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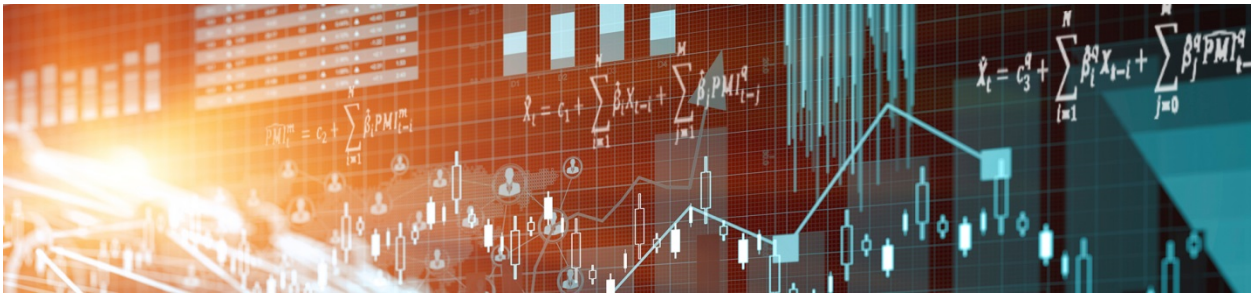
A Comprehensive Evaluation of Measures of Core Inflation in Canada: An Update



by Helen Lao and Ceciline Steyn

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A Comprehensive Evaluation of Measures of Core Inflation for Canada: An Update

by

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Abstract

We provide an updated evaluation of the value of various measures of core inflation that could be used in the conduct of monetary policy. We find that the Bank of Canada's current preferred measures of core inflation—CPI-trim, CPI-median and CPI-common—continue to outperform alternative core measures across a range of criteria. These measures remain less biased, less volatile and much more persistent relative to alternative core measures and CPI inflation. They are also still moving with the economic cycle. Our analysis shows that historical revisions have been relatively small among these three core inflation measures since their inception and that CPI-common seems less prone to revisions and sector-specific shocks than CPI-trim and CPI-median.

Bank topics: Inflation and prices; Monetary policy framework
JEL codes: E, E3, E31, E5, E52

Résumé

Nous proposons une nouvelle évaluation de l'utilité de diverses mesures de l'inflation fondamentale pouvant servir à la conduite de la politique monétaire. Nous constatons que les mesures actuellement privilégiées par la Banque du Canada, à savoir l'IPC-moyenne tronquée, l'IPC-médiane pondérée et l'IPC-composante commune, répondent encore le mieux à toute une série de critères. Comme à l'évaluation précédente, celles-ci sont moins biaisées, moins volatiles et beaucoup plus à même de rendre compte des variations persistantes de l'inflation que les autres mesures de l'inflation fondamentale et que l'inflation mesurée par l'IPC. De plus, elles continuent à ce jour de suivre le cycle économique. Notre analyse révèle que les révisions historiques apportées à ces trois mesures depuis leur mise en place ont été relativement mineures et que l'IPC-composante commune semble moins susceptible de faire l'objet de révisions et moins sensible aux chocs sectoriels que l'IPC-moyenne tronquée et l'IPC-médiane pondérée.

Sujets : Inflation et prix; Cadre de politique monétaire
Codes JEL : E, E3, E31, E5, E52

Introduction

Monetary policy in Canada has been conducted within an inflation-targeting framework since 1991. A key part of this framework is the Bank of Canada's objective of keeping inflation at the 2 percent midpoint of a control range of 1 to 3 percent. The inflation target in Canada is expressed in terms of consumer price index (CPI) inflation, which is a broad measure of price changes faced by an average Canadian consumer. However, various temporary factors can affect the short-term movements of CPI inflation (e.g., changes in global commodity prices that affect gasoline prices and weather-related movements that affect the prices of fruits and vegetables). The Bank "looks through" these temporary effects when setting monetary policy. Measures of core inflation can therefore be useful tools because they help the Bank focus on the underlying trend in inflation at the starting point of its projection.

CPI-common, CPI-median and CPI-trim have served as Bank of Canada's main operational guides for monetary policy since 2017, replacing CPIX. An evaluation conducted in 2016 found that CPIX was outperformed by the current three core measures across a range of criteria, including persistence, volatility, relationship with the output gap and impact from sector-specific shocks (Bank of Canada 2016). As a result of that analysis, the Bank stopped using CPIX as its preferred measure of core inflation and replaced it with these three measures. Over the past few quarters, CPI-common, CPI-median and CPI-trim averaged close to 2 percent, roughly consistent with an economy operating near capacity.

We provide an updated evaluation of the core inflation measures in Canada and assess whether these measures remain the top contenders. First, we apply the same set of evaluation criteria used in previous research to assess measures of core inflation in Canada. Second, we introduce a new measure, CPI excluding a systematic measure of idiosyncratic prices (CPIXSMIP), which captures underlying trends in inflation by removing components that are considered idiosyncratic, and assess it along with the other core measures. Lastly, we discuss some practical considerations for core inflation measures (including an examination of the degree of revisions) and provide some concluding remarks.

