



BANK OF CANADA
BANQUE DU CANADA

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Getting to the Core of Inflation

Introduction

Thank you for the invitation to speak to you today.

In October, the Bank of Canada renewed its agreement on the inflation-control target with the federal government for the sixth time since 1991.¹ The target is a critical component of our monetary policy framework, which also includes a market-determined flexible exchange rate.

It's not often that a policy performs better than expected. Our inflation-control target did just that and continues to do so.

Over the past 26 years, we have reduced consumer price index (CPI) inflation and maintained it at a level close to our 2 per cent target, with no persistent episodes of inflation outside our inflation-control range of 1 to 3 per cent (**Chart 1**).² Because inflation has been low, stable and predictable, Canadians have been able to make better economic decisions and achieve better economic outcomes. Consequently, real output has expanded at an average rate of close to 2 1/2 per cent per year. In addition, there has been much less volatility in inflation, interest rates and real GDP growth.

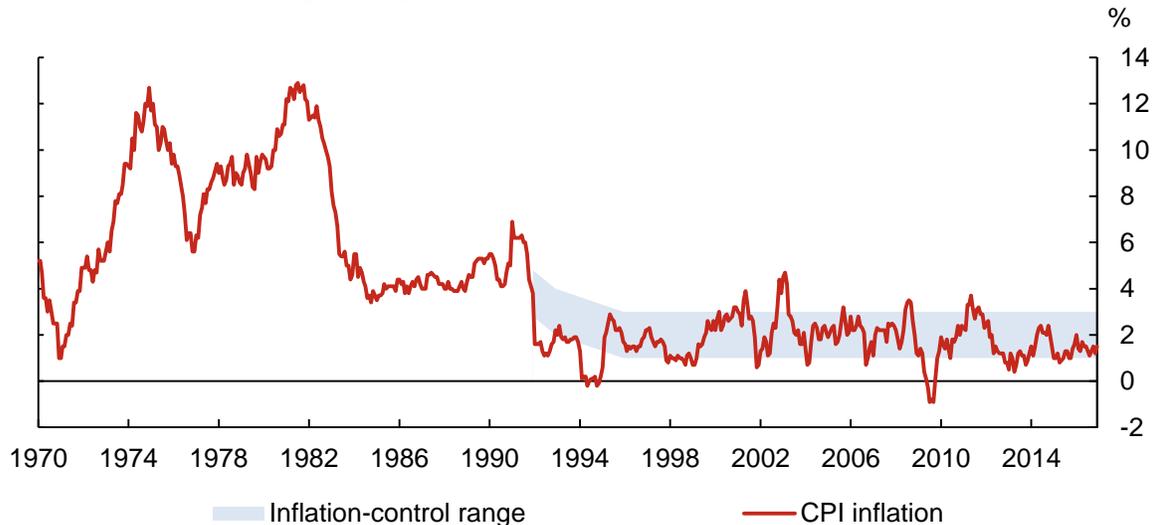
¹ The inflation-control agreement between the Bank and the federal government was established in 1991 and is renewed every five years. Canada was the second advanced economy to adopt inflation targeting; New Zealand was the first. The 1991 agreement established a path for a progressive reduction in the rate of inflation to 3 per cent by the end of 1992, 2 1/2 per cent by the middle of 1994 and 2 per cent by the end of 1995. The target has remained at 2 per cent since then.

² CPI inflation has averaged 1.9 per cent since 1991.

I would like to thank Patrick Sabourin, Stefano Gnocchi and Laurence Savoie-Chabot for their help in preparing this speech.

Chart 1: Since 1991, inflation has remained mostly within the Bank's operating band

Year-over-year percentage change, monthly data



Sources: Statistics Canada and Bank of Canada calculations

Last observation: December 2016

That's a solid track record, so, as you can imagine, it would take some compelling evidence for us to consider major changes to the policy.

Given its effectiveness, the renewals of the inflation-targeting agreement every five years have generally gone smoothly, but I can assure you they are not automatic. Because we are committed to having the best monetary policy framework for Canadians, we use the term of each agreement to conduct an intensive research and consultation program to critically examine aspects of the policy. For example, leading up to the 2016 renewal we investigated three questions:

1. Is 2 per cent still the appropriate target for inflation?
2. How do we incorporate financial stability considerations into the formulation of monetary policy?
3. How should core inflation be used and measured?

Our research led us to conclude that the 2 per cent target is still appropriate and that monetary policy should be adjusted to address financial vulnerabilities only in exceptional circumstances.³

³ Because the financial system is important for supporting economic activity and for transmitting monetary policy, financial system considerations are always taken into account in the formulation of monetary policy. For more information on our research into these issues, see S. S. Poloz, "25 Years of Inflation Targets: Certainty for Uncertain Times" (speech to the Business Council of

Today, I want to focus on our findings on the third issue: the use and measurement of core inflation to assess the underlying trend of inflation. First, I'll explain the purpose of core inflation measures in our policy deliberations and what we look for in reliable measures. Lastly, I'll review the three new core measures we have adopted and what they are telling us about current inflationary pressures.

