Rate vs. Inflation Rate, graph (since 2018)

Figure 9 graphs the cost rate of frozen peas against the rate of inflation between 2018 and 2022. This graph assists in visualizing the differences between the two rates, highlighting the relatively low increases in cost when compared to inflation. The graph also shows that, prior to and after 2020, frozen peas remained below yearly inflation rates—aside from the aforementioned possible adjustment between 2018 and 2019.

Year	Frozen Peas Cost	Frozen peas Cost Rate	Inflation Rate
2018	$2.81	0%	2.3%
2019	$2.94	4.63%	2%
2020	$3	2.04%	0.7%
2021	$3.05	1.67%	3.4%
2022	$3.19	4.59%	6.8%

Figure 10: Cost of Frozen Peas Rate vs. Inflation Rate, data (since 2018)

Figure 10 shows a breakdown of the data by year, comparing the raw cost (in $CAD), the cost rate, and the inflation rate.

In the given time period, frozen peas appeared relatively relation-resistant. Although a significant finding, inflation-resistance does not assist consumers in tracking the nation's inflation rates and thus frozen peas are not suited for such a task.

3.6 Pasta Sauce (per 650 millilitres)

As a shelf-stable food item, pasta sauce possessed the opportunity to display an ability to track or resist inflation. Despite these assumptions, pasta sauce generally increased at rates greater than that of yearly inflation. On average, the cost of eggs increased by 5.71% over the observed period while the inflation rate increased by 3.04%. The highest price increase was between 2021 and 2022, which saw an increase 12.7% from \$2.44 to \$2.75. Generally, aside from 2018 when the cost increase was below interest rates, the cost of pasta sauce remained above the rate of inflation. In 2020 and in 2022, the difference was 6%.
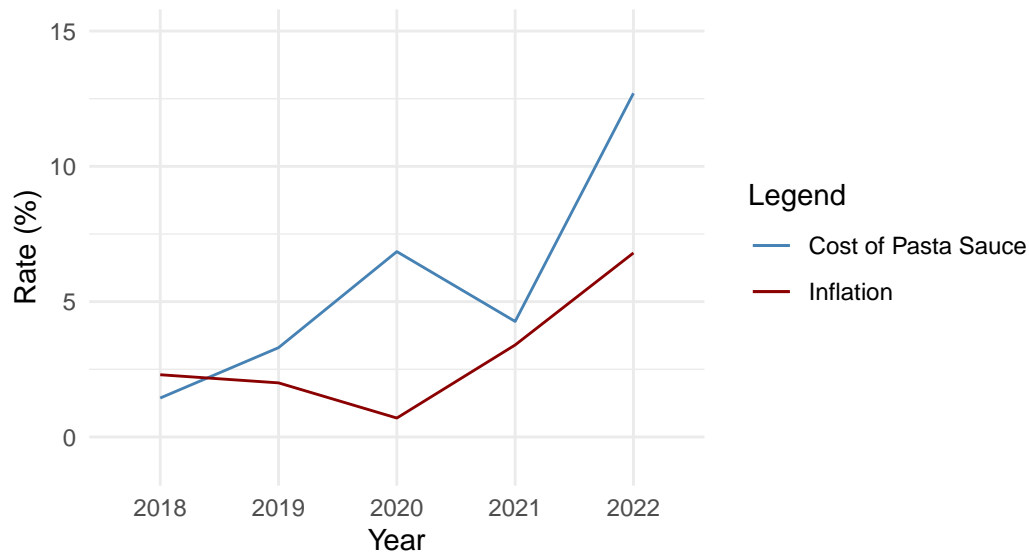

Figure 11: Cost of Pasta Sauce Rate vs. Inflation Rate, graph (since 2018)

Figure 11 graphs the cost rate of pasta sauce against the rate of inflation between 2018 and 2022. This graph assists in visualizing the differences between the two rates, demonstrating how pasta sauce generally increased at rates above inflation.

Year	Pasta Sauce Cost	Frozen peas Cost Rate	Inflation Rate
2018	$2.12	1.44%	2.3%
2019	$2.19	3.3%	2%
2020	$2.34	6.85%	0.7%
2021	$2.44	4.27%	3.4%
2022	$2.75	12.7%	6.8%

Figure 12: Cost of Pasta Sauce Rate vs. Inflation Rate, data (since 2018)

Figure 12 shows a breakdown of the data by year, comparing the raw cost (in $CAD), the cost rate, and the inflation rate.

In the given time period, generally pasta sauce remained above yearly inflation rates and is not suitable for tracking Canada's inflation rate. With the cost increase peaking at 6% in two of the five observed years, pasta sauce defied expectations by consistently remaining at rates above inflation.