Measures of core inflation in Canada

This section describes the measures of core inflation evaluated in this paper. These measures are plotted in **Chart 1**, and most are described in Khan, Morel and Sabourin (2015). The new measure being evaluated—CPIXSMIP—was recently developed.

CPIX Calculated using a price index that excludes eight of the most volatile components of the CPI and the effect of indirect tax changes on the remaining components. The eight excluded components are fruits, vegetables, gasoline, fuel oil, natural gas, mortgage interest, intercity transportation and tobacco products.

CPIXFET Calculated using the CPI excluding food, energy and the effect of changes in indirect taxes.

CPIW Assigns a weight to each CPI component that is inversely proportional to its historical volatility (i.e., it is a volatility-weighted measure).

CPI-trim Excludes CPI components whose rates of change in a given month are found in the tails of the distribution of price changes.

CPI-median Corresponds to the price change located at the 50^{th} percentile (in terms of CPI basket weights) of the distribution of price changes in a given month.

CPI-common Tracks common price changes across categories in the CPI basket.

CPIXSMIP Excludes components that are considered idiosyncratic. The systematic measure of idiosyncratic prices (SMIP) identifies CPI components as idiosyncratic when they have the highest scores based on five criteria:

- high volatility,
- low persistence,
- low degree of correlation with common movement across CPI components,
- low correlation with the output gap, and
- extreme movements (Dockrill and Savoie-Chabot 2018).