Why Is Core Inflation “Core”?

Let's start with the basics. Inflation is simply a general increase in the average price of goods and services over a given time period, in other words, a trend increase in the cost of living.⁴ We measure inflation using the increase in total CPI, which is estimated and published by Statistics Canada and tracks the cost of a representative fixed “shopping basket” of goods and services over time.⁵ The Bank of Canada officially targets the 12-month increase in the CPI because it is a broad gauge of inflation that is most relevant to Canadians. It is essential that the inflation target be widely understood and visible so that citizens can hold their policy-making institutions accountable.

Our monetary policy framework posits that CPI inflation will be at 2 per cent on an ongoing basis when actual output equals potential output. This is the level of goods and services that an economy can produce and sustain without adding to inflationary pressures.⁶ The difference between actual and potential output is the output gap, which can be positive or negative.

We achieve our monetary policy target by helping align demand for domestically produced goods and services with the economy's capacity to produce them. If aggregate demand is expected to exceed or fall short of the economy's potential output, we typically raise or lower the policy interest rate to close the gap and keep CPI inflation on target.

As much as we aim for low, stable and predictable inflation, there will always be sharp movements in CPI inflation. These movements are generally driven by volatility in the prices of a small number of goods and services. This volatility typically has a transitory impact on the rate of inflation (most frequently, its effects dissipate within a year). Since the effects of monetary policy on demand have long and variable lags, the Bank must look ahead to achieve our inflation target over our policy horizon. Consequently, we “look through” short-lived price

British Columbia, Vancouver, B.C., 1 November 2016) and the [Renewal of the Inflation-Control Target: Background Information—October 2016](#)

⁴ J. Murray, “Measuring Inflation: Methodology and Misconceptions” (speech to the Certified General Accountants of Ontario, Toronto, Ontario, 18 September 2008).

⁵ Statistics Canada worked closely with the Bank to produce the new measures of core inflation. See [“Consumer Price Index: The Bank of Canada's Preferred Measures of Core Inflation”](#) on Statistics Canada's website.

⁶ Given the uncertainties around measuring the output gap and the timing of the impact of excess capacity on inflation, achieving the 2 per cent target and closing the gap may not, in practice, occur simultaneously.

changes by forecasting CPI inflation and the output gap beyond the horizon of the impact of these price changes.⁷

If we reflexively raised our policy rate whenever inflation was above target and lowered it whenever inflation was below target, we would end up reacting to a lot of temporary factors.⁸ This would lead to what has been called “instrument instability”—like trying to steer a car by constantly overcorrecting one way and then the other. It would be counterproductive and would simply destabilize both inflation and real economic activity. For this reason, many central banks use core inflation measures, which are designed to help filter transitory deviations from CPI inflation and therefore serve as a useful operational guide for policy. Such measures help us estimate where the underlying trend of inflation is relative to the target in the current month or quarter. They also help to corroborate other indicators of capacity pressures (especially the output gap), which are uncertain.

Given this purpose, what criteria do we look for in an effective measure of core inflation? We want a measure that (i) closely tracks long-run movements in CPI inflation (in other words, one that is unbiased); (ii) is less volatile than CPI inflation and captures persistent movements in inflation; (iii) is related to the underlying macroeconomic determinants or drivers of inflation, particularly the output gap; and (iv) is easy to explain and understand.

Now, let me describe how we measure core inflation.

The Limitations of CPIX

A common approach to measuring core inflation is to exclude items from the CPI basket based on various criteria, such as their volatility.

The measure we used as an operational guide from 2001 until October 2016 is CPIX, which strips out eight of the most volatile components of the CPI and adjusts the remaining components for the effects of changes in indirect taxes.⁹

In recent years, however, the usefulness of CPIX inflation as an operational guide for policy has deteriorated. Most notably, there have been large transitory shocks to CPI components not excluded from CPIX. Indeed, this highlights an inherent weakness in measures of core inflation such as CPIX, which include a fixed and pre-determined set of components. What to exclude is often evident only after the fact. In the span of 12 months in the early 2000s, for example, the inflation rate of automobile insurance premiums rose from 2.0 per cent to 30.6 per cent. At its peak, this one component of the CPI basket was adding a

⁷ The normal policy horizon for returning CPI inflation to target is six to eight quarters, but there is flexibility built into the inflation-control framework to adjust the horizon as other considerations warrant, namely financial stability and output variability. *Renewal of the Inflation-Control Target: Background Information—October 2016*, Bank of Canada.