4 Model

Generally, the rate of inflation is a year-over-year (although it may also be measured quarter-over-quarter or month-over-month) change in the Consumer Price Index (CPI). The equation used to represent this change rate is as follows, with CPI_1 representing the present CPI and CPI_2 representing the previous year (or quarter):

$$Inflation\ Rate = \frac{CPI_1 - CPI_2}{CPI_2} \cdot 100$$

This equation, however, is insufficient in serving as a true model to forecast inflation. Economists and financial analysts spent decades developing detailed models to forecast inflation, among other relevant economic indicators. The Bank of Canada uses the Terms-of-Trade Economic Model (ToTEM) as its main dynamic stochastic general equilibrium (DSGE) model. A white paper by Corrigan et al. (2021) explains this model in-depth, accurate as of 2021, and should be used to model and forecast inflation rates.

5 Discussion

Groceries generally proved ineffective at tracking Canada's inflation rates. Although the yearly increase in the cost of milk demonstrated promise in matching in inflation rates, all other selected products proved ineffective at tracking inflation—often either well above or below yearly rates. Groceries may play a significant factor in influencing the perception of inflation, but Canadians should not rely on groceries alone as inflation metrics.

One possible reason for groceries' ability to defy inflation rates is because of the weight given to the various Consumer Price Index categories. Food in general, including restaurants, accounted for 15.75% of the CPI, with groceries making up 10.93% of the total CPI (Drew 2022). As one of the most frequently purchased consumer goods, groceries may seem reflective of inflation because the cost of groceries often increases at rates surpassing inflation.

A high increase in the cost of groceries, however, may be attributed to a number of factors external to this study.

One example of an external factor is "food inflation," or the impact of climate change and high transportation costs, "as a result of higher oil prices" (Charlebois et al. 2023). When consider the raw cost of food, examining the entire supply chain is required to fully understand the cost. Changes in production, transport, and sellers may increase—or decrease—the cost of food beyond the influence of inflation.

Another example of an external factor is "greedflation," or the "taking advantage of high inflationary times to earn excessive profits at the expense of consumers who have limited choice in grocery shopping" (Charlebois et al. 2023). Large Canadian grocery chains are currently in the spotlight for price gouging, taking advantage of the high costs created by the recent pandemic. This question is so significant that Canada's Competition Bureau launched a study of grocery store competition in October 2022, examining "to what extent are higher grocery prices a result of changing competitive dynamics" (*Competition Bureau to Study Competition in Canada's Grocery Sector* 2022). Roughly 80% of Canadians claim "abuse in the system" by grocery stores, placing the blame for high costs squarely on corporations (Charlebois 2022). A review of the largest Canadian grocery chains found "flat" performance in the income of these chains, "when compared to the increase in the cost of living," and "yields were usually below or at the same level as the rate of food inflation" in the observed 5-year period (Charlebois 2022).

This analysis reveals that, as a whole, Canadians should not trust the cost of groceries to measure and monitor inflation. However, it did reveal that some groceries, like milk, show potential for paralleling inflation. Although, as this discussion revealed, the CPI weighs each category and thus the groceries that currently show promise for tracking inflation may not always possess such a quality. As Canadians continue to see weakened spending power, compounded by a higher cost of living, they should remain vigilant in understanding inflation, the factors that cause it, and the impact it has on various industries. Unfortunately, Canadians will have to look elsewhere for a practical, every-day method of monitoring inflation.

6 Inclusive Acknowledgements

Land Acknowledgement

We wish to acknowledge the land on which this data was analyzed. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca, and the Mississaugas of the Credit. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

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Data Acknowledgement

The data used in this paper was obtained from Statistics Canada and the Bank of Canada. As the Bank of Canada uses data from Statistics Canada to create their data set, both of the data sets used in this paper are governed by the Statistics Canada Open Licence.[1] The two data sets used in this paper are as follows:

- **Statistics Canada:** Monthly average retail prices for selected products[2]
- **Bank of Canada:** Inflation: Definitions, graphs and data[3]

Resources Acknowledgment

The primary tool used to analyse data in this paper is R, an open-source statistical programming language (R Core Team 2022). The paper also uses a number of R packages, including: arrow (Richardson et al. 2023), dplyr (Wickham et al. 2022), ggplot2 (Wickham 2016), here (Müller 2020), janitor (Firke 2021), kableExtra (Zhu 2021), knitr (Xie 2023), lubridate (Grolemund and Wickham 2011), opendatatoronto (Gelfand 2022), readr (Wickham, Hester, and Bryan 2022), RColorBrewer (Neuwirth 2022), scales (Wickham and Seidel 2022), and tidyverse (Wickham et al. 2019).

