The Rise (And Fall?) of Inflation in Canada: A Detailed Analysis of Its Post-Pandemic Experience

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Abstract

Canada's inflation rate rose from 3.1 percent in June 2021 to 8.1 percent one year later. What is behind this rapid surge? And will higher interest rates ease the pressure? We explore these questions with a detailed analysis of recently rising inflation. We find a few items dominate, especially energy and items sensitive to oil prices. To separate demand- from supply-driven inflation, we use detailed household expenditure data and find rising inflation is primarily the latter. We also find items with normally transitory price changes or those highly sensitive to interest rates also account for nearly all of inflation's rise. While much uncertainty remains, time and tighter monetary policy may likely help decrease inflation.

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1 Introduction

Canada's inflation rate rose from 3.1 percent in June 2021 to 8.1 percent one year later—the highest rate since the early 1980s and the fastest accelerating one since the early 1950s. This paper sheds new light on the underlying drivers of inflation's recent rise. In particular, using detailed data on the prices and quantities of household consumption items, we identify and isolate the demand-side versus supply-side drivers of inflation. We find both demand- and supply-side factors are important contributors, though the latter increasingly so. We find three-quarters of Canada's accelerating inflation since Q2 2021 is from supply shocks, roughly 15 percent from demand, and the residual is ambiguous. With supply-side factors accounting for most of Canada's rising inflation, monetary policy will potentially have a difficult time combating it. Separating items according to whether price changes are normally persistent and whether expenditures on those items are sensitive to interest rates paints a more nuanced picture. We find that most recent price increases are among items that normally do not see persistent inflation. And of those items that do, almost all of the recent increases are among those where demand is highly sensitive to interest rates. Though it is only a first look, and much uncertainty remains, this paper sheds new and important light on the factors driving Canada's inflation to generational highs.

We begin with a simple decomposition of consumer price changes. Measuring the contribution of individual goods and services to year-over-year changes in the all-items consumer price index (CPI) is relatively straightforward. Intuitively, the basket-weighted price change of an item is (almost) its contribution to overall inflation. We follow Statistics Canada (2019)'s approach and describe the full method in more detail in the next section. We find that a clear majority of Canada's high inflation is due to a small handful of items: energy, food, and home-ownership costs. The latter is particularly interesting since Statistics Canada infers home depreciation from changes in new home prices (excluding land), which increased dramatically through the COVID-19 pandemic until early 2022. These three items account for over 60 percent of Canada's overall inflation in June, and an even larger share of the acceleration over the prior year. They also suggest supply shocks, to global energy and food markets in particular, were central to Canada's rising inflation rate.

Beyond the direct effect of energy prices, we further estimate the extent to which spillover effects may be important. Energy, after all, is an important input in the production of many goods and services throughout the economy. Products that are transportation intensive or that require heating or cooling—food, for example, satisfies both these conditions—may be particularly sensitive to energy price increases. To estimate this, we statistically identify items whose prices normally increase during periods of rising oil prices. We estimate that approximately one-quarter of the non-energy items within the consumer price index are sensitive to oil prices. These include air transport, restaurant meals, most food categories, hotels, various durable goods, and so on. We estimate that items sensitive to oil prices accounted for nearly 60 percent of Canada's July non-energy inflation as well as well over 85 percent of the increase since February 2020. This also suggests supply-side factors are particularly important.

To more robustly quantify the relative contribution of supply- versus demand-side factors, we

turn to other data. Specifically, we use detailed household final consumption expenditures, with quarterly information on prices and quantities for nearly 100 specific items. Unlike the CPI, which only periodically updates quantities, the consumption expenditure data does so continuously. This allows us to adapt the method from Shapiro (2022a) to identify whether changes in individual components of the overall personal consumption expenditure (PCE) price index are demand- or supply-driven. Intuitively, if an item's price increases but its quantity decreases, we label this change as a supply-driven price increase. Conversely, if both price and quantity increase, then it is demand-driven. Using a rolling ten-year window of quarterly price and quantity data, we identify unexpected changes in each by focusing on prediction errors. That is, if prices or quantities rise or fall by more than one would expect based on historically patterns, then we classify price changes as supply-driven (if unexpected quantity and price changes move in the opposite direction) or demand-driven (if they move in the same direction); they are ambiguous if the changes in either direction are sufficiently close to zero.

We find supply-side factors dominate the acceleration of Canada's inflation. Demand- and supply-driven factors each account for approximately half of the four percentage point increase in the PCE inflation rate from Q1 2021 to Q1 2022. Much of this is due to a sharp spike in demand-driven price increases in the third quarter of 2021; demand's contribution remains relatively stable thereafter. From Q2 2021 onwards, the increase in supply-side factors dominates. Through to Q2 2022, we find three-quarters of the increase from one year earlier was supply-driven. In terms of their overall level contribution, supply-driven price increases account for 2.3 percentage points more of overall PCE inflation than do their 2010–2019 historical norms, while demand-driven price increases account for 1.6 percentage points more. The magnitudes and trends of both factors are consistent with estimates for the U.S. by Shapiro (2022b). The same is true for the specific items that we find contributing to supply-driven inflation—especially fuel, food, vehicle parts, and more.

That supply-side pressures drive most of the recent acceleration is a challenge for the Bank of Canada. After all, whether and how monetary policy should respond to rising inflation depends on the cause. While raising interest rates is a powerful tool against demand-driven inflation, it does not "solve" inflation arising from supply shocks such as oil production disruption, supply chain bottlenecks, or disappointing crop harvests. Unlike positive demand shocks that increase both output and inflation, negative supply shocks reduce output while increasing inflation. As a result, contractionary monetary policy tends to be costlier—in terms of job losses and lower output—when inflation is supply-driven. This has long been known (Gordon, 1975; Phelps, 1978; Blinder, 1980; Aizenman and Frenkel, 1986) and recent rising inflation has brought wide attention to and concerns about its consequences and the risks of weakening growth (OECD, 2022; World Bank, 2022; United Nations, 2022). Our work sheds light on these issues in the Canadian context.

To better understand the prospects for monetary policy to lean against rising prices, we explore whether price increases occur among items sensitive to interest rates or those that normally do not experience persistent inflation. Contractionary monetary policy affects consumer and business expenditure on some items more than others. Adopting the empirical estimates of sensitivity

from Chernis and Luu (2018), we find that most of the demand-driven inflation is in items that are responsive to interest rates. To measure persistence, we estimate the extent to which price increases are strongly predictive of further price increases one year later. We find that roughly one-third of overall PCE inflation is driven by items that typically have persistent price changes. But among those, nearly all are highly sensitive to interest rates. The rest of the items, meanwhile, do not usually have persistent price increases. These results together paint a more nuanced picture of inflation and the potential effectiveness of monetary policy than current policy debates in Canada tend to see.

Our PCE inflation measure also provides complementary information to existing analyses of inflation using the CPI. Employers, governments and financial institutions widely use CPI as a measure of inflation. The Bank of Canada's inflation-control target is also based on it. Less known to the Canadian public, since there is no official series, PCE is another common measure of inflation. In the U.S., the PCE price index is published monthly by the Bureau of Economic Analysis and has been the Federal Reserve's preferred measure since 2000 (BEA, 2021). Compared to CPI, the expenditure weights in the PCE can change as households substitute away from certain goods and services toward others, avoiding some of the upward bias associated with the fixed-weight nature of the CPI (Bullard, 2013; Greenspan, 2000). PCE inflation also allows for a more consistent comparison over time. Our analysis of PCE inflation also suggests the Bank of Canada may benefit from using it to evaluate, estimate, and predict inflation.