⁸ T. Lane, “Inflation Targeting—A Matter of Time” (speech to the CFA Society Atlantic Canada, Halifax, Nova Scotia, 27 October 2015).

⁹ The eight items excluded from CPIX are fruits, vegetables, gasoline, fuel oil, natural gas, mortgage interest, intercity transportation and tobacco products.

full percentage point to CPIX inflation. Other components, such as electricity prices, have also shown particularly high, but temporary, volatility, leading to noticeable movements in CPIX inflation, while auto prices have, at times, moved countercyclically, thereby obscuring the relationship between CPIX and the deviation of actual from potential output.¹⁰

These three examples illustrate the flaw in simply excluding a fixed set of components *ex ante*. In particular, adding more items to the list of exclusions based on their observed price volatility, which may only be temporary, would not solve the problem of how to account for unexpected spikes in the prices of other components in the future. Moreover, it would reduce the number of components tracked, rendering the core inflation measure less representative of household consumption. More flexible approaches to estimating core inflation are needed.

The shortcomings in CPIX led us to evaluate the properties of a wide selection of alternative measures of core inflation.¹¹

Alternative Measures of Core Inflation

After studying these alternatives, we decided to replace CPIX with three new measures of core inflation—CPI-trim, CPI-median and CPI-common. They perform well across a range of evaluation criteria. In particular, they allow the data to “speak” and thereby more accurately identify persistent movements in inflation that reflect the evolution of macroeconomic variables important to monetary policy (**Chart 2**).

Still, each measure was judged to have limitations, so we decided to use a set of measures, instead of relying on a single one. This underscores our view that monetary policy decisions should not be based on the mechanical use of such indicators. As policy-makers, we grapple with a high degree of uncertainty in estimating trend inflation and the output gap. Using multiple measures of core inflation helps us manage this uncertainty.¹²

Let me describe the characteristics of each.

CPI-trim excludes CPI components whose prices in any given month have exhibited the most extreme movements. In particular, it trims off 20 per cent of the weighted monthly price variations at both the bottom and top of the distribution of price changes. It therefore always removes 40 per cent of the total CPI basket. These excluded components can vary from month to month,

¹⁰ One example of the countercyclical behaviour in auto prices began with their fall in 2007 when the US–Canada exchange rate reached near parity, which set off a surge in cross-border shopping. As a result of the competitive price pressure, the inflation rate of automobiles was close to an all-time low at a time when economic activity was growing.

¹¹ *Renewal of the Inflation-Control Target: Background Information—October 2016*, Bank of Canada.

¹² A number of other central banks, including the Bank of England and the Swiss National Bank, have also opted not to use one explicit focal measure of core inflation. Both offer projections of CPI inflation without offering projections of core inflation.

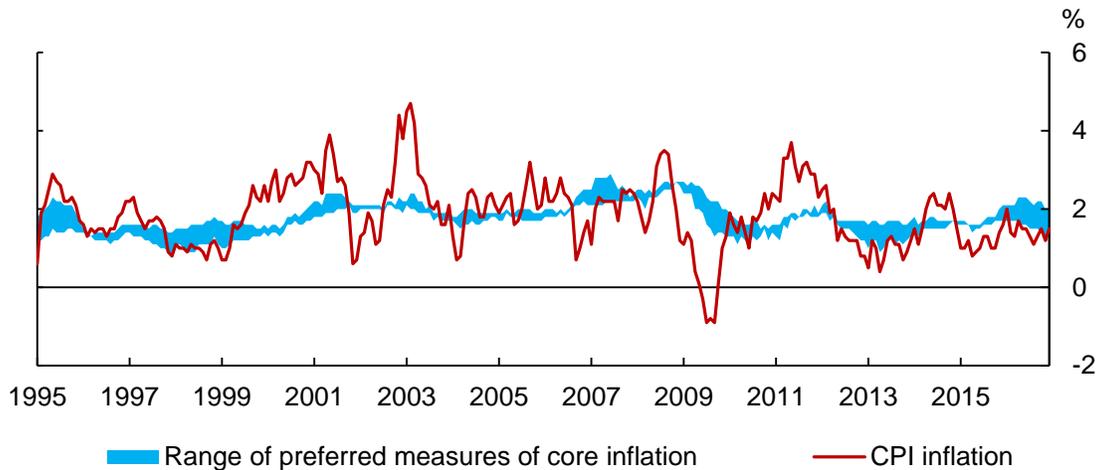
depending on which experience extreme movements at any given time. A good example would be the impact of severe weather on the supply and prices of certain food components.

