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Introducing a Systematic Measure of Idiosyncratic Prices



by Madigan Dockrill and Laurence Savoie-Chabot

Canadian Economic Analysis Department
Bank of Canada
Ottawa, Ontario, Canada K1A 0G9
mdockrill@bankofcanada.ca
lsavoie-chabot@bankofcanada.ca

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Abstract

There is a risk that Bank of Canada staff may inadvertently be biased when analyzing inflation: when inflation surprises on the downside, staff might emphasize negative idiosyncratic factors. When inflation surprises on the upside, staff might emphasize the positive idiosyncratic factors. The goal of this paper is to create a systematic measure of idiosyncratic prices (SMIP) that would provide an unbiased evaluation of temporary factors in Canadian consumer price index (CPI) inflation. SMIP considers CPI components 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 in the current period. The components captured by SMIP are found to account for a large proportion of the deviation of inflation from target over the sample, after controlling for the output gap. In the third quarter of 2018, in terms of the components and their contribution to the deviation of inflation from target, results from SMIP reinforce the narrative in the October 2018 *Monetary Policy Report*—CPI inflation is currently above target due to temporary factors.

Bank topics: Inflation and price; Recent economic and financial developments

JEL codes: E, E3, E31

Résumé

Il y a un risque que les membres du personnel de la Banque du Canada soient involontairement partiaux dans leur analyse de l'inflation : lorsqu'une baisse imprévue de l'inflation survient, ils risquent d'accentuer les facteurs idiosyncratiques négatifs. Et inversement, lorsqu'une hausse imprévue de l'inflation se produit, ils risquent d'accentuer les facteurs idiosyncratiques positifs. Le présent document vise à créer une mesure systématique des prix idiosyncratiques (MSPI) qui permettrait une évaluation non biaisée des facteurs temporaires agissant sur l'inflation mesurée par l'indice des prix à la consommation (IPC) au Canada. La MSPI se fonde sur cinq critères pour établir qu'une composante de l'IPC est relativement plus idiosyncratique qu'une autre, à savoir : une volatilité élevée, une faible persistance, un faible degré de corrélation avec les variations communes des composantes de l'IPC, un faible degré de corrélation avec l'écart de production et des variations extrêmes pendant la période courante. Les composantes prises en compte par la MSPI expliquent en grande partie l'écart de l'inflation par rapport à la cible pour l'échantillon analysé, après neutralisation de l'effet de l'écart de production

sur l'inflation. Pour le troisième trimestre de 2018, en ce qui a trait aux composantes et à leur contribution à l'écart de l'inflation par rapport à la cible, les résultats de la MSPI appuient ce qui était expliqué dans le *Rapport sur la politique monétaire* d'octobre 2018, soit que l'inflation mesurée par l'IPC se situe actuellement au-dessus de la cible en raison de facteurs temporaires.

Sujets : Inflation et prix; Récents développements économiques et financiers

Codes JEL : E, E3, E31

Summary

There is a risk that Bank of Canada staff may be biased when analyzing inflation: when inflation surprises on the downside, staff might emphasize negative idiosyncratic factors. When inflation surprises on the upside, staff might emphasize the positive idiosyncratic factors. The goal of this paper is to create a systematic measure of idiosyncratic prices (SMIP) that would improve our analysis of relative price shocks and allow for an unbiased evaluation of temporary factors in Canadian consumer price index (CPI) inflation.

SMIP measures idiosyncratic components using five criteria: high volatility, low persistence, low degree of correlation with common movements across CPI components, low correlation with the output gap, and extreme movements in the current period. The score for each CPI component is obtained by standardizing the distributions of these criteria across components and adding the standardized values of each criterion. CPI components are considered idiosyncratic in a given quarter if their score is more than one standard deviation above the mean of the 55 CPI component scores in that period.