Overall, our paper informs ongoing debates about the nature and consequences of recently high inflation. We are the first to disentangle the effects of demand and supply shocks on Canada's overall inflation. Our findings align with recent research examining specific shocks and their impacts on inflation. Leibovici and Dunn (2021) and LaBelle and Santacreu (2022b) investigate the effect of supply chain disruptions on prices in the U.S. and found they contributed significantly to rising inflation. Di Giovanni et al. (2022) study Euro Area inflation during the pandemic and found that foreign shocks and global supply chain bottlenecks played an outsized role relative to domestic aggregate demand shocks. Celasun et al. (2022b) use data from 30 countries in 2021 to show that supply shocks negatively impacted manufacturing output, which contributed to higher goods prices. These studies confirm that supply-side factors have been a major driver behind the recent elevated inflation in many countries. We also help shed light on the connection between pandemic-related disruptions and inflation (Shapiro, 2022a; Ball et al., 2021; Leibovici and Dunn, 2021; de Soyres, Santacreu, and Young, 2022; Di Giovanni et al., 2022; Celasun et al., 2022a; LaBelle and Santacreu, 2022b) and on Canada's recent experience in particular (Azad, Serletis, and Xu, 2021; Ambler and Kronick, 2021).

2 The Composition of CPI Inflation

Knowing whether high inflation is demand- or supply-driven is essential not just for its own sake but also for the appropriate conduct of monetary policy. Of course, this is not easy. The price

increase of some goods might be caused by rising demand, while for others, the same price increase might be caused by falling supply. In this section, we provide two decompositions to examine the drivers of inflation. First, we estimate the contribution of individual products to Canada's overall inflation by applying well-established methods to the latest data. Second, we adapt the novel approach of Shapiro (2022a) to identify the relative importance of demand and supply shocks.

2.1 A Simple Product-Level Decomposition

We begin with a decomposition of Canada's CPI. In a simple Laspeyres price index, overall inflation is the average change in prices across items, weighted by base-period expenditure shares. Each item j's contribution is then that item's price change times its weight. Canada's CPI, however, is more complex: a chain-linked index with periodic basket re-weighting.

Determining an item's contribution to inflation is complicated when periods span two baskets. Following Statistics Canada (2019, Ch. 8), consider a situation where between months $t-12$ and t there is a change in basket weights from b_{t-12} to b_t at link month $(t-12) < s < t$. The contribution of item j to inflation over this period is

$$c^j_{t-12,t} = \left(\frac{p^j_s}{p^j_{t-12}} - 1\right) w^j_{t-12} + \left(\frac{p^j_t}{p^j_s} - 1\right) w^j_s \left(\frac{P_s}{P_{t-12}}\right), \tag{1}$$

where P_t is the all-item CPI at time t and w^j_t is the relative importance of item j,

$$w^j_t = \frac{b^j_t(p^j_t/p^j_s)}{\sum_k b^k_t(p^k_t/p^k_s)}, \tag{2}$$

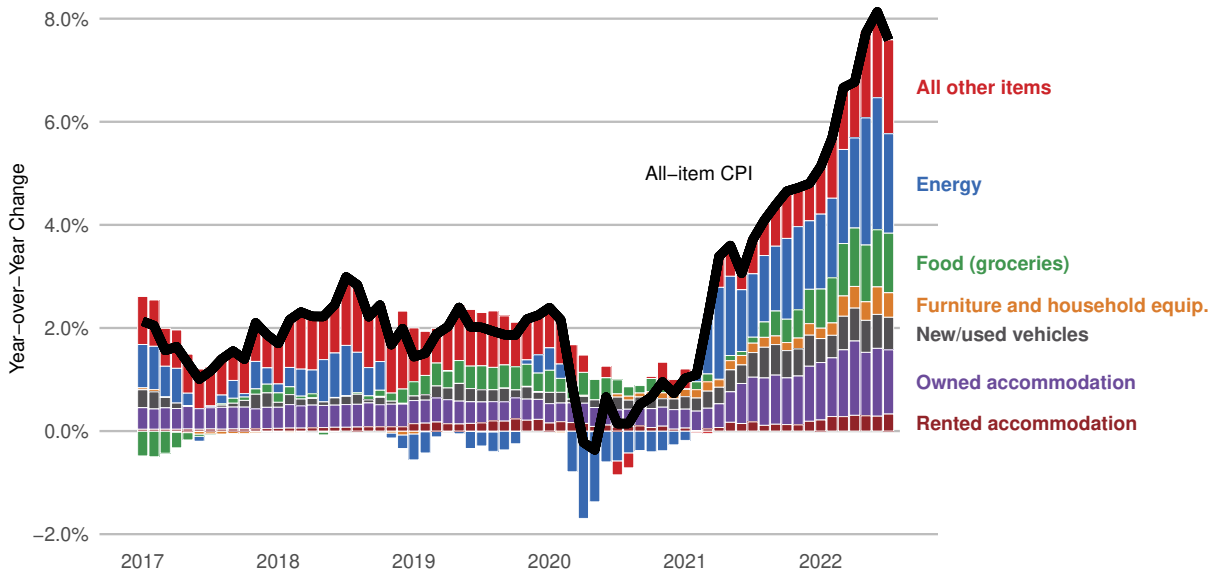
using whatever basket weight b^j_t is relevant for that month. Notice that if months $t-12$ and t share the same basket—such as would occur if $s < (t-12)$—then the above collapses to

$$c^j_{t-12,t} = \left(\frac{p^j_t}{p^j_{t-12}} - 1\right) w^j_{t-12}. \tag{3}$$

In either case, overall CPI inflation is $\pi_{t-12,t} = \sum_j c^j_{t-12,t}$. Changing basket weights matters for estimating an item's contributions to recent inflation because the latest link month was April 2022.

With this method, we find only a few items account for rising inflation. We display the results in Figure 1. Of the 8.1 percent inflation in June 2022, higher energy prices caused 2.6 percentage points (with 1.9 percentage points from gasoline alone). This was followed by 1.6 percentage points from owned and rented accommodation, 1.1 percentage points from groceries, 0.7 percentage points from new and used vehicles, and 0.5 percentage points from furniture and household equipment. Indeed, the rise in these half-dozen categories fully accounts for the recent increase. Had energy and shelter prices remained constant, we estimate headline inflation in July would have been 4.1

Figure 1: Key Drivers of Consumer Price Inflation in Canada, Jan 2017 to Jul 2022



Note: Displays the contributions of specific categories of items to Canada's headline rate of consumer price inflation over time.

Source: Authors' calculations using Statistics Canada data tables 18-10-0004-01 and 18-10-0007-01. See text for details.

percent instead of the actual 7.6 percent. And the modest decrease in the July inflation rate, as is also clear in Figure 1, was due to energy prices falling relative to June.

That energy is an important determinant of changes in Canada's inflation is not new. A Shapley-Owen Decomposition of inflation between February 1995 and February 2020 regressed on the contributions from these six items gives energy a value of nearly 0.7, suggesting the overwhelming majority of the variation was due to energy.[1] But the large and abrupt increase in 2021 and 2022 was unusual. So long as oil prices do not rapidly rise once again, this critical factor driving high inflation will soon dissipate. To be clear, inflation pressures are broad-based, with three-quarters of items experiencing annual price increases above three percent. But the top contributors are quantitatively the most important drivers. We find that the top ten of 150 individual items accounted for nearly five percentage points of Canada's CPI inflation in June.