CPI-median captures the price change located at the 50th percentile (in terms of the CPI basket weights) of the distribution of price changes in a given month. It helps filter out extreme price movements specific to certain components. Similar to CPI-trim, it eliminates all the weighted price variations at both the bottom and top of the distribution of price changes in any given month, except the price change for the component that is the midpoint of that distribution.

CPI-common is based on trends in price changes that are similar across the various categories in the CPI basket, rather than focusing on increases to specific items, such as the prices of gasoline or fruit. It uses a statistical procedure called a factor model to detect these common variations, which helps filter out price movements that might be caused by factors specific to certain components.¹³ Such common movements in prices are more likely to reflect underlying inflationary pressures related to aggregate demand and supply forces than sector-specific disturbances.

Chart 2: The three new measures of core inflation effectively filter out volatile but temporary price changes

Year-over-year percentage change, monthly data



Sources: Statistics Canada and Bank of Canada calculations

Last observation: December 2016

¹³ CPI-common is calculated as follows: a factor model is estimated using data on year-over-year movements in 55 CPI components. The first principal component that is extracted from that estimation is then transformed into a core inflation rate measure using a simple linear regression of the annual CPI inflation rate, excluding the effect of changes in indirect taxes, on an intercept and on the first principal component. This process is performed monthly using the historical data series, starting in 1990. See ["Consumer Price Index: The Bank of Canada's Preferred Measures of Core Inflation"](#) on Statistics Canada's website.

Reliability of the Three New Core Measures

Of the various core measures we evaluated, we found CPI-trim, CPI-median and CPI-common all met three of our four criteria: they were found to be roughly unbiased, more persistent than CPI inflation and related to underlying macroeconomic drivers, notably the output gap. CPI-common was the top performer for two criteria: it was the most persistent and moved most closely with the output gap. In addition, all three were relatively effective at looking through sector-specific shocks. Two of the measures—CPI-median and CPI-common—fell short on one criterion: they are relatively more difficult to explain and understand than CPIX. I hope this speech and the supporting documentation available on the Bank's and Statistics Canada's websites will help in that regard.

Nonetheless, all the new measures performed better than CPIX for three main reasons.

First, they are less influenced by sector-specific shocks and therefore more accurate. In episodes such as the sharp rise in auto insurance premiums in the early 2000s that I mentioned earlier, as well as the deflation in auto prices that started in 2007 and the run-up in meat prices in 2014, CPIX was unable to filter out these transitory shocks (**Chart 3**). The new measures were relatively more effective at doing so.

It is important to note, however, that no measure of core inflation can filter out every type of temporary shock that a central bank may wish to look through when conducting monetary policy. In an open economy like Canada, for example, currency movements can have a profound impact on consumer prices. A movement in the exchange rate would have an effect on the level of prices for imports and domestic import-competing goods and the persistence of this effect would depend on the duration of the exchange rate movement, but its impact on the rate of inflation would be much shorter. Thus, this exchange rate pass-through (ERPT) effect would not warrant a policy response as long as inflation expectations remain well anchored. The impact of ERPT does not typically reflect changes in the underlying trend of inflation, which is affected by the degree of excess capacity in the labour market and in the economy more broadly.¹⁴

At the same time, most measures of core inflation tend to be affected by ERPT in varying degrees because they are sensitive to the relatively broad-based price movements caused by ERPT in Canada. Still, on average, these measures were found to have somewhat lower pass-through from the exchange rate compared with CPIX. In particular, CPI-trim and CPI-common attach relatively more

¹⁴ See L. Savoie-Chabot and M. Khan, "Exchange Rate Pass-Through to Consumer Prices: Theory and Recent Evidence," Bank of Canada Staff Discussion Paper No. 2015-9 (October 2015).

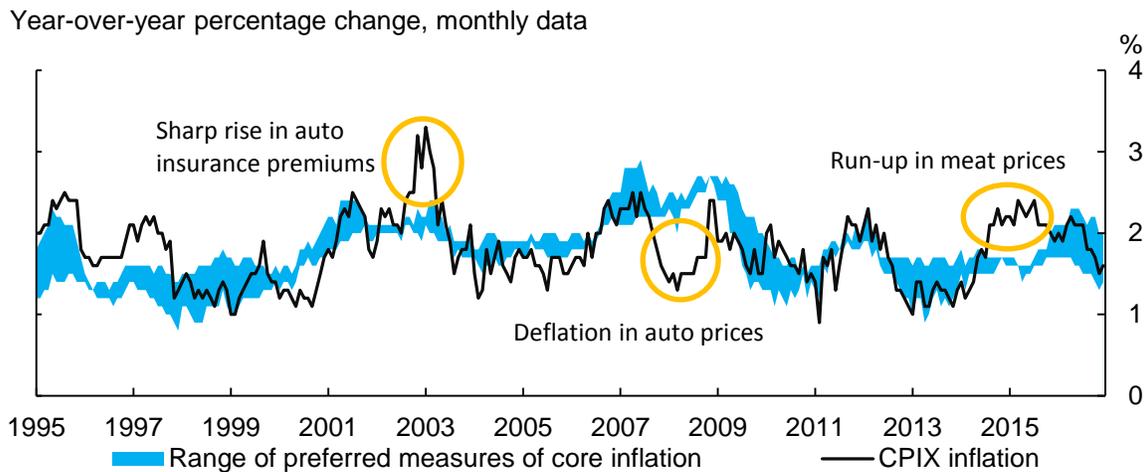
importance than CPIX does to the prices of services, which are largely not traded across borders.¹⁵