The main results of this approach are as follows:

- The components captured by SMIP each quarter are found to account for a large amount of the deviation of CPI inflation from target over our sample (from the fourth quarter of 2001 to the third quarter of 2018), after controlling for the output gap. The components most frequently considered idiosyncratic by SMIP are those related to energy (fuel oil, natural gas, gasoline). This partly reflects the typically sharp movements of these components.
- However, this measure appears unable to fully capture broad-based supply shocks. For example, heightened competition around 2013 or among food retailers more recently is not captured by our method.
- The CPI decomposition in the October 2018 *Monetary Policy Report* (MPR) suggests that in the third quarter of 2018 temporary factors were boosting CPI inflation above target by about 0.7 percentage points (pps) on net. Below-average inflation in food was more than offset by upward pressure from strong inflation in gasoline prices, intercity transportation and some service prices (due to the effect of increases to the minimum wage).
 - SMIP suggests that idiosyncratic components put upward pressure on CPI, with a net impact of about 0.6 pps (in deviation from mean), slightly below the MPR assessment. According to SMIP, the idiosyncratic components with the largest impact in the third quarter of 2018 are gasoline (+0.4 pps), intercity transportation (+0.2 pps), communications (-0.1 pps) and natural gas (-0.1 pps).

- Below-average inflation in food and the effects of increases to the minimum wage are not captured by SMIP in the third quarter of 2018. Nevertheless, results from SMIP support the narrative that CPI inflation is currently above target due to temporary factors. As such, this also supports the October MPR forecast of CPI inflation close to 2 per cent in early 2019 up to the end of the projection horizon, once prices have fully adjusted to incorporate the effects of temporary factors and the associated upward pressures on inflation have faded.

1. Constructing a systematic measure of idiosyncratic prices

Motivation

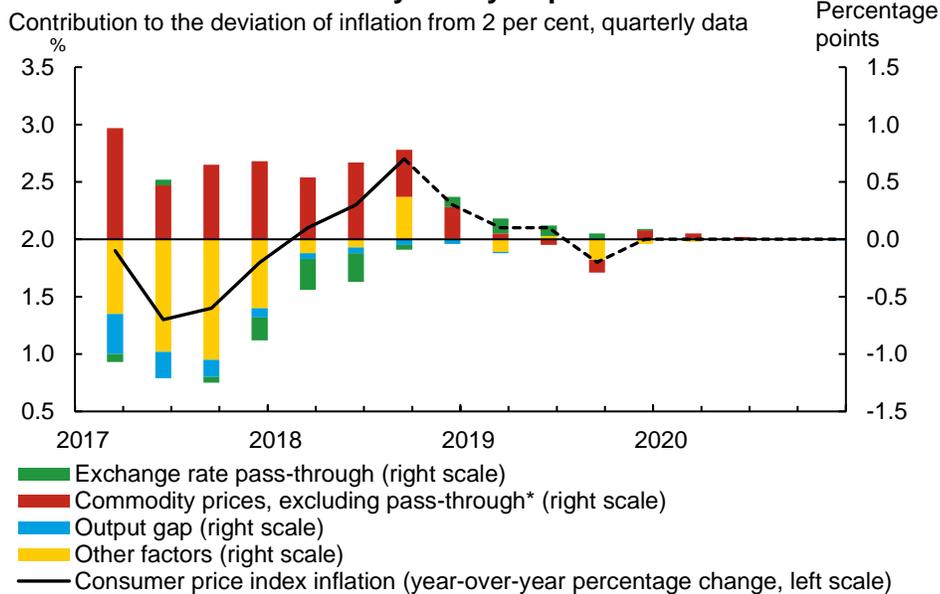
From a monetary policy perspective, disentangling price movements in the consumer price index (CPI) into underlying pressures or temporary and idiosyncratic factors is important because the two types of price movements have different policy implications. Underlying pressures would be related to changes in economic conditions or preferences in Canada. These include demand-driven price movements and are usually more persistent and/or structural.

In the Bank's quarterly Monetary Policy Report (MPR), a key chart decomposes deviations of Canadian CPI inflation from the target through three main macroeconomic factors: commodity prices, exchange rate pass-through (ERPT) and the output gap (**Chart 1**).¹ The remaining unexplained divergence from the target is labelled "other factors." Every quarter, Bank staff analyze what those other factors are and update their assessment of temporary factors (defined here as sum of the impact from commodity prices, ERPT and other factors). This note proposes a systematic measure of idiosyncratic prices (SMIP). SMIP's main advantage is to provide a systematic measure of potential idiosyncratic components of CPI inflation, allowing for an unbiased evaluation of temporary factors. A central bank would usually want to look through temporary factors and focus more on the underlying trend of inflation, as long as inflation expectations remain well anchored.

Every quarter, SMIP would estimate the components of CPI that are characterized as being the most idiosyncratic based on a pre-specified list of criteria. An idiosyncratic price movement is a relative one-time price change, usually from the supply-side, that is limited to a (few) specific CPI component(s).