Chart 1a : CPIX

year-over-year percentage change

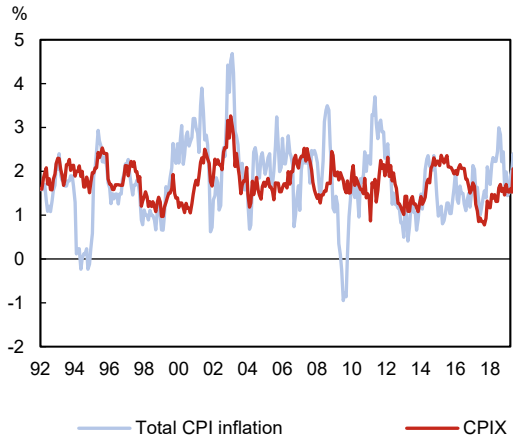


Chart 1b : CPIXFET

year-over-year percentage change

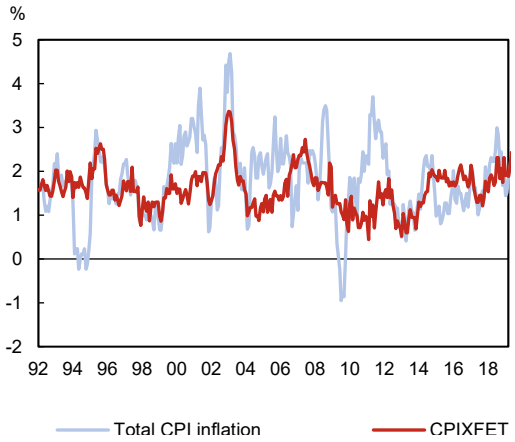


Chart 1c: CPIW

year-over-year percentage change

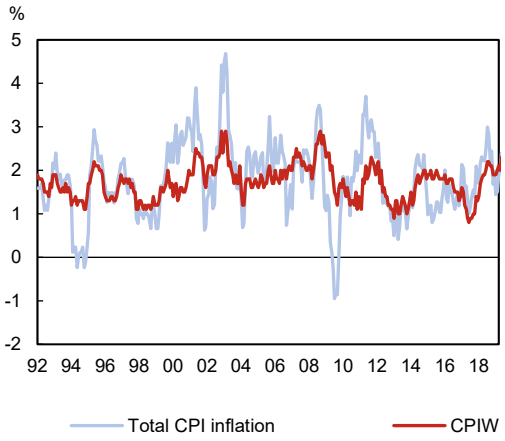


Chart 1d: CPI-trim

year-over-year percentage change

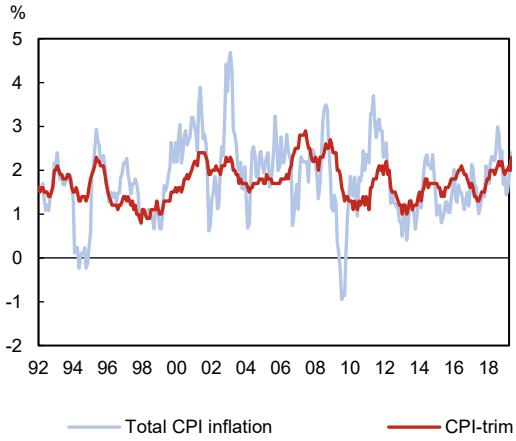


Chart 1e: CPI-median

year-over-year percentage change

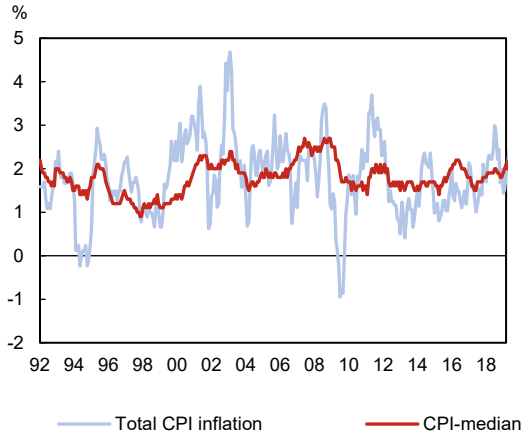


Chart 1f: CPI-common

year-over-year percentage change

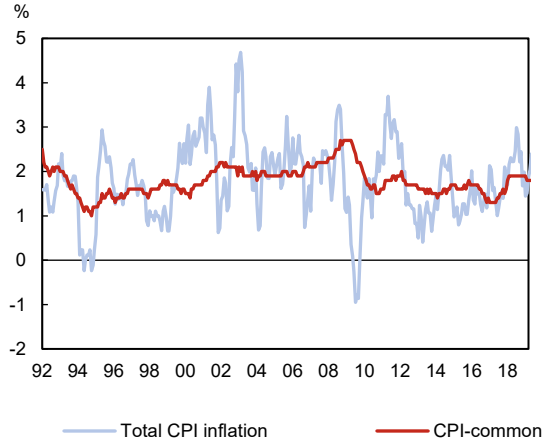
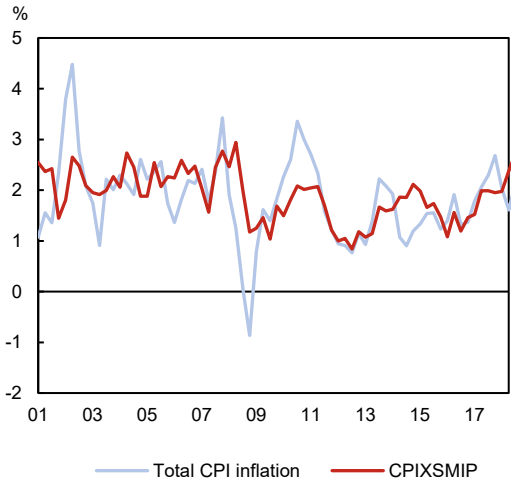


Chart 1g: CPIXSMIP

year-over-year percentage change



Evaluation of core inflation measures in Canada

Effective measures of core inflation must satisfy several criteria, as presented in Khan, Morel and Sabourin (2015). We begin by examining the statistical properties of the various core inflation measures to investigate whether these measures track long-run movements in total inflation in a manner that is less biased, less volatile and more persistent than total inflation. We also examine the relationship between measures of core inflation and the output gap through simple correlation and estimation of Phillips curves. We assess the degree to which measures of core inflation are subject to idiosyncratic shocks and historical revisions. Finally, we review the extent to which different measures are easy to understand and explain to the public.

Assessing the statistical properties

Our framework for evaluating the statistical properties of the core inflation measures is based on the following decomposition, which expresses total CPI inflation as the sum of core inflation (intended to capture the underlying signal, π_t^C) and a residual (the noise, e_t):

$$\pi_t = \pi_t^C + e_t$$

We follow Khan, Morel and Sabourin (2015) and focus on three key statistical properties of the core inflation measures: bias, volatility and persistence.

Bias with respect to total CPI inflation

A useful core inflation measure should theoretically track the underlying trend of total CPI inflation well. It should also have a long-term mean similar to that of total CPI inflation. The average difference between the two series should therefore theoretically be close to zero. In practice, central banks can account for the presence of bias in the core inflation measure. However, due to potential communication challenges, it may be preferable to have a measure of core inflation that is relatively unbiased from total inflation. **Table 1** presents the average difference in year-over-year growth of the core inflation measures and total CPI excluding indirect taxes. The bias of most of the core inflation measures (CPIX, CPIW, CPI-trim, CPI-common and CPI-median) is close to zero. CPIXFET has averaged 0.2 percentage points lower than total CPI inflation since the start of inflation targeting in Canada, while CPIXSMIP has averaged about 0.1 percentage point higher than total CPI inflation.

Table 1: Bias of core inflation measures[a]	
CPIX	0.00
CPIXFET	-0.15
CPIW	-0.04
CPI-trim	-0.04
CPI-median	0.03
CPI-common	0.03
CPIXSMIP	0.11

a. Average difference in the year-over-year growth rate of core and total CPI excluding tax (percentage points) from 1992Q1–2019Q2

Volatility and persistence

It is common that core inflation measures are less volatile and more persistent than total CPI inflation because core inflation measures are supposed to capture longer underlying trends in CPI inflation. Khan, Morel and Sabourin (2015) argue that the volatility of core inflation should not be seen independently from its persistence because reducing volatility in inflation does not necessarily amount to reducing the influence of transitory price changes.