Second, the new core measures better capture persistent movements in inflation. In other words, their movements endure across a number of periods, whereas CPIX inflation shows no persistence.¹⁶ This implies that transitory price changes are more predominant for CPIX than for the three new measures (**Chart 3**).

And third, the new measures have stronger relationships with key macroeconomic drivers, such as the output gap. For example, the correlation with the output gap is much higher for the new measures than with CPIX.¹⁷

Finally, it is important to note that, like CPIX, the three new measures are roughly unbiased estimates of CPI inflation. Their averages from 1991 to 2016 are very close to that of CPI inflation.¹⁸ Their outlooks will therefore converge to that of CPI inflation over the policy horizon, as transitory factors dissipate.

Chart 3: The new measures of core inflation have shown they are more effective than CPIX at looking through sector-specific shocks



Sources: Statistics Canada and Bank of Canada calculations

Last observation: December 2016

¹⁵ For CPIX, the weight on services is about 56 per cent, according to the 2013 Survey of Household Spending. For CPI-trim, the higher relative importance attached to services could be due to the fact that more goods prices are “trimmed” from the calculation because their movements are sharper and tend to reflect commodity price shocks. For CPI-common, this could be because prices for services tend to move in tandem since they appear to be largely influenced by labour market conditions and associated wage pressures, given that labour is typically the most important input for the production of many services.

¹⁶ Although CPIX and the three new measures have similar variance over the 1991–2016 period, CPIX is subject to much more short-term variability.

¹⁷ The correlation with the output gap for CPIX is 0.2; for the new measures it is 0.5–0.6. See Bank of Canada, *Monetary Policy Report*, January 2017, Box 2, p. 12.

¹⁸ CPIX and the three new core inflation measures have an average of 1.8 per cent over this period, which is the same as CPI inflation, excluding the effect of indirect tax changes.

Recent Evidence

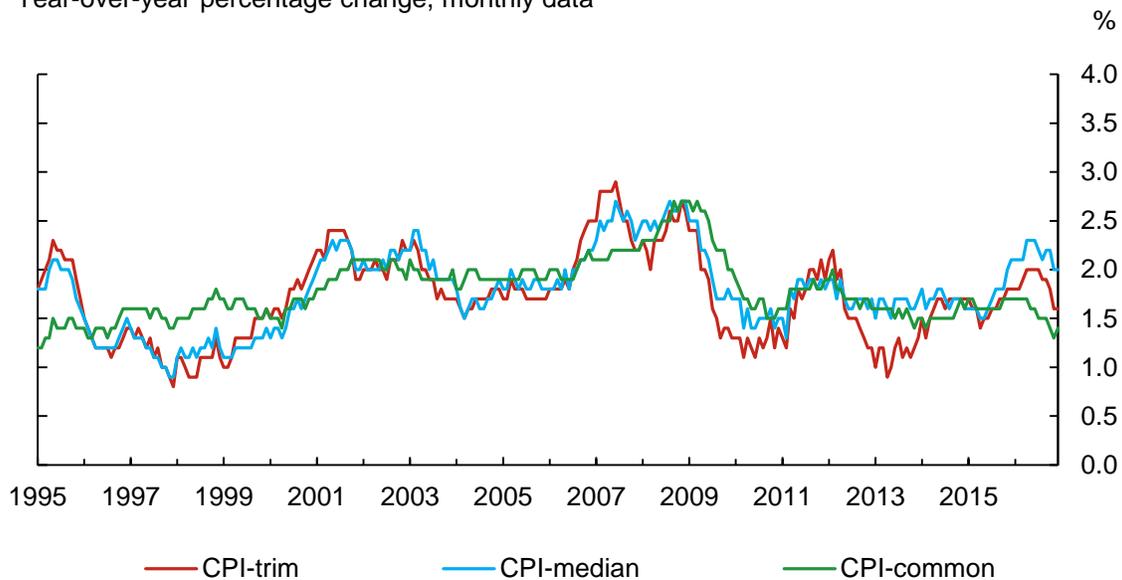
Let's now look at how these new core measures have performed recently and what they are telling us about ongoing inflationary pressures.