¹ This chart is based on Chart 16 in the October 2018 MPR.

Chart 1: Consumer price index inflation is usually decomposed into three main factors in the Monetary Policy Report



Note: Numbers may not add to total because of rounding.

* This also includes the effect on inflation of the divergence from the typical relationship between gasoline and crude oil prices, and of the Alberta carbon levy. The cap-and-trade plan in Ontario also had a positive impact in 2017, but its recent removal is expected to weigh on inflation from mid-2018 to the second half of 2019.

Sources: Statistics Canada and Bank of Canada estimates, calculations and projections

Criteria

We select criteria according to what best reflects idiosyncratic price changes. Some of these criteria are the same, although interpreted in the opposite way, as of those used to evaluate the core inflation measures in the context of the most recent renewal of the inflation-control target (jointly by the Bank of Canada and the federal government).² The SMIP criteria are calculated for each of the 55 components of CPI.³

- **Volatility:** standard deviation of the year-over-year growth rate of each component (STDEV).
 - A high standard deviation suggests that a component is relatively more volatile and thus more likely to be subject to idiosyncratic shocks.
- **Persistence:** sum of the lags of the autoregressive process (AR). ARs are estimated with one to five lags on the quarter-over-quarter growth rate of each component. We keep the model with the highest sum that is significantly different from zero. We give this criterion a value of zero if none is significantly different from zero.

² See Khan, Morel and Sabourin (2015) and Bank of Canada (2016).

³ These are the components used as inputs for the construction of the measures of core inflation. They cover the whole CPI basket, and the components are adjusted to remove the effect of changes in indirect taxes. Series adjusted for taxes are preferred because monetary policy sees through the first-round effects of changes in indirect taxes.

- If price changes for a component have a low persistence, it can suggest that the component is more often affected by transitory shocks and is more likely to be idiosyncratic.
- **Common movement across CPI components:** correlation between the year-over-year growth rate of each component and CPI-common (CORR COMM).⁴
 - If the correlation with CPI-common is low, it suggests that inflation for that component is less related to common price changes across CPI basket and is probably reflecting idiosyncratic shocks.
- **Evolution with macroeconomic conditions:** correlation between the year-over-year growth rate of each component and the output gap (CORR OG). For this criterion, we calculate the correlations with the output gap from time t to $t - 4$ and keep the highest of the five.
 - A low correlation with the output gap would suggest that inflation of that component is less reflective of underlying price pressures and is likely more affected by idiosyncratic shocks.
- **Current period:** the number (over a continuous spectrum) of standard deviations away from the mean for the current quarter using year-over-year percentage change (DEV).
 - If the year-over-year percentage change of a component is well above or below its mean, we consider this to be an idiosyncratic behaviour.

Estimation period

All criteria except AR are calculated over a 10-year rolling window, allowing SMIP to capture different components each quarter (see **Appendix A** for more details on AR). This feature allows flexibility if some components exhibit different behaviour over time. The first observation of the criteria is in fourth quarter of 2001, which is calculated using data from the first quarter of 1992 to the fourth quarter of 2001. The AR criterion is estimated over the period from 1995 to 2012⁵ and is kept constant throughout all quarters. If the AR is estimated using a rolling window, there is a large amount of volatility in the sum of the coefficients, an undesirable feature in our tool.⁶

⁴ CPI-common was chosen among the Bank's three preferred measures of core inflation because it is constructed to track common price changes across categories in the CPI basket.

⁵ CPI inflation averaged 2 per cent over this period.

⁶ Some of this volatility comes from the AR interpreting large unidirectional idiosyncratic movements that last for more than one period as persistence. When this happens, the higher AR makes the component seem less idiosyncratic, the opposite of what we think might be happening. Removing the AR from our criteria leads to a worse-performing measure, in terms of accounting for the divergence between CPI inflation and the 2 per cent target, once we have taken the estimated impact of the output gap into account.