Table 2 shows the volatility and estimated persistence of the core inflation measures and their respective residual components. Volatility is measured by the standard deviation of year-over-year inflation rates, while persistence is estimated as the sum of autoregressive coefficients from univariate regressions of quarter-over-quarter inflation rates. As **Table 2** shows, all the core inflation measures are less volatile than total CPI excluding indirect taxes, with CPI-common being the least volatile. This finding is consistent with Khan, Morel and Sabourin (2015) and reflects the fact that common movements among CPI components account for only a small portion of the variability in total CPI. Most of the variance of inflation is instead driven by sector-specific price movements, as found in Khan, Morel and Sabourin (2013).

CPI-common also ranks the highest in terms of estimated persistence, with CPI-median and CPI-trim ranking second and third, respectively. CPIXFET is also found to exhibit a statistically significant degree of inflation persistence, while CPIW, CPIXSMIP and CPIX show little to no persistence. As in Khan, Morel and Sabourin (2015), the estimated persistence of the residual components shows that CPIX may have included a greater share of transitory price changes on average than it has excluded because the residual component is more persistent than the core inflation component. For CPIXSMIP, the residual component shows strongly negative autocorrelations, which is characteristic of an idiosyncratic component and a reflection of the way CPIXSMIP is constructed.

Table 2: Volatility and persistence of underlying inflation measures

Core inflation measure	Volatility[a]		Persistence[b]	
	π_t^c	e^t	π_t^c	e^t
CPIX	0.40	0.74	0.05	0.17
CPIXFET	0.46	0.65	0.35	-0.02
CPIW	0.39	0.58	0.20	-0.04
CPI-trim	0.41	0.60	0.62	-0.40
CPI-median	0.37	0.67	0.73	-0.15
CPI-common	0.32	0.76	0.77	-0.17
CPIXSMIP	0.50	0.68	0.21	-0.98
Total CPI (excl. indirect taxes)	0.76	---	-0.16	---

a. Standard deviation of year-over-year growth rate over 1992Q1–2019Q2, with the exception of CPIXSMIP, which is based on sample from 2001Q4 to 2019Q2.
b. Sum of first five autoregressive coefficients on quarter-over-quarter inflation based on sample from 1992Q1 to 2019Q2, with the exception of CPIXSMIP, which is based on sample from 2001Q4 to 2019Q2.
*Statistically significant at the 10 percent level.

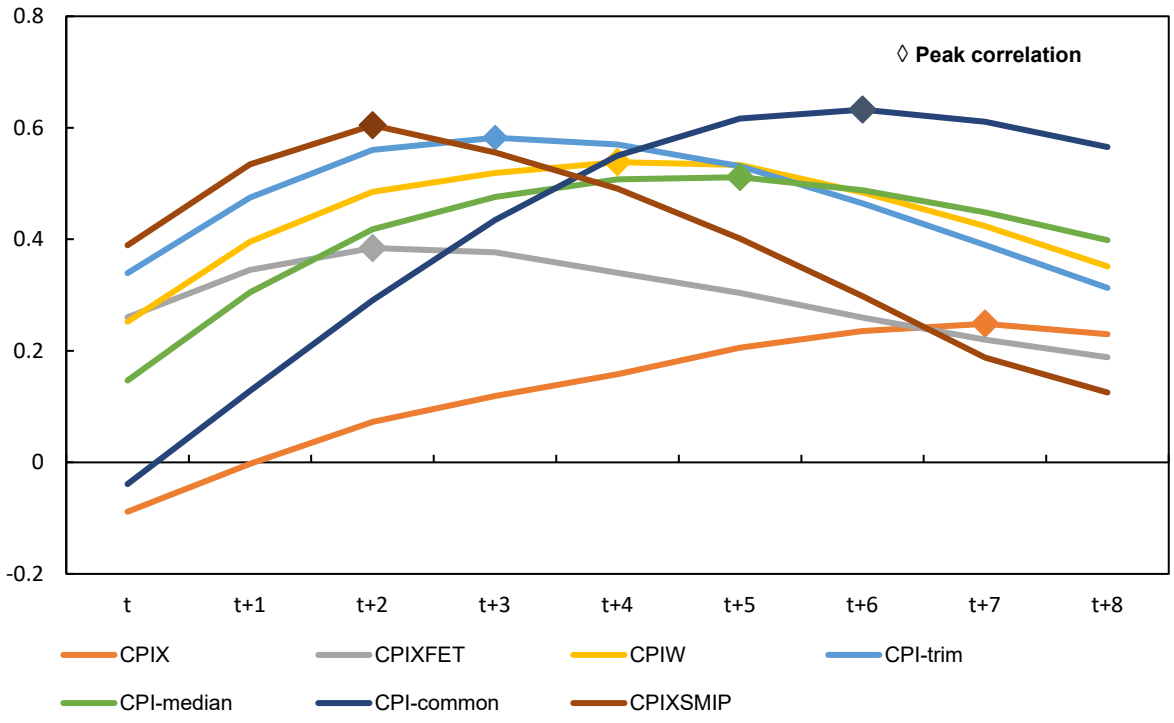
Assessing the relationship with macroeconomic drivers

Having desirable statistical properties is only a first step in evaluating core inflation measures. It is also important that these statistical properties reflect meaningful economic phenomena. Therefore, we examine the relationship of the core inflation measures with the economic cycle, as represented by the output gap, to investigate whether these core inflation measures are informative of economic conditions.