The three measures have generally evolved broadly in line over time, although there have been instances when their behaviour has differed. For example, in the fourth quarter of 2016 their range was relatively wide—between 1.4 and 2.1 per cent (**Chart 4**).

To explore this behaviour, we based our analytical framework on the Phillips curve.¹⁹ We assume that core inflation depends on the degree of excess capacity in the economy and degree of ERPT.²⁰ In the short run, inflation is also affected by relative price changes and other temporary demand and supply shocks.²¹

Chart 4: The new measures of core inflation have diverged recently

Year-over-year percentage change, monthly data



Source: Statistics Canada

Last observation: December 2016

¹⁹ There are various ways to represent and estimate the Phillips curve. The framework used here is based on a restricted backward-looking version of the Phillips curve. The constant in the current framework represents the mean of the dependent variable (the selected measure of core inflation), which is close to the official inflation target of 2 per cent and, as such, represents relatively well-anchored expectations of inflation in the past.

²⁰ Since exchange rate movements have been significant in recent years, our framework was augmented to include the impact of ERPT. The impact of ERPT was derived using a bottom-up approach for each measure.

²¹ Most prices are not very flexible in the short run. An increase in the price of one very important good, such as gasoline, will typically not be immediately offset by small declines in all other prices, and hence, the overall price level will rise. This will show up as an increase in the rate of change of the price level: measured inflation.

These specific determinants are not included in the framework and are thus captured empirically by the residual term.²²

The new core measures are constructed to minimize the impacts of temporary disturbances and relative price shocks, so they should, in principle, largely reflect movements in excess capacity. **Chart 5** shows the deviation from average of the year-over-year percentage change in each measure since 2000 and the decomposition of this deviation into three causes: excess capacity (or slack), ERPT, and an unexplained residual term (“others” in the chart). Let me say a few words about each of these three elements.

First, excess capacity in the economy has had a material and persistently negative impact on the three measures of core inflation since the Great Recession.

Second, the depreciation of the Canadian dollar since mid-2014, largely driven by the decline in commodity prices, has had a positive impact on all core measures, although it has been diminishing since the beginning of 2016.

In the absence of ERPT and other unexplained factors, all three preferred measures of core inflation would be below two per cent, broadly consistent with the Bank’s assessment of the degree of excess capacity in the Canadian economy.

Third, while these macroeconomic determinants shed some light on the recent evolution of all three measures, they are unable to fully account for the typically temporary divergence among them at different times, including the recent one. This can be seen in the positive residuals for CPI-trim and CPI-median in the fourth quarter of 2016 and the negative residual for CPI-common. To shed a bit more light on why the measures may diverge more markedly from time to time, let me focus on the last three major occurrences: at the time of the Great Recession in 2007–09, in 2012–13 and more recently.

During the Great Recession, the widening range can partly be explained by the effects of the rapidly increasing excess capacity. In 2008Q4, all three were close to 2.6 per cent. CPI-trim started to ease in 2009Q1, bottoming out at 1.2 per cent in 2010Q1. CPI-common started a less pronounced descent a quarter later. This is likely because excess capacity has a larger impact in the near term on CPI-trim than it does on CPI-common. The impact of excess capacity on CPI-common tends to be more delayed.²³

²² Provided the relative price change does not affect expected inflation or the output gap, this effect on inflation will be temporary because its rate of change (i.e., inflation) is no longer affected once the price level has adjusted.

²³ The slower response of CPI-common may reflect the fact that it is more heavily influenced by the prices of services. As noted earlier, the prices of services are, in turn, dependent on the evolution of wages. Because nominal wages are normally viewed as sticky downward, they are typically slower to respond to growing slack in the labour market and in the economy.