Another unusual feature of the recent inflation acceleration is the large contribution of a non-cash component of owned accommodation: homeowners' replacement cost. As with any physical asset, homes depreciate, and this is a cost to the owner. Statistics Canada estimates the cost of depreciation using its index of new home prices (excluding land). It specifically presumes annual depreciation costs equal 1.5 percent of new home prices. So as home values increase, there is a mechanical effect on rising consumer price inflation, despite this not representing a cash expense of homeowners and despite their wealth increasing. There is no single ideal approach to measuring the cost of home ownership, and various statistical agencies opt for different methods, while some

[1]Starting in Feb 1995 avoids the 1994 tobacco tax cut; ending in Feb 2020 avoids the pandemic.

exclude it entirely. In Canada, it has rarely mattered for movements in the overall headline rate of CPI inflation. But between July 2021 and April 2022, this single factor contributed on average over 0.7 percentage points to CPI inflation—nearly triple the previous record contribution set by this item in 2006 and well over two-thirds of the total contribution from owned accommodation costs. This post-pandemic experience may motivate a reform to the CPI or the use of other, complementary measures of inflation, which we will describe next. Regardless, as real estate prices decline—and they have been doing so since April 2022—this important driver of inflation will ease.

For other items, there is no shortage of potential explanations for the rapid rise in prices. Energy prices increased through 2021 and early 2022 due to a robust economic recovery from the pandemic and lagging oil production in key OPEC countries. Russia's invasion of Ukraine sent them higher still. As an important input into the production of so much else, energy prices may be a broad source of price increases. Durable goods like vehicles and household appliances also faced supply chain disruptions and transportation bottlenecks, both of which may have pushed up producer prices(LaBelle and Santacreu, 2022a). Some point to rising corporate profits as a driver, although we estimate average markups (excluding oil and gas) increased only 0.6 percent in Q2 2022 compared to one year earlier.[2] On a macroeconomic level, others point to expansionary fiscal and monetary policy as key drivers. Income support programs through the pandemic may have increased consumer demand, which in turn may have increased prices (Summers, 2021). And low interest rates and rising asset prices, perhaps driven by loose monetary policy, may have added to this pressure. To further investigate the nature of and quantify the significance of different contributors to inflation, we first explore the potential for high energy prices to account for non-energy price increases. We then turn to a new approach and different data to separately identify demand- versus supply-driven inflation.

2.2 Items Sensitive to Oil Prices

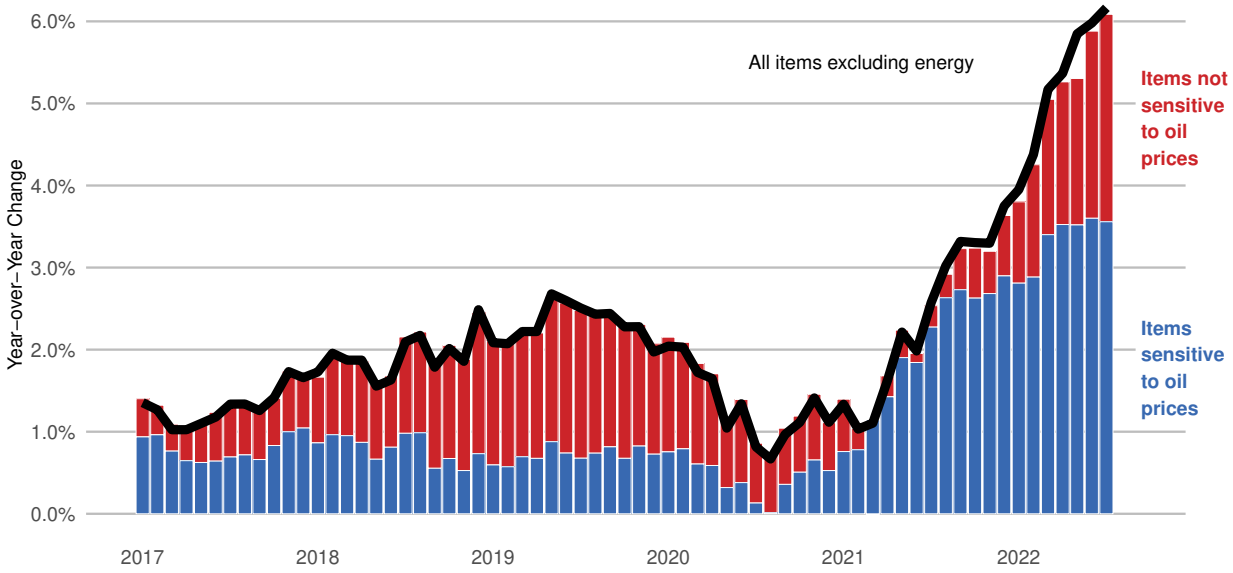
To classify items according to whether they are sensitive to oil prices, we statistically estimate the historic relationship between year-over-year changes in oil prices and in a given item's price. Specifically, for each item, we estimate

$$\pi^j_{t-12,t} = \beta^j_0 + \beta^j_1 \Delta p^{WTI}_{t-12,t} + \epsilon^j_t, \tag{4}$$

where $\pi^j_{t-12,t}$ is the year-over-year increase in item j's price and $\Delta p^{WTI}_{t-12,t}$ is the change in the Canadian-dollar per barrel price of West Texas Intermediate crude oil over that same period. We classify items where β^j_1 is positive and statistically significant as sensitive to oil prices. Estimating this relationship on a subset of 145 individual non-energy CPI components, we find 41 items tend to move with oil prices and 104 do not. The oil price–sensitive items include homeowners' replacement costs, other owned accommodation expenses, traveller accommodation, air transportation,

[2]Source: Authors' calculations from Statistics Canada data table 33-10-0226.

Figure 2: Contribution of Items Sensitive to Oil Prices to Non-Energy CPI Inflation



Note: Displays the contribution of items sensitive to oil prices to Canada's rate of non-energy CPI inflation. Estimates are based on 150 individual components of the CPI, excluding natural gas, fuel oil and other fuels, gasoline, electricity, fuel, and parts and accessories for recreational vehicles. May not aggregate to the official all-items excluding energy series due to rounding.

Source: Authors' calculations using Statistics Canada data tables 18-10-0004-01, 18-10-0007-01, and FRED databases MCOILWTICO and DEXCAUS. See text for details.

vehicle rentals, almost all food categories, restaurant meals, and various durable goods categories such as new vehicles, furniture, and most clothing.

Aggregating the contribution of each individual item to Canada's non-energy CPI inflation, we find most of the recent acceleration is due to items sensitive to oil prices. We display these results in Figure 2. In July 2022, we estimate that of the over six percent increase in non-energy consumer prices, as compared to one year earlier, items sensitive to oil prices contributed 3.6 percentage points. That is, nearly 60 percent of Canada's non-energy inflation rate in July arises from items that historically tend to move closely with oil prices. And of the four percentage point rise in non-energy inflation since February 2020, increases among those items sensitive to oil prices account for fully 3.5 percentage points. These results suggest high energy prices, and the resulting production cost increases for many other goods and services throughout the economy, may largely explain Canada's accelerating inflation.

While high energy prices are a negative supply shock for many non-energy sectors, other supply-side disruptions and strong post-pandemic demand could also contribute. To quantify the contributions of demand- versus supply-side factors more precisely, we require continuously updated data on prices *and* quantities. The CPI does not include this, but a lesser-known database does. We present this alternative measure of inflation in the next section.

3 Household Consumption Expenditure Inflation

We construct a measure of inflation using a personal consumption expenditure (PCE) deflator. Our main data source is the publicly available Statistics Canada dataset *Detailed Household Final Consumption Expenditure* (DHFCE, table 36-10-0124-01), which provides a detailed disaggregation of final expenditures into nearly 100 specific items.[3] These data report nominal quarterly expenditures by item and, importantly for our purposes, real expenditures at constant prices. The implied price index for an item is the ratio of nominal to real expenditures and changes in real expenditures provide a measure of quantity changes. This feature of the data is critical for our analysis: the CPI data normally used to measure inflation do not contain the necessary quantity information for each item, which we will need.