We begin by looking at simple correlations between core inflation measures and the output gap. **Chart 2** shows the correlations between the level of the Canadian output gap and the core inflation measures expressed in 12-month rates of change at different horizons. For example, $t + 3$ denotes the correlation of the output gap at time t with core inflation three quarters ahead. This simple exercise shows that the correlation between CPI-common and the output gap peaks later than that for most of the other core inflation

measures, at *t* +6, this is the highest correlation among the core measures at 0.6. CPIXSMIP also shows significantly high correlation with the output gap at 0.6, but that relationship seems to be less persistent than other core measures because the correlation declines relatively sharply after its peak at *t* + 2. CPI-median, CPI-trim and CPIW also show significant correlation with the output gap at about 0.5 to 0.6, and the peak correlations for these measures occur after three to five quarters. CPIX is still showing a trivial correlation with the output gap at all time horizons.

Chart 2: Correlations with the output gap



To further investigate the relationship between the core inflation measures and the output gap, we also estimate Phillips curve models in which quarter-over-quarter inflation is regressed on lags of the output gap[1] and a set of control variables,[2] as in Khan, Morel and Sabourin (2015). **Table 3** lists the sum of the estimated coefficients[3] on the output gap for both the baseline estimation of quarter-over-quarter change in the core inflation

[1] The lag length for the output gap for each of the Phillips curve estimations is based on the Akaike's information criterion (AIC).

[2] The control variables include global commodity prices and the exchange rate.

[3] What matters in that test is the significance of the sum of the coefficient, not the size.

measures as well as core inflation measures excluding mortgage interest cost (MIC).[4] MIC is an important consideration because it is a CPI component that is directly affected by monetary policy. It may therefore be useful to examine the results based on core inflation measures excluding MIC because doing so helps to look through this direct impact of the Bank's actions.

Interestingly, CPIXSMIP reports the highest sum of coefficients on output gap in the baseline specification, but its relationship with the output gap becomes insignificant once the impact of MIC is accounted for. This suggests that MIC has a significant and important contribution in CPIXSMIP, likely because MIC is never identified as idiosyncratic and therefore always included in the estimation of CPIXSMIP.[5] Excluding MIC also makes a marked difference in the results for CPIXFET and CPIW. These measures appear to show a positive and statistically significant relationship with the output gap in the baseline specification, but the relationship becomes statistically insignificant once MIC is accounted for. Consistent with the insights from the simple correlation exercise, it is difficult to detect a significant relationship between CPIX inflation and the output gap. CPI-median, CPI-trim and CPI-common all report statistically significant relationships with the output gap based on the Phillips curve estimations. Although the sum of the coefficients of output gap for these three core measures sums slightly with the exclusion of MIC, the positive and significant relationship with the output gap seems to hold even when accounting for the impact of MIC. This was a key consideration in the Bank's selection of them as preferred measures of core inflation. The fact that this result still holds after their adoption indicates that they remain valuable.[6]

[4] The output gap used for the estimation is the projection output gap, but we also tested the integrated framework and extended multivariate filter output gaps and the results do not change significantly. The specification of the Phillips curves estimation is consistent with that in Khan, Morel and Sabourin (2015).

[5] See Chart 2 in Dockrill and Savoie-Chabot (2018).

[6] Other Phillips curve specifications were tested, including the lagged dependent variable, and these results remain robust to these specifications.

Table 3: Phillips curve estimates (1992Q1–2019Q2) **				
Core inflation measure	Baseline		Excluding MIC	
	Sums of coefs. on output gap	Adj. R^2	Sums of coefs. on output gap	Adj. R^2
CPIX	0.06	0.00	0.06	0.00
CPIXFET	**0.17***	0.11	-0.03	-0.00
CPIW	**0.16***	0.08	0.01	-0.01
CPI-trim	**0.20***	0.25	**0.18***	0.22
CPI-median	**0.18***	0.18	**0.14***	0.18
CPI-common	**0.12***	0.34	**0.11***	0.39
CPIXSMIP	**0.25***	0.06	0.11	-0.02

* Statistically significant at the 10 percent level
** Estimation sample for CPI excluding systematic measure of idiosyncratic prices (SMIP) is from 2001Q1 to 2019Q2.