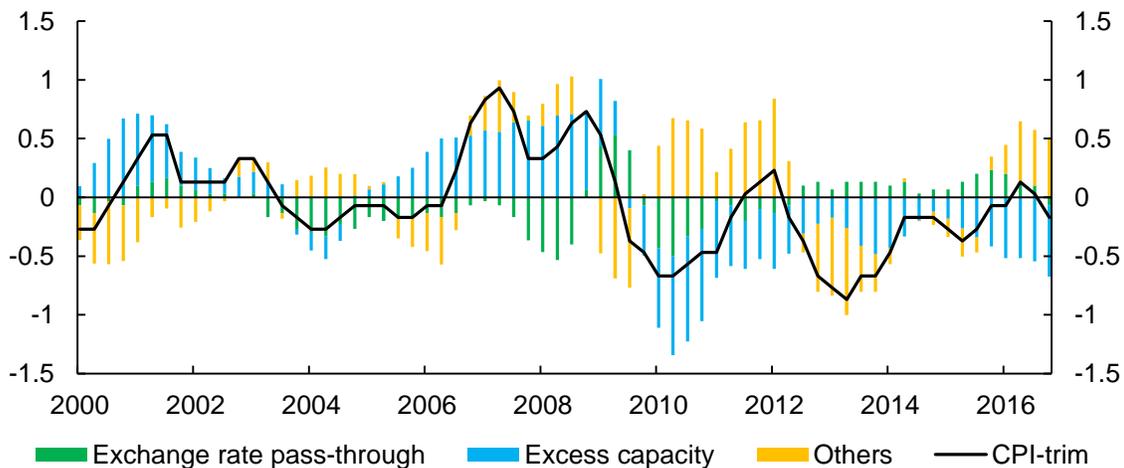
The two most recent episodes of a larger divergence are more challenging to explain. In 2012–13, CPI-trim eased from 1.5 per cent to roughly 1.0 per cent, while CPI-median and CPI-common have remained closer to 1.5 per cent. In the recent episode, CPI-common has been weakening more than the other two measures. A closer look at the distribution of the price changes for all 55 components used as inputs to compute these core measures offers some insights.

The distribution of the monthly price changes has not been symmetric in recent years, particularly over these two periods, meaning that the negative shocks affecting inflation have been more prevalent and more pronounced than positive shocks. This likely reflects more-intense competition among Canadian retailers during these two periods as well as ongoing excess capacity, which has increased somewhat in the latest period, owing to the large negative commodity price shock Canada has experienced since 2014. These factors have likely lowered CPI-trim more than CPI-median over the past few years. CPI-trim, as a weighted average, would be more affected by the asymmetries of shocks while CPI-median would be more insulated from them.²⁴

Chart 5: Deviation from the average core inflation for CPI-trim, CPI-median and CPI-common

a. CPI-trim

Contribution to the deviation of the core inflation measure from its average, percentage points, quarterly data



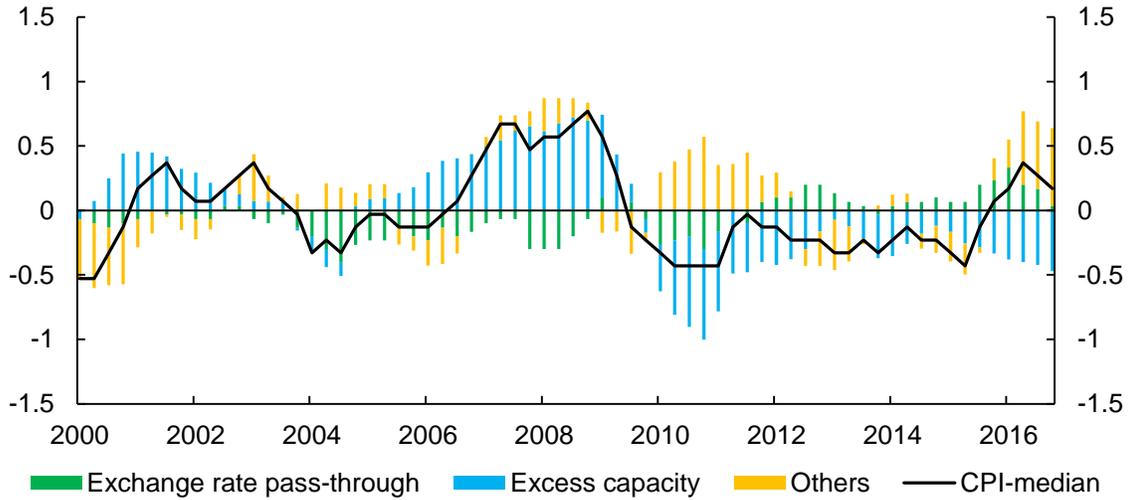
Note: Both the output gap and unit labour costs are included in excess capacity.
Sources: Statistics Canada and Bank of Canada estimates and calculations

Last observation: 2016Q4

²⁴ While the recent weakness in CPI-common partly reflects the slack in the labour market, which has persisted and increased somewhat since the commodity price decline and is holding down the growth of wages and services prices, part of this weakness remains unexplained.

b. CPI-median

Contribution to the deviation of the core inflation measure from its average, percentage points, quarterly data