Before discussing the method to identify demand- and supply-side factors driving inflation, a brief detour to understand PCE inflation may be beneficial. While our PCE inflation measure differs from the CPI, it is nevertheless highly informative. Both are widely used by central banks, and they broadly follow similar trends.[4] We display quarterly PCE and CPI inflation in Figure 3. The two series are highly correlated, though there are differences. In Q1 2022, we estimate Canada's PCE inflation rate to be five percent, while the all-items CPI increased 5.8 percent over that same period.[5] In the second quarter, we estimate the PCE inflation rate rose to 6.1 percent, compared to a CPI increase of 7.5 percent. The lower rate of PCE inflation as compared to CPI is visible in the United States as well, where the former was 6.5 percent in the second quarter, while the latter was 8.6 percent.[6]

Several factors account for these differences, including data sources, product coverage, calculation formulas, and the frequency of basket updates. Our PCE inflation is based on the seasonally adjusted DHFCE data, which are a component of Canada's system of national accounts. CPI prices are collected from a sample survey to reflect retail prices, and the CPI basket is constructed with the same data we use, plus supplementary data from the *Survey of Household Spending*. There is also a difference in the scope, as our PCE index covers all resident households and CPI contains only private ones.[7] The formula and calculations also differ. The CPI, as we noted, infers homeowner depreciation costs from an index of new home prices, while the DHFCE aligns with national accounts and estimates the rental equivalent cost of home ownership.

PCE inflation has two advantages over CPI inflation that are particularly relevant to understanding recent inflation trends. First, the expenditure weights are more frequently updated, as

[3]We exclude adjusting entries, net expenditure abroad and its subcategories, and cannabis-related items. These detailed data begin in 1981. For a longer time series, we use the dataset *Household Final Consumption Expenditure* (table 36-10-0107-01), which begins in 1961, but with a more aggregated classification.

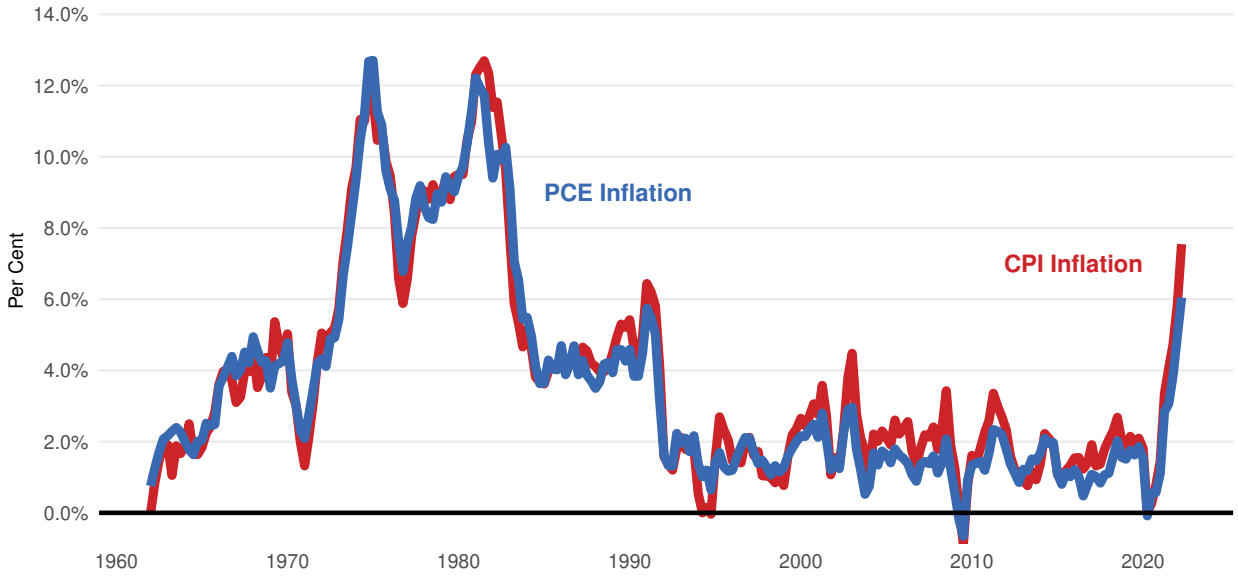
[4]Since 1962, quarterly PCE inflation has averaged 3.6 percent compared to 3.8 for quarterly CPI. Since 2000, PCE inflation averaged 1.6 percent, compared to 2.1 percent for CPI. That PCE is generally lower than CPI inflation is consistent with McCully, Moyer, and Stewart (2007). CPI also tends to report larger deflation if changes are negative.

[5]Source: Authors' calculations from Statistics Canada data table 18-10-0006-01.

[6]Source: Authors' calculations from St. Louise FRED data series PCECTPI and CPIAUCSL.

[7]The CPI target population does not include people who live in collective households, such as members of communal colonies, prison inmates, and chronic care patients in hospitals and nursing homes.

Figure 3: Two Measures of Inflation in Canada, Q1 1962 to Q2 2022



Note: Displays our aggregate measure of quarterly PCE inflation, as compared to an estimate of quarterly CPI inflation.

Source: Authors' calculations using Statistics Canada data tables 18-10-0004-01 and 36-10-0107-01.

they are constructed from expenditure data, as opposed to CPI's fixed-basket design. Second, unlike CPI, the PCE data is revised and modified to account for newly available information and improvements in measurement techniques within the national accounts. The result is a more consistent series over time and a potentially better comparison to historical data, which we undertake in Section 3.2. Understanding movements in PCE inflation is therefore highly informative and complements the CPI measure.

To cleanly decompose the contributions of specific items to inflation, we use a Laspeyres approach. This is distinct from the U.S. PCE inflation, which uses a Fisher approach, but it better approximates the method used in determining the headline rate of CPI and provides for a more intuitive decomposition.[8] Specifically, quarterly changes in item j's price area

$$\pi^j_{q-1,q} = \frac{p^j_q}{p^j_{q-1}} - 1, \tag{5}$$

where p^j_q is the item's price index. Given expenditure weights ω^j_q, the contribution of item j to

[8]Our results are robust to using Fisher weights for each item. In Q1 2022, for example, year-over-year inflation using a Laspeyres approach is 5.1 percent and that using a Fisher approach is 5.0. The largest difference between the two approaches since 1982 is 0.1 percentage points. A chain-type index is also similar.

overall final consumption expenditure price changes is $\omega^j_{q-1}\pi^j_{q-1,q}$, and therefore,

$$\pi_{q-1,q} = \sum_j \omega^j_{q-1}\pi^j_{q-1,q}. \tag{6}$$

Annual PCE inflation is then the rolling four-quarter sum of these quarterly changes. In the analysis to come, we will report both annual and quarterly PCE inflation, but the former will be our primary focus.

3.1 Estimating Supply- and Demand-Driven Price Changes

We adapt Shapiro (2022a) to distinguish between demand and supply shocks in the data. The intuition is simple. We categorise changes for each item in the household expenditure data as *supply-driven*, *demand-driven*, or *ambiguous*, based on whether unexpected changes in quantity and price are in the same direction (demand) or not (supply). By unexpected changes, we mean deviations from historically normal changes in quantities and prices. Specifically, using a ten-year rolling window, we regress log price levels or log quantity levels for each item on the information available over the past year. That is, for $x \in \{price, quantity\}$ we estimate

$$\log(x^j_q) = \beta^j_0 + \sum_{s=1}^{4} \beta^j_s \log(Z^j_{q-s}) + \epsilon^j_q, \tag{7}$$

where Z^j contains both past price and quantity data. Intuitively, this method uses information within a window from quarter $q-40$ to $q-1$ to construct a prediction for the price or quantity of item j during quarter q. The residuals $\hat{\epsilon}^j_q$ capture unexpected changes. Using these residuals for both price and quantity, we classify shocks based on their signs. If the unexpected changes in price and quantity are in the same direction, then we conclude this item was subject to a demand shock. Similarly, if the unexpected changes in price and quantity are in opposite directions, we conclude the item was subject to a supply shock. We classify any unexpected change in price or quantity between the 45th and 55th percentiles of the residuals in each rolling 10-year window as ambiguous. Our results are generally robust to using one lag, or as many as eight.