The score

A score, calculated using the information from all five criteria, identifies which components of CPI are behaving idiosyncratically. This is done by standardizing (mean, 0; standard deviation, 1) the distributions of the criteria across components. For each component i , the standardized values of the criteria are aggregated to create the idiosyncratic score:⁷

$$score_t^i = \frac{STDEV_t^i - \mu_t^{STDEV}}{\sigma_t^{STDEV}} - \frac{CORR OG_t^i - \mu_t^{CORR OG}}{\sigma_t^{CORR OG}} - \frac{CORR COMM_t^i - \mu_t^{CORR COMM}}{\sigma_t^{CORR COMM}} - \frac{AR^i - \mu^{AR}}{\sigma^{AR}} + \frac{DEV_t^i - \mu_t^{DEV}}{\sigma_t^{DEV}}.$$

A high score implies that a CPI component is more idiosyncratic, while a low score implies it is less idiosyncratic.⁸ CPI components are considered idiosyncratic if their score is more than one standard deviation above the mean of the 55 scores in that period. Any cut-off chosen will be relatively arbitrary, so we test the sensitivity by checking other cut-off points (1.5 and 2 standard deviations). The one standard deviation cut-off can best explain the deviation of CPI inflation from target after accounting for the effect of the output gap, and therefore it is our preferred cut-off (see **Appendix A**).

In a given quarter, the distribution of each criterion is standardized to calculate the scores for each of the CPI components. The standard deviation of the distribution of the 55 scores in that quarter is then calculated, and the cut-off of one standard deviation above the mean is found. Any components with a score above the cut-off will be considered idiosyncratic by SMIP in that specific quarter. In **Appendix A**, we illustrate the distribution of the 55 components in the third quarter of 2018 together with the cut-off.

Components are captured in SMIP in two ways:⁹

- If the component is consistently idiosyncratic, its year-over-year percentage change will have a low degree of common movement with the year-over-year percentage changes of other components (low CORR COMM), a weak correlation with output gap (low CORR OG), a low degree of persistence (low AR), will be relatively more volatile (high STDEV), and a high score over time.

⁷ For each criterion, the mean and standard deviation are calculated as follows (the example is given with the STDEV):

$$\mu_t^{STDEV} = \frac{1}{55} \sum_{i=1}^{55} STDEV_t^i \text{ and } \sigma_t^{STDEV} = \sqrt{\frac{1}{55} \sum_{i=1}^{55} (STDEV_t^i - \mu_t^{STDEV})^2}.$$

⁸ Three criteria, CORR COMM, CORR OG and AR, enter the equation negatively, while DEV and STDEV enter positively. This is because a high value for the DEV and STDEV would suggest that the component is behaving idiosyncratically and therefore should increase its score. In contrast, a high value of the CORR COMM, CORR OG or AR should lower the score. The standardized AR value is the same each quarter because it is estimated over a fixed period.

⁹ See charts in the **Appendix B** for the scores of selected CPI components.

- If the year-over-year percentage change of a component is behaving idiosyncratically only in the current quarter, this specific observation may not have enough influence on the previously mentioned criteria to be considered idiosyncratic. However, it will still be captured through the DEV criterion, which increases the score if the year-over-year percentage change of this observation suddenly deviates far from its mean over the past 10 years.

The score formula puts the same weight on each criterion. We think this is appropriate, given our view that each criterion is of equal importance in determining what is idiosyncratic. However, we test the sensitivity of our results by changing the weights. In general, we think that equal weights are appropriate. See **Appendix A** for details.

Calculating the impact on CPI inflation

Once the idiosyncratic components have been identified by SMIP, the impact on CPI inflation can be calculated as follows:

impact on CPI inflation in deviation from 2 per cent_t

$$= \sum_{i=1}^x \left(y/y_t^i - \overline{y/y}_{1995:2012}^i \right) * w_t^i.$$

The impact on CPI inflation is calculated as the sum of the weighted deviation for each component of its current year-over-year percentage change (y/y_t^i) from its average over 1995–2012 ($\overline{y/y}_{1995:2012}^i$).¹⁰ Each quarter, a different number of components (x) can be captured by SMIP. The weights (w_t^i) represent the share of the CPI basket for each component. The impact on CPI inflation can be calculated using monthly or quarterly data, while the idiosyncratic components change only every quarter.¹¹

As previously mentioned, we conduct sensitivity analysis around our base specification, testing alternative specifications for all criteria. We also consider different estimation periods and cut-off points. Lastly, we use different weights in the score. The results of the sensitivity analysis do not meaningfully alter our main findings and confirm that our base specification is the best option in terms of explaining the divergence of CPI inflation from the 2 per cent target that is unrelated to the output gap. More details are available in **Appendix A**.