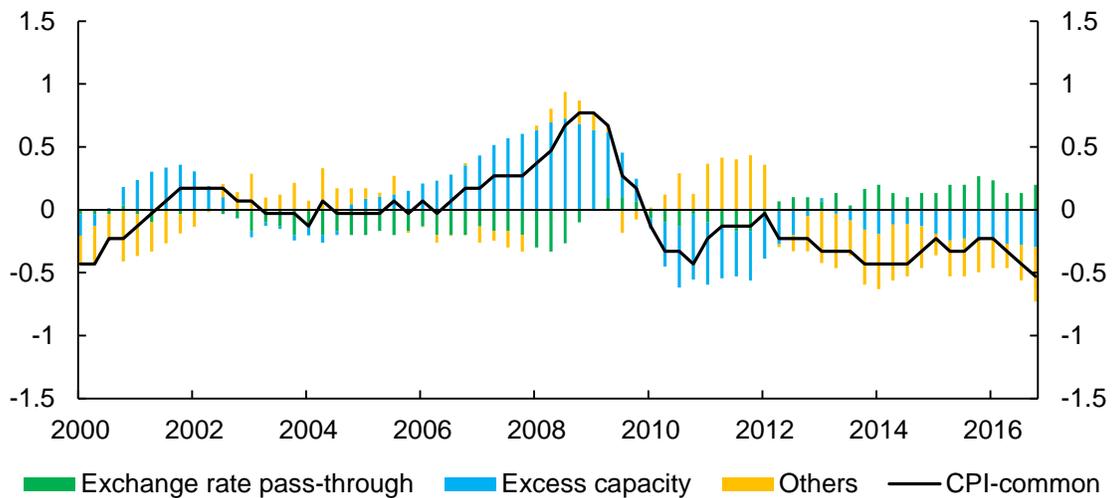


Note: Both the output gap and unit labour costs are included in excess capacity.
Sources: Statistics Canada and Bank of Canada estimates and calculations

Last observation: 2016Q4

c. CPI-common

Contribution to the deviation of the core inflation measure from its average, percentage points, quarterly data



Note: Both the output gap and unit labour costs are included in excess capacity.
Sources: Statistics Canada and Bank of Canada estimates and calculations

Last observation: 2016Q4

Let me quickly summarize. These measures have declined since mid-2016 to close to 2 per cent or below, in part, because of the diminishing effects of ERPT and persistent excess capacity. The wide divergence among them in recent years might reflect in some measure the prevalence of the negative price shocks that have hit the economy. In addition, let me say that as policy-makers, we view the divergence among the measures not as a weakness, but as an important insight that validates our decision to use all three. If we had focused on just one, we would have been led astray in our assessment of the underlying trend of inflation.

Conclusion

Time to conclude. A key challenge we face as policy-makers working within an inflation-targeting framework is to distinguish the *trend* from the *transitory*—that’s why measuring core inflation accurately is “core” to our approach. The better we are at separating the two, the better we will be at understanding the current state of the economy and capacity pressures, and the better we will be at achieving our inflation target. Our ability to keep inflation on target is the means by which the Bank and the target earn credibility and trust. That credibility gives Canadians confidence and helps anchor their inflation expectations. This is a virtuous circle. Having expectations solidly anchored is critical to conducting effective monetary policy and achieving the target, especially in turbulent times such as the recent Great Recession.

Although we’ve had 26 years of success in hitting our target, we are anything but complacent. We are committed to learning from experience and from academic research—including work conducted here at Western University—to continuously improve our monetary policy framework. We used the period leading up to the renewal of our target last year to update the framework by replacing CPIX with three new core inflation measures, which give us a more effective reading of the underlying trend of inflation. Using these multiple measures will also help us to manage the measurement risk associated with any single indicator and to better communicate the uncertainty involved in gauging inflationary pressures.

In our past quarterly *Monetary Policy Reports* (MPRs), we provided projections of CPIX inflation and regularly described the extent to which movements in it were due to sector-specific factors. However, we have come to realize that the attention paid to CPIX inflation may have created the misperception that it was the target for monetary policy rather than a useful operational guide. Going forward, we have decided that only the projection for CPI inflation will be included in the MPR to reinforce its role as the target for monetary policy. In addition, we will focus our analysis on the key forces underpinning the inflation process. The new core inflation measures will contribute importantly to this analysis.

In that regard, I want to emphasize that these measures are only one set of inputs into our broad and ongoing assessment of pressures on capacity and inflation. We also take into account a wide range of information, including responses to our *Business Outlook Survey* and more informal conversations that we conduct with businesses and other Canadians. We use a combination of

models and our own judgment to understand the underlying forces working on inflation.

For many of you in this room, hearing about life in Canada before our inflation target—when inflation and interest rates were in the double digits—must be as difficult to imagine as life without laptops and smartphones. However, those of you who *are* old enough to remember when mortgage interest rates hit 19 per cent know first-hand how transformative the past 26 years of low and stable inflation have been for family finances and for our economy. We understand that Canadians want and expect low and stable inflation, and we are committed to ensuring that we meet those expectations through the successful conduct of monetary policy.