Figure 4a and 4b reveal several important patterns. Annual PCE inflation fell at the onset of the pandemic, stayed low during it, and rose at the beginning of 2021. The year-over-year inflation rate continued to grow. By 2022 Q2, PCE inflation exceeded six percent, which is the highest rate since 1983. Quarterly changes reveal a sharp decline in Q2 2020, followed by an equally sharp rebound in the third quarter. The relative contributions of demand- and supply-side factors are also clear. Early in the pandemic, between Q1 2020 and Q2 2020, demand accounted for nearly two-thirds of the drop in annual inflation. And early in the initial recovery, through Q2 and Q3 2021, demand-side factors were the main source of increases. But the picture later changed, with supply driving more recent inflation increases, accounting for 3 percentage points of PCE inflation in Q2 2022. And supply contributions were nearly three-quarters of the total increase in PCE in

Table 1: Top Contributors to Annual PCE Inflation (Q2 2022)

Demand Shocks		Supply Shocks	
Item	Contribution	Item	Contribution
Imputed rent (homeowners)	0.38	Fuels/oils for vehicles	0.66
Natural gas for homes	0.13	Food (groceries)	0.38
Furniture and furnishings	0.11	Food (restaurants)	0.25
Games of chance	0.07	Accommodation services	0.16
Used motor vehicles	0.07	Paid rental fees for housing	0.15
Durables for outdoor rec.	0.05	New trucks/vans/SUVs	0.13
Out-patient services	0.05	Vehicle parts/accessories	0.09
Personal elec. appliances	0.04	Alcoholic beverages	0.08
Electricity	0.04	Non-alcoholic beverages	0.05
Cable/satellite service	0.04	Household appliances	0.05

Note: Displays the top ten demand and supply contributors to year-over-year PCE inflation in Q2 2022. Calculated as the cumulative quarterly percentage point contributions of each item accounted for by demand and supply shocks, respectively. Products with both demand-driven and supply-driven changes are listed in only one column, depending on which cumulative contribution is largest.

Source: Authors' calculations using Statistics Canada data table 36-10-0124-01. See text for details.

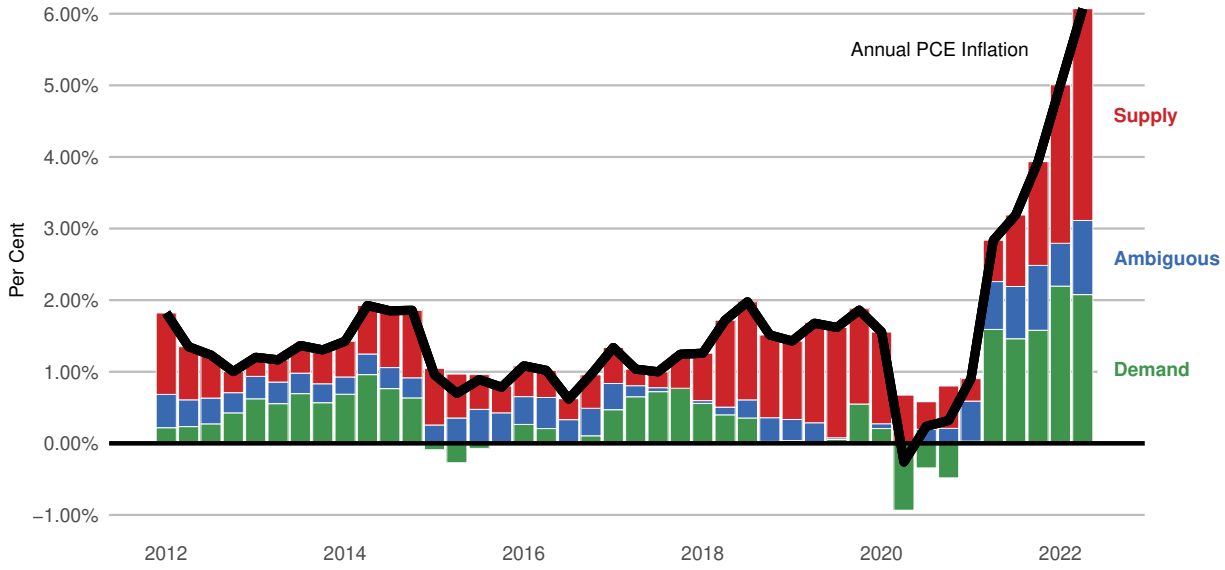
Q2 2022 compared to one year earlier. The contribution of supply-side drivers has also increased strongly in recent quarters, which will post a challenge for monetary policy going forward. To be clear, both supply and demand factors have increased relative to their historic norms. Between 2010 and 2019, for example, the average contribution of supply-side factors to annual PCE inflation was 0.7 percentage points. For demand-side factors, the average contribution was 0.5 percentage points. In Q2 2022, meanwhile, supply-side factors were 2.3 percentage points higher than these historical levels and demand-side factors were 1.6 percentage points higher.

As for individual drivers of PCE inflation, we report the top contributors in Table 1. We estimate the contribution of each item to overall demand- or supply-driven inflation by summing that item's supply or demand contribution over the past four quarters. Consider the simple example of air transportation. We estimate that from Q3 2021 to Q2 2022 (inclusive), this item's price increase was demand-driven in three quarters and supply-driven in one. Its contribution to demand-driven inflation over the year would then be the sum of the three demand-driven quarters' contributions only. The table reports the contributions in percentage points towards the overall annual PCE inflation in Q2 2022. We find the top demand-driven inflation contributors come from imputed rent (for owned accommodation), natural gas for home heating, household furnishings, used car purchases, durable goods for outside recreation, and other items. The supply-side items pushing inflation reveal different sources of disruptions, including high global commodity prices after Russia's invasion of Ukraine (fuel, food) and supply chain disruption (new vehicles, vehicle parts). Altogether, the top ten supply-driven contributors account for two percentage points of overall PCE inflation. The top demand contributors, meanwhile, account for one percentage point.

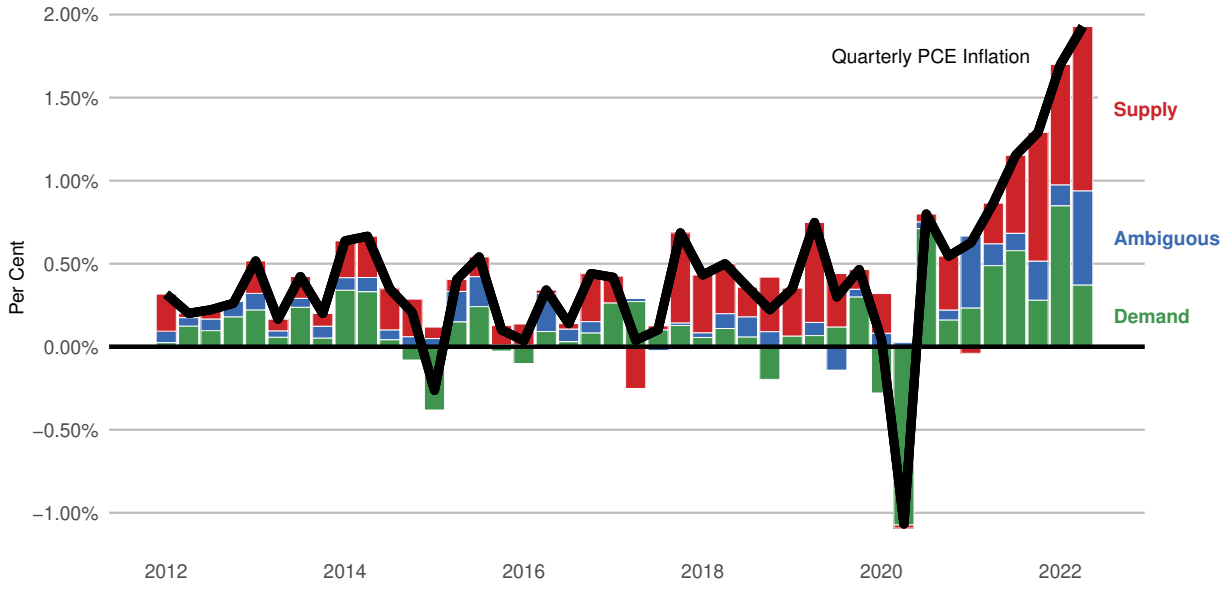
The Bank of Canada's mandated target is headline inflation between one and three percent,