¹⁰ With this metric, we are assuming that all deviation in the inflation rate of a component captured by SMIP from its historical average is idiosyncratic.

¹¹ All the criteria are evaluated at a quarterly frequency for consistency with the output gap frequency.

2. Which components are considered idiosyncratic?

Summary of idiosyncratic components since the fourth quarter of 2001

There are 68 quarters in our sample. **Chart 2** shows the number of quarters that each CPI component is considered idiosyncratic. One energy component is always considered idiosyncratic by SMIP (fuel oil and other fuels), while two others are almost always considered idiosyncratic (gasoline and natural gas), and 18 CPI components are never considered idiosyncratic (e.g., health care goods, mortgage interest costs and food purchased from restaurants). Each quarter, our methodology allows for a different number of components to be captured by SMIP (**Chart 3**). On average, 10 components (averaging about 17 per cent of the CPI basket) are captured, in a range of 7 to 13.

Chart 4 illustrates that, in general, important deviations of CPI inflation from the 2 per cent target are largely driven by idiosyncratic components captured by SMIP, even after controlling for the effect of the output gap.¹² For example, at the beginning of the 2000s, the strong increase in CPI inflation can be partly accounted for by large increases in the inflation of auto insurance. **Box 1** investigates whether SMIP captures past episodes of sector-specific shocks that were highlighted in previous MPRs as being temporary.

Chart 4 highlights a more important disconnect since the global financial crisis between the estimated impact from idiosyncratic components on CPI inflation and its deviation from its average. This could be explained by the fact that the Canadian economy was generally in excess supply over that period (as illustrated by the estimated effect of the output gap on the deviation of CPI inflation from target). However, there also appear to be instances where movements in CPI inflation are not explained by SMIP and the output gap over that period. This is the case between 2012 and 2014 and starting again in the second half of 2016. These periods coincide with two episodes of increased competition among grocery retailers, which affected food prices.¹³ We find that, except for vegetables and fruit, food CPI components are mostly considered non-idiosyncratic during the most recent period. These episodes seem associated with relative price shocks that could be broad-based across components and persistent and, as such, might not be captured by SMIP. This is because SMIP is constructed to capture more temporary and individual price shocks. Furthermore, the influence of competition, while meaningful, would not necessarily lead to extreme movements in each affected component. This illustrates one of the limits of this measure. There is also a risk that some information about underlying inflationary pressures is captured by SMIP. A given component (e.g., a sudden change in

¹² The estimated impact of the output gap is based on the decomposition found in the October 2018 MPR (**Chart 1**).

¹³ See the MPRs from January 2017 and July 2013.

energy prices) could be considered idiosyncratic by SMIP while still partly reflecting economic changes that would be considered fundamental. Given those limits, and although SMIP is a useful tool to identify idiosyncratic shocks, Bank staff will continue to assess the importance of relative supply and demand factors when evaluating underlying inflation pressures.¹⁴

Lastly, we construct a measure of inflation that excludes from every period the impact of the components considered idiosyncratic by SMIP.¹⁵ **Chart 5** puts this measure into perspective with the range of the three preferred core inflation measures and CPI inflation. This measure of CPI inflation excluding idiosyncratic components captured by SMIP follows the dynamic of core inflation relatively well, suggesting that it allows us to abstract from factors less related to underlying forces. Over the past year, CPI inflation excluding SMIP has also improved and is now close to 2 per cent, consistent with an economy operating near potential.

¹⁴ The weakness in Canadian CPI inflation in 2017 that is beyond what is captured by the output gap and SMIP could be related to global factors. Brouillette and Savoie-Chabot (2017) investigate whether the weakness in Canadian CPI inflation that was unrelated to macroeconomic factors (ERPT, output gap and commodity prices) was related to global factors rather than Canada-specific temporary factors (e.g., electricity rebates and below-average inflation in food). Their results do not find strong support for global factors. However, they highlight the risk that part of the weakness could be related to global factors through undetermined channels and that further work is needed to explore such channels (e.g., digitalization).

¹⁵ This measure is constructed as follows: the inflation rate of each component selected by SMIP is removed from total inflation each month using the appropriate weights. The inflation rate of the remaining components is then reweighted.