Assessing the degree of historical revision

Since January 2017, the Bank's preferred core inflation measures are CPI-common, CPI-trim and CPI-median. Although CPI inflation (as well as CPIX, CPIXFET and CPIW) is not subject to historical revisions, these preferred core inflation measures are. CPI-median and CPI-trim are revised because they are based on seasonally adjusted price index series, and the seasonal factors are subject to revisions. Every month, Statistics Canada revises seasonally adjusted CPI data for the previous seven years.[7] For CPI-common, revisions are due to the statistical technique used in which the factor model is estimated over all available historical data.[8] For CPIXSMIP, large revisions to the output gap can trigger potential revisions.[9] According to Luciani and Trezzi (2019), policy-makers making and communicating decisions in real time may prefer core inflation measures that are not subject to large revisions. Therefore, we examine the extent of the revisions that CPI-common, CPI-trim, CPI-median and CPIXSMIP are subject to.[10]

Chart 3, **Chart 4**, **Chart 5** and **Chart 6** plot the largest positive monthly/quarterly revision, the largest negative monthly/quarterly revision, the average revision as well as the cumulative revision (the difference between the most recent values and the earliest

[7] For more information, see "Revisions and seasonal adjustment" in Consumer Price Index: The Bank of Canada's Preferred Measures of Core Inflation Methodology Document

[8] For more information, see "Revisions and seasonal adjustment" in Consumer Price Index: The Bank of Canada's Preferred Measures of Core Inflation Methodology Document

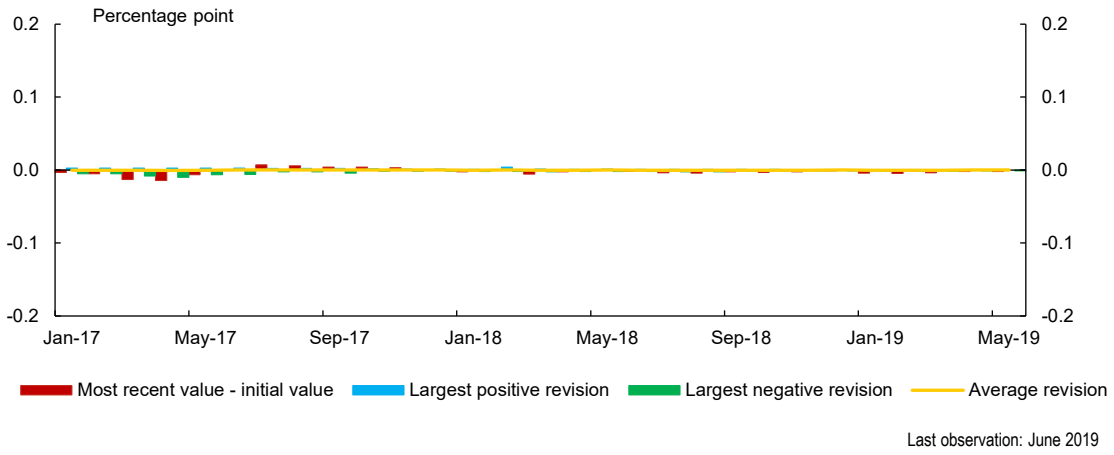
[9] While CPI components are not subject to historical revisions, the list of components selected by SMIP can be affected by revisions to the output gap.

[10] The sample covers the past three years because the preferred measures of core inflation were introduced at the beginning of this period. CPIX, CPIXFET and CPIW are not subject to revisions.

vintage) for CPI-common, CPI-trim, CPI-median and CPIXSMIP.[11] The average revision for all of the three preferred core inflation measures as well as CPIXSMIP since January 2017 is 0 percentage points (p.p.). However, the maximum positive and negative revision is smaller for CPI-common than it is for CPI-trim, CPI-median and CPIXSMIP. For CPI-common, most of the maximum positive and negative revision as well as the absolute revision (difference between the latest values and the first vintage) are very close to 0 p.p. (**Chart 3**). For CPIXSMIP, the maximum positive quarterly revision since 2017Q1 is about 0.1 p.p., but the maximum negative quarterly revision reaches -0.14 p.p. (**Chart 6**).