Figure 4: Contribution of Supply and Demand Shocks to PCE Inflation, Q1 2012 to Q2 2022

(a) Annual PCE Inflation



(b) Quarterly PCE Inflation



Note: Displays the contribution of demand and supply shocks to individual goods and services to headline final consumer expenditure inflation in Canada. Items are classified based on whether unexpected price and quantity changes move together (demand) or not (supply). Ambiguous changes are those too small to classify, defined as being within the middle ten percent of residuals for each window.

Source: Authors' calculations using Statistics Canada data table 36-10-0124-01. See text for details.

regardless of whether is supply- or demand-driven. However, the source of inflation matters for how fast the central bank can bring it down and how likely they are to achieve a "soft landing" of the economy. Simple macroeconomic theory tells us contractionary monetary policy can mitigate demand-driven inflation by lowering aggregate demand and therefore prices. To the extent that such inflation occurs due to the economy operating above its potential output level, monetary policy can both lower inflation and move the economy towards a sustainable level. Supply shocks, on the other hand, are a trickier beast. In this case, a central bank would have to bring aggregate demand down while the supply shock lowered output levels below potential. In addition, supply shocks might cause negative demand effects if forward-looking consumers and investors have concerns regarding future output and generate pessimistic expectations of future income and wealth.

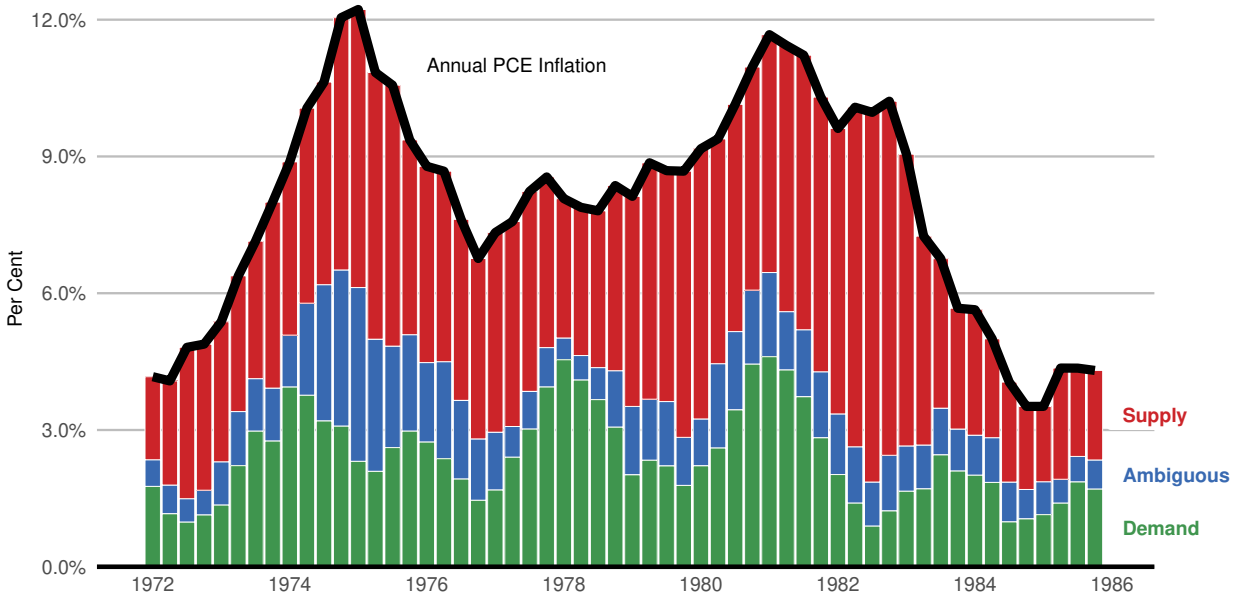
The persistence of shocks also matters. Those that are large and persistent can be particularly harmful, as wages and salaries across the economy will be under pressure to increase over time to keep pace. This may create a wage-price spiral that is more difficult for the central bank to control. In such a situation, the bank may need to be more aggressive and raise interest rates rapidly. A recession may likely follow. But temporary shocks may not affect inflation expectations of wage and price setters in the same way. A central bank should therefore avoid a rapid increase in interest rates (Caballero and Simsek, 2022). In section 4.2, we categorise items that contribute to inflation according to their price persistence and sensitivity to monetary policy. Before turning to this more detailed decomposition, a comparison to the 1970s may be instructive.

3.2 A Brief Comparison to the 1970s and Early 1980s

The last major supply shock that most economists and non-economists alike would remember was in the 1970s. A four-fold increase in oil prices—due to lower supply from oil-exporting countries in the Middle East—accelerated inflation and slowed economic growth. In Canada, inflation rose from less than six percent early in 1973 to over 12 percent by the end of 1974. Though it declined somewhat thereafter, it increased again through the late 1970s and early 1980s, reaching nearly 13 percent by 1981. Meanwhile, the economy struggled. By 1982, actual GNP was 18 percent lower than the steady growth path, accumulating a $91 billion loss (in 1971 dollars) between 1974 and 1982 (Helliwell, 1983). Unemployment also increased. Today's rising inflation rate is leading many to draw parallels with the 1970s.

As before, we isolate supply- and demand-side factors and display the results in Figure 5. For this, we use the Household Final Consumption Expenditure dataset (table 36-10-0107-01), which begins in 1961, but with a more aggregated classification. We treat as ambiguous any unexpected change in price or quantity that is within the middle ten percent of the sample distribution of residuals, as before. Though these data are not as detailed, and our estimates are slightly more volatile, the overall pattern is clear. On average, PCE inflation in 1974 was nearly 11 percent—up from an average of 4.5 percent two years earlier. Rising demand-side factors account for over one-third of this increase, while supply-side factors account for nearly as much. While large in

Figure 5: Contribution of Supply and Demand Shocks to PCE Inflation, 1972 to 1985



Note: Displays the contributions of demand and supply shocks to headline final consumer expenditure inflation in Canada. Items are classified based on whether unexpected price and quantity changes move together (demand) or not (supply). Ambiguous changes are those too small to classify in either category, defined as being within the middle ten percent of residuals for each window.

Source: Authors' calculations using Statistics Canada data table 36-10-0107-01. See text for details.

magnitude, these initial shocks were not persistent, and PCE inflation receded notably by 1977, led by larger declines in demand-side factors than in supply-side ones.