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[1]View the Statistics Canada Open License: https://statcan.gc.ca/en/reference/licence

[2]Statistics Canada's "Monthly average retail prices for selected products" data set is available at: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810024501

[3]The Bank of Canada's "Inflation: Definitions, graphs and data" data set is available at: https://bankofcanada.ca/rates/indicators/capacity-and-inflation-pressures/inflation

7 References

Charlebois, Sylvain. 2022. *CHARLEBOIS: Ottawa Will Investigate Food Prices. It's about Time.* Toronto Sun. https://torontosun.com/opinion/columnists/charlebois-ottawa-will-investigate-food-prices-its-about-time.

Charlebois, Sylvain, Andrea Rankin, Stacey Taylor, Vlado Keselj, Gumataw Abebe, Stefanie Colombo, Kathleen Kevany, et al. 2023. *Canada's Food Price Report 2023.* Dalhousie University. https://cdn.dal.ca/content/dam/dalhousie/pdf/sites/agri-food/Canada%27s%20Food%20Price%20Report%202023_Digital.pdf.

Competition Bureau to Study Competition in Canada's Grocery Sector. 2022. Competition Bureau Canada. https://www.canada.ca/en/competition-bureau/news/2022/10/competition-bureau-to-study-competition-in-canadas-grocery-sector.html.

Consumer Price Index Survey. 2023. Statistics Canada. https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&Id=1516333.

Corrigan, Paul, Hélène Desgagnés, José Dorich, Vadym Lepetyuk, Wataru Miyamoto, and Yang Zhang. 2021. *ToTEM III: The Bank of Canada's Main DSGE Model for Projection and Policy Analysis.* Bank of Canada. https://www.bankofcanada.ca/wp-content/uploads/2021/06/tr119.pdf.

D'Acunto, Francesco, Ulrike Malmendier, Juan Ospina, and Michael Weber. 2021. *Exposure to Grocery Prices and Inflation Expectations. Journal of Political Economy.* Vol. 129. https://doi.org/10.1086/713192.

Drew, Denam. 2022. *An Analysis of the 2022 Consumer Price Index Basket Update.* Statistics Canada. https://www150.statcan.gc.ca/n1/en/pub/62f0014m/62f0014m2022009-eng.pdf?st=RV7Sd1o7.

Firke, Sam. 2021. *Janitor: Simple Tools for Examining and Cleaning Dirty Data.* https://CRAN.R-project.org/package=janitor.

Gelfand, Sharla. 2022. *Opendatatoronto: Access the City of Toronto Open Data Portal.* https://CRAN.R-project.org/package=opendatatoronto.

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/.

Inflation: Definitions, Graphs and Data. n.d. Bank of Canada. https://www.bankofcanada.ca/rates/indicators/capacity-and-inflation-pressures/inflation/.

Land Acknowledgement. n.d. University of Toronto. https://indigenous.utoronto.ca/about/land-acknowledgement.

Monthly Average Retail Prices for Selected Products. 2023. Statistics Canada. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810024501.

Müller, Kirill. 2020. *Here: A Simpler Way to Find Your Files.* https://CRAN.R-project.org/package=here.

Neuwirth, Erich. 2022. *RColorBrewer: ColorBrewer Palettes.* https://CRAN.R-project.org/package=RColorBrewer.

Orlando, James. 2022. *Canadian Inflation: A New Vintage.* TD Bank. https://economics.td.com/ca-inflation-new-vintage.

Price Check: Inflation in Canada. 2019. Bank of Canada. https://www.bankofcanada.ca/

2019/02/price-check-inflation-in-canada.

R Core Team. 2022. *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, and Apache Arrow. 2023. *Arrow: Integration to 'Apache' 'Arrow'.* https://CRAN.R-project.org/package=arrow.

Wickham, Hadley. 2016. *Ggplot2: Elegant Graphics for Data Analysis.* Springer-Verlag New York. https://ggplot2.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, Romain François, Lionel Henry, and Kirill Müller. 2022. *Dplyr: A Grammar of Data Manipulation.* https://CRAN.R-project.org/package=dplyr.

Wickham, Hadley, Jim Hester, and Jennifer Bryan. 2022. *Readr: Read Rectangular Text Data.* https://CRAN.R-project.org/package=readr.

Wickham, Hadley, and Dana Seidel. 2022. *Scales: Scale Functions for Visualization.* https://CRAN.R-project.org/package=scales.

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

Zhu, Hao. 2021. *kableExtra: Construct Complex Table with 'Kable' and Pipe Syntax.* https://CRAN.R-project.org/package=kableExtra.