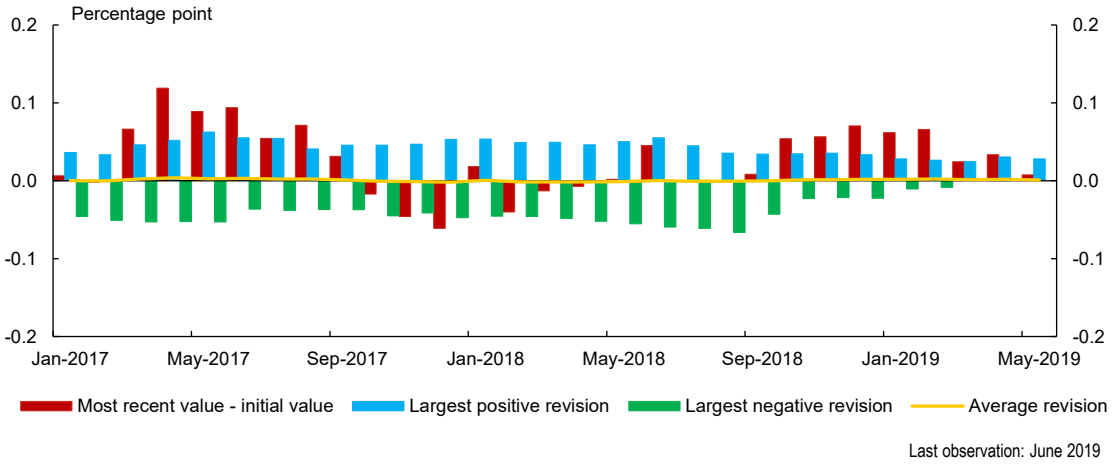
All three of the preferred core inflation measures are subject to revisions, but they are smaller than the revisions to CPIXSMIP. Revisions are larger for the CPI-trim and CPI-median than for CPI-common. This suggests that CPI-common may be preferable over CPI-trim and CPI-median based on its stability across data vintages and avoidance of revisions.

Chart 3: Revisions to common component since January 2017



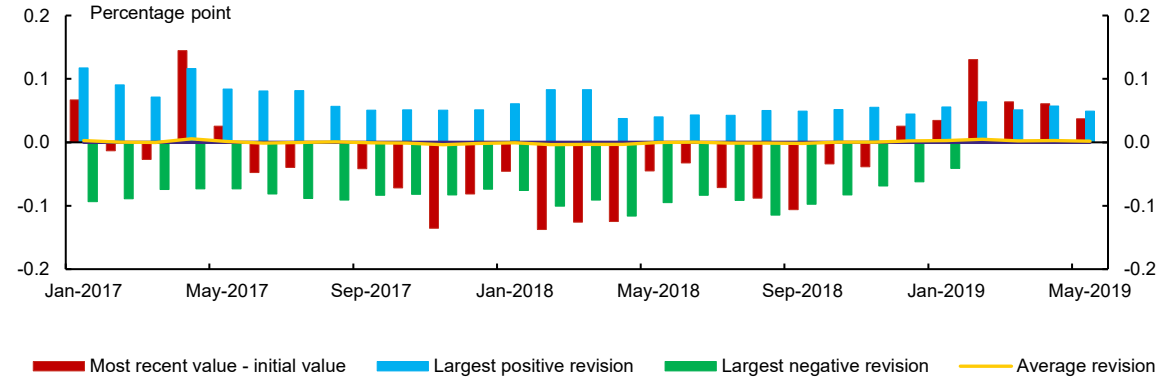
[11] The vintages of CPI-common, CPI-trim and CPI-median are based on the authors' replication of Statistics Canada's calculation of the core inflation measures based on vintages of inputs.