The early 1980s may also be relevant. PCE inflation gradually increased, averaging over 11 percent in 1981. Both supply- and demand-side factors largely accounted for this. But a sharp drop in Canada's inflation soon followed. From Q1 1982 to Q1 1985, we estimate PCE inflation declined by over seven percentage points—from nearly 11.2 percent to 4.1 percent. Comparing the annual average in 1985 to that in 1981, we find supply accounted for 54 percent of the decline (3.8 of a total seven percentage points) while demand accounted for nearly one-third (2.3 percentage points). Falling oil prices, especially in the mid-1980s, may have contributed on the supply side, as might labour market developments. The Bank of Canada, for example, noted the most important driver of inflation's decline in 1983 was "a slowing in the rate of increase of domestic production costs. Of particular significance was the deceleration of nominal wage increases in 1983...." (Bank of Canada, 1983, p. 17). On the demand side, contractionary monetary policy, especially in the United States, sharply slowed economic activity in the early 1980s. Whatever the cause, we conclude much of the rise and subsequent fall in Canada's inflation rate in the 1970s and 1980s was a story of both demand- and supply-side factors. A Shapley-Owen decomposition of demand- and supply-side contributions to overall PCE inflation between 1972 and 1985 suggests supply accounts for 42 percent of the variation and demand for 33 percent. Today, the decline in inflation may also be supply-driven if the strain in global energy markets and supply chain bottlenecks ease, though

contractionary monetary policy will likely cause several demand-driven factors to contribute as well. We turn now to the potential for monetary policy to influence Canada's high inflation rate.

4 Potential Effectiveness of Monetary Policy

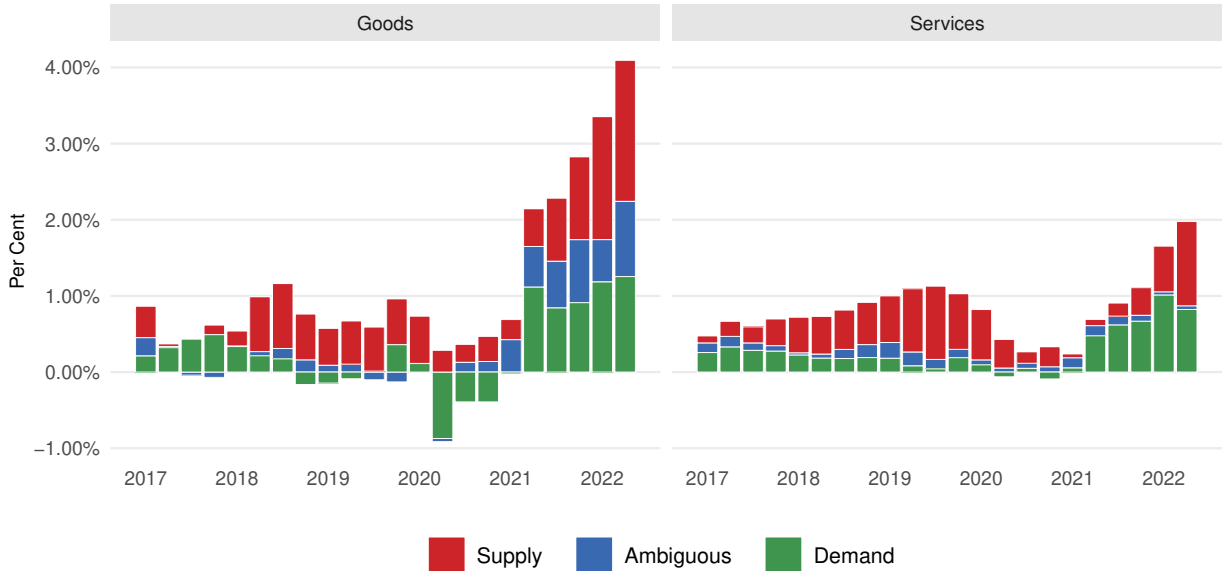
In response to the decades-high inflation, monetary policy is tightening. The Bank of Canada's key policy rate, which affects interest rates throughout the economy, increased from 0.25 percent in January 2022 to 0.5 percent in March, 1 percent in April, 1.5 percent in June, 2.5 percent in July, and 3.25 percent in September. These rapid rate increases aim to bring inflation down to the Bank's mandated target range of between one and three percent. By raising interest rates, monetary policy can lower household and business expenditures on goods and services that are sensitive to those rates, of which durable goods and residential investment are two notable examples. But monetary policy acts with a considerable lag, so central bank decisions reflect not only current conditions but expected future ones. To gain insight into the prospects of effective monetary policy action being able to combat inflation in Canada, we further decompose PCE inflation into goods and services, degrees of price persistence, and sensitivity to interest rates.

4.1 Goods vs Services

For several reasons, goods and service sectors tend to respond differently to different shocks. Supply chain disruptions, for example, can tighten capacity constraints on businesses and add to production costs. This primarily affects physical goods rather than services and can harm firms' ability to accommodate increased demand without sharply raising prices. The Bank of Canada's Business Outlook Survey, which collects information from many businesses, asks "What would be the most important obstacles or bottlenecks to being able to meet an unexpected increase in demand?" Over 40 percent of firms in recent quarters pointed to supply chain disruptions—up significantly from the 10 percent that said this between 2010 and 2019 (Bank of Canada, 2022). Another increasingly important supply shock is labour disruptions or shortages. Due to high labour input shares, service sectors are more vulnerable to rising labour costs and therefore more susceptible to contributing to a wage-price spiral. In the Business Outlook Survey mentioned above, over 60 percent of firms point to "labour bottlenecks" as the most important obstacle to meeting demand. Of those firms surveyed, the average expected wage increase from Q2 2022 to Q2 2023 is 5.8 percent—the highest expected increase in many years—and nearly 60 percent of firms report inflation-related pressures as an "important source of wage growth" (Bank of Canada, 2022). As a result, comparing service versus goods sectors might help us better understand both inflation's drivers and its potential impacts.

We separately identify demand- and supply-driven price increases across goods and services and display the results in Figure 6. Both goods and services show sharp increases in prices since Q2 2021, with the magnitude of the former being twice that of the latter. Starting in Q2 2021, demand shocks to goods contributed roughly one percentage point to overall PCE inflation in