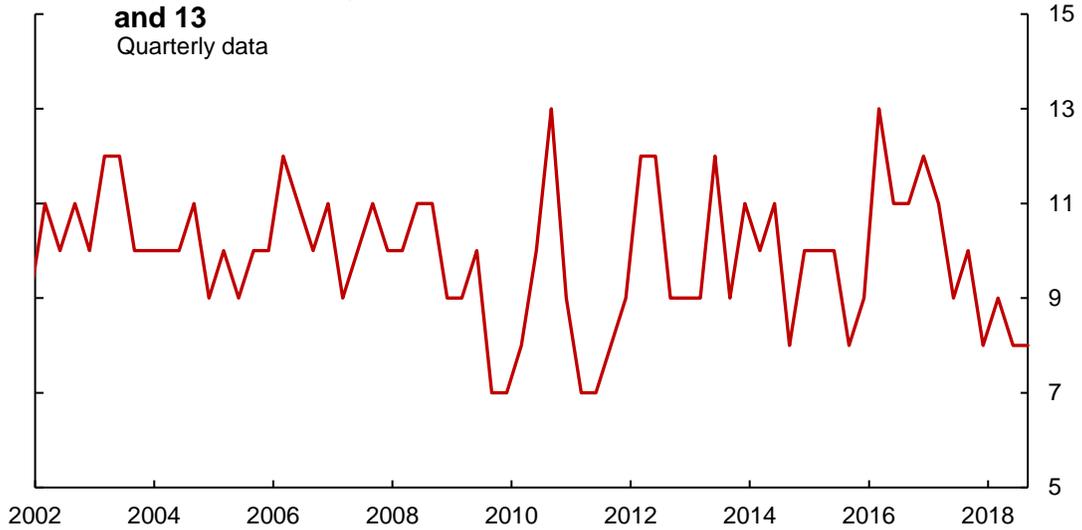
Chart 2: Number of periods each component is considered idiosyncratic

Quarterly estimation from 2001Q4 to 2018Q3



Source: Bank of Canada calculations

Chart 3: The number of components captured by the systematic measure of idiosyncratic prices fluctuates between 7 and 13
 Quarterly data

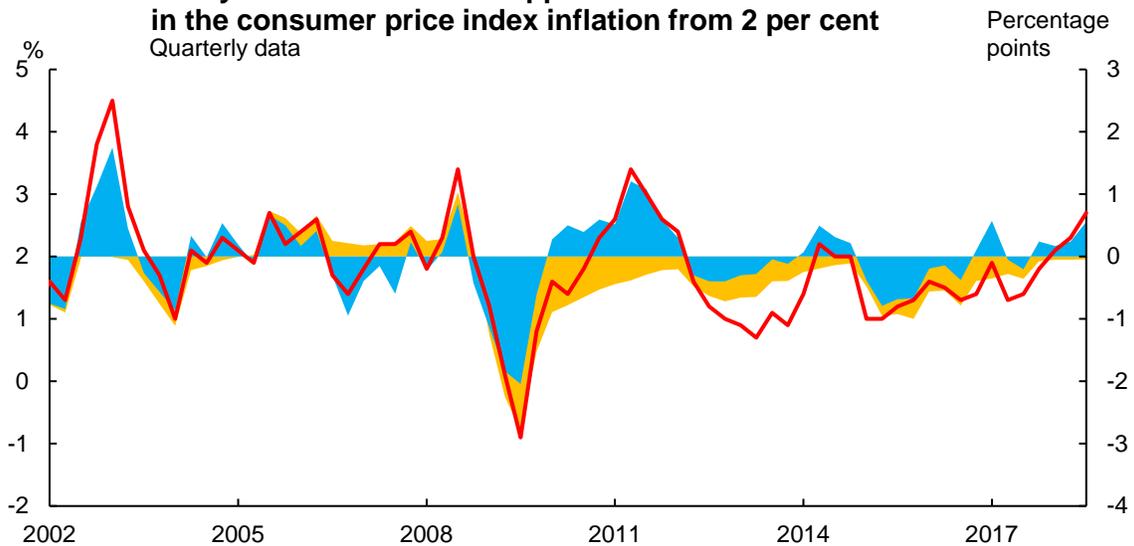


— Number of components captured by the systematic measure of idiosyncratic prices

Source: Bank of Canada calculations

Last observation: 2018Q3

Chart 4: Idiosyncratic movements appear to drive most of deviations in the consumer price index inflation from 2 per cent
 Quarterly data