Chart 4: Revisions to trimmed mean since January 2017



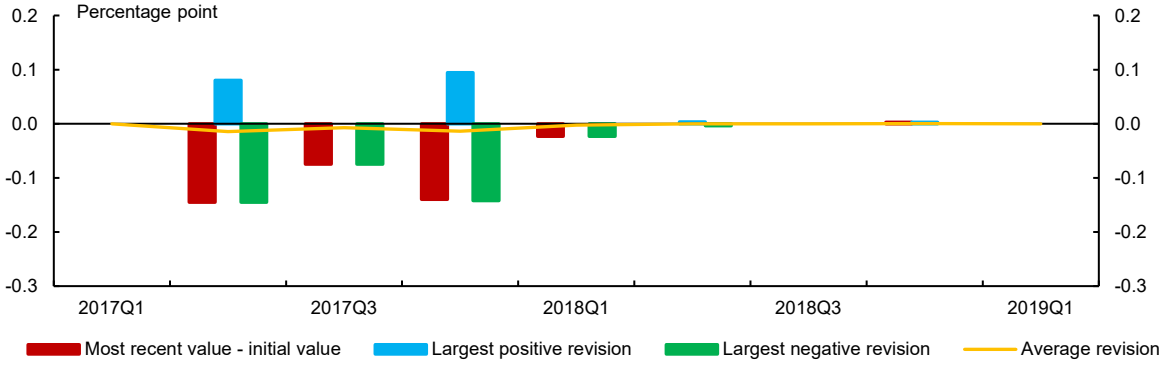
Last observation: June 2019

Chart 5: Revisions to weighted median since January 2017



Last observation: June 2019

Chart 6: Revisions to CPIXSMIP since 2017Q1



Last observation: 2019Q1

Assessing the impact from sector-specific shocks

Another key aspect is the ability of the core measures to filter unanticipated transitory sector-specific shocks. This could manifest, for instance, when the price increase of a CPI component surges suddenly despite relatively stable historical behaviour until that point. The surge in automobile insurance premiums in the early 2000s or, more recently, the change in methodology to the air transportation index in 2018 are examples of phenomena that occurred specifically to a given sector/component. To assess the impact of sector-specific shocks on the three core inflation measures, we look at SMIP to identify which CPI components are most frequently assessed as idiosyncratic. As Dockrill and Savoie-Chabot (2018) show, among the most idiosyncratic components are energy-related series such as gasoline prices and autos. SMIP identifies this last component as idiosyncratic about 30 percent of the time. While there is no obvious evidence that gasoline prices affect these core measures in a meaningful way, we find that the differences between CPI-trim and CPI-median (excluding autos) and CPI-trim and CPI-median (including autos) is much larger than the difference in CPI-common.[12] In the second quarter of 2019, CPI-median excluding autos is at 2.0 percent (0.1 p.p. weaker than CPI-median, with May being 0.2 p.p. weaker) and CPI-trim is at 2.1 percent (0.1 p.p. lower than CPI-trim, with May being 0.2 p.p. weaker). CPI-common is at 1.8 percent, with and without autos. This suggests that CPI-trim and CPI-median may be more subject to sector-specific shocks than CPI-common is.[13]

Practical considerations

The last step in evaluating measures of core inflation is to assess whether they help articulate the conduct of monetary policy in an easy and effective way. This is admittedly a more subjective criterion than the others, but it is nevertheless worthy of discussion.

From a central bank's perspective, some communication considerations can be associated with the choice of the core inflation measures. The communication considerations could stem from how easily and effectively the construction of the core inflation measure can be explained as well as how effectively the measure can facilitate communication of

[12] Core inflation measures that exclude certain CPI components, such as CPIXFET and CPIX, have continued to show sensitivity to idiosyncratic shocks. On the other hand, CPIXSMIP would be exempt from such shocks by construction.

[13] The assessment of idiosyncratic shocks is based on empirical identification by CPI components (SMIP). However, CPI-trim and CPI-median are not susceptible to structural breaks triggered by methodological changes in a given month (e.g., airfare in 2018 and auto insurance premiums in 2003) because they tend to filter out sharp price movements. In contrast, CPI-common would tend to capture structural breaks with lags, given that the loadings are estimated over a long period and would thus be slow to adjust. Because all loadings on all CPI components are very small, none of the CPI components (shocks) has a meaningful impact in isolation.

monetary policy decisions. Although having more than one core inflation measure involves important communication trade-offs, CPI-common, CPI-median and CPI-trim have helped the Bank manage the risks associated with the shortcomings of any single indicator transparently. Furthermore, the transition from CPIX to the current three core inflation measures was relatively smooth.

Traditional exclusion-based measures of core inflation (e.g., CPIX, CPIXFET) are perhaps the most easily understood measures. However, in the previous section we show that they lack persistence as well as correlation with the output gap. This could make them difficult to use as an effective tool for monetary policy decisions. In contrast, the methodology of CPI-trim is similar to the traditional exclusion-based measure and continues to rank higher across several criteria (bias, persistence and impact from sector-specific shocks). CPI-median and CPI-common may require some statistical knowledge to be understood. However, these two measures still outperform most of the other core inflation measures in terms of bias, persistence, volatility and relationship with the output gap. The new core inflation measure, CPIXSMIP, is not able to outperform CPI-trim, CPI-median and CPI-common overall. The methodology of CPIXSMIP is also relatively challenging to explain because it is based on several selection criteria.

Conclusion

We have assessed the relative performance of the core inflation measures across a range of criteria established by previous Bank evaluations, with the new core inflation measure, CPIXSMIP added to the evaluation. As shown in **Table 5**, CPI-common, CPI-median and CPI-trim continue to stand out as the top performers across several criteria. They are less biased and volatile than total CPI inflation, they capture persistent price movements, and they tend to move with the output gap. The performance of the new contender, CPIXSMIP is somewhat worse than the actual preferred measures. CPIXSMIP is more biased and less persistent than the three preferred measures.

Examining the historical revisions of these core measures reveals that they may be bigger in CPI-median, CPI-trim and CPIXSMIP relative to CPI-common. Similarly, we find that CPI-common may be less affected by sector-specific shocks than CPI-trim and CPI-median.

We should emphasize, however, that all core inflation measures have their respective strengths and weaknesses. They can also provide different information on underlying price pressure and therefore merit continued monitoring. We should also emphasize that although core inflation measures can be helpful guides to monetary policy, they are just one of many inputs into the process. It is important to consider them alongside a range

of other indicators (e.g., the output gap and labour market indicators) to get a fuller picture of the overall Canadian economy.

Table 5: Summary of an evaluation of different core inflation measures

	CPI-common	CPI-median	CPI-trim	CPIX	CPIXFET	CPIW	CPIXSMIP
Unbiased	✓	✓	✓	✓	✗	✓	✗
Persistent	✪	✓	✓	✗	✓	–	–
Volatile	✪	✓	✓	✓	✓	✓	✓
Moves with output gap	✓	✓	✓	✗	✗	✗	✗
Looks through sector-specific shocks	✓	–	–	✗	✗	✗	✓
Methodology easily understood	✗	–	✓	✓	✓	✓	✗

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