Figure 6: Goods and Services Inflation, 2016 to Q2 2022



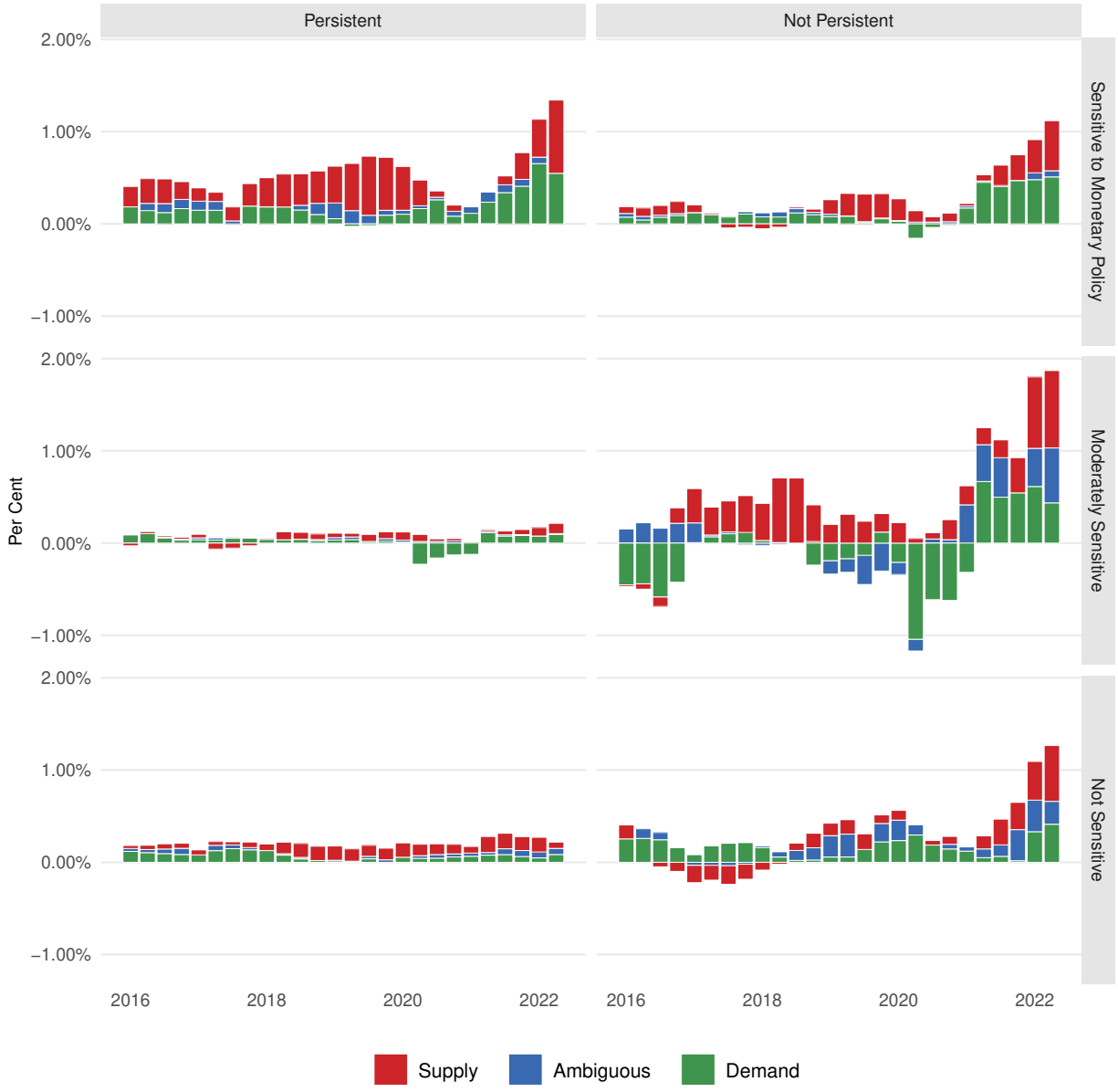
Note: Displays the contributions of demand and supply shocks to headline annual final consumer expenditure inflation in Canada.

Source: Authors' calculations using Statistics Canada data table 36-10-0107-01. See text for details.

Canada, and they have remained relatively stable since. Demand shocks formed a similarly large contribution to price increases for services over the same period, but supply shocks are clearly concentrated among goods. In Q2 2022, nearly two percentage points of overall PCE inflation is among goods subject to supply shocks. In contrast, supply shocks facing services account for just over one percentage point. Though the contribution of service-sector supply shocks has grown rapidly in recent quarters, the accelerated rise may also indicate the effects of mounting labour shortages and the need to increase wages, and therefore costs, to retain and recruit talent. It further suggests the recent rapid increases in policy rates to prevent such an outcome are warranted.

While many consider oil price shocks and supply chain bottlenecks transitory—in the sense that their causes are not long-term structural shifts and they could dissipate quickly—labour shortages can be a temporary phenomenon too. Persistently rising labour costs, however, might cause a wage-price spiral that would increase inflation expectations and lead to yet more inflation. This may become problematic for the central bank. As with the other supply shocks, there is little that monetary policy can do to alleviate labour shortages, but by lowering overall aggregate demand, the pressure on these businesses to expand capacity and hiring may decline. To be clear, this does not imply supply shocks to services are more persistent or a greater source of concern than those to goods. Some of contributors to supply-driven service price increases, after all, may be in interest-sensitive areas, such as imputed rent for homeowners. We explore these issues next.

Figure 7: Inflation Persistence and Sensitivity to Monetary Policy, 2016 to Q2 2022



Note: Displays the contributions of demand and supply shocks to annual final consumer expenditure inflation. Items are classified according to those experiencing demand and supply shocks, as before, and according to (1) whether the underlying household expenditure categories are sensitive to interest rate changes and (2) whether historical price changes tend to persist for at least a year.

Source: Authors' calculations using Statistics Canada data table 36-10-0107-01 and the monetary policy sensitivity as determined by Chernis and Luu (2018). See text for details.

4.2 Interest Sensitivity and Inflation Persistence

Some goods and services are more sensitive to interest rate increases than others. Demand for items that are not discretionary, such as groceries or healthcare related expenditures, may change little as monetary policy tightens. Durable goods, such as new vehicles or residential investments, meanwhile, can be highly sensitive. Recent empirical work by Chernis and Luu (2018) estimates the response of Canadian household expenditures to monetary policy, and conveniently uses similar data to that with which we measure PCE inflation and identify demand- and supply-driven factors. They classify goods and services into three categories: sensitive to monetary policy shocks, moderately sensitive, and not sensitive. We map their classification onto our detailed household expenditure data to determine if items that will respond to monetary policy are among the recent drivers of accelerating inflation.

We further identify whether the price increases are among goods and services that tend to have persistent price changes or those that tend to have transitory changes. To empirically estimate this, we regress annual price changes on their one-year lag. Intuitively, this will classify items as persistent if price increases in one year are typically followed by others one year later. That is, we estimate

$$\pi^j_{q-4,q} = \beta^j_0 + \beta^j_1 \pi^j_{q-8,q-4} + \epsilon^j_q, \tag{8}$$

where $\pi_{q-4,q}$ denotes the price change from quarter $q-4$ to q. We label items showing a strong positive and statistically significant relationship between past and current price increases as persistent. Our results are generally unaffected by using quarter-over-quarter price changes regressed on the one-year lag of quarter-over-quarter changes. They are also robust to just using a single-quarter rather than one-year lag. We estimate this for the period between Q1 1995 and Q4 2019; that is, for the low inflation period prior to the pandemic.

Combining these two classifications—sensitivity to monetary policy and the historic persistence of price increases—reveals important results for policymakers. We display a decomposition of demand- and supply-driven factors separately for persistent and non-persistent items and for items very sensitive, moderately sensitive, and not sensitive to monetary policy in Figure 7. Non-persistent items account for two-thirds of the over six percent PCE annual inflation in Q2 2022. Both demand and supply shocks are important drivers of price increases in all categories, though the contribution of items with typically non-persistent price changes is far higher. More importantly, nearly all of the one-third contribution by persistent items is among items highly sensitive to monetary policy. This suggests that price increases among items of the greatest potential concern (those with typically persistent increases) may respond strongly to recent interest rate increases. Moreover, among items that we estimate are experiencing demand-driven inflation, three-quarters of their contribution to overall annual PCE inflation in Q2 2022 is among by items responsive to monetary policy. While only suggestive, these results imply that most of the rising inflation should respond well to tighter monetary policy. With the aggressive interest rate hikes the Bank of Canada has implemented, we might expect inflation pressures to dissipate in response to these policies.

5 Conclusion

While future inflation and monetary policy remain uncertain, this paper explores various drivers leading to higher recent rates of inflation. First, we demonstrate that a relatively small number of items—energy and shelter costs, in particular—account for much of the rise in average consumer prices. And of the non-energy items in the CPI, we show that the overwhelming majority of the increase relative to pre-pandemic inflation rates is due to price increases among the relatively few items that are historically sensitive to oil prices. This suggests supply-side factors are a key driver of Canada's accelerating inflation. To identify this more precisely, we use different data that contain both price and quantity information to separate demand- from supply-driven price increases, following Shapiro (2022a). We find supply-side drivers of price increases are the dominant contributor. This makes monetary policy more difficult and costly. We present further suggestive evidence, however, that recent price increases are driven either by items that normally do not see persistent price increases or by items that are highly sensitive to interest rates. Though there is much else to learn, this paper sheds new and important light on Canada's post-pandemic inflation experience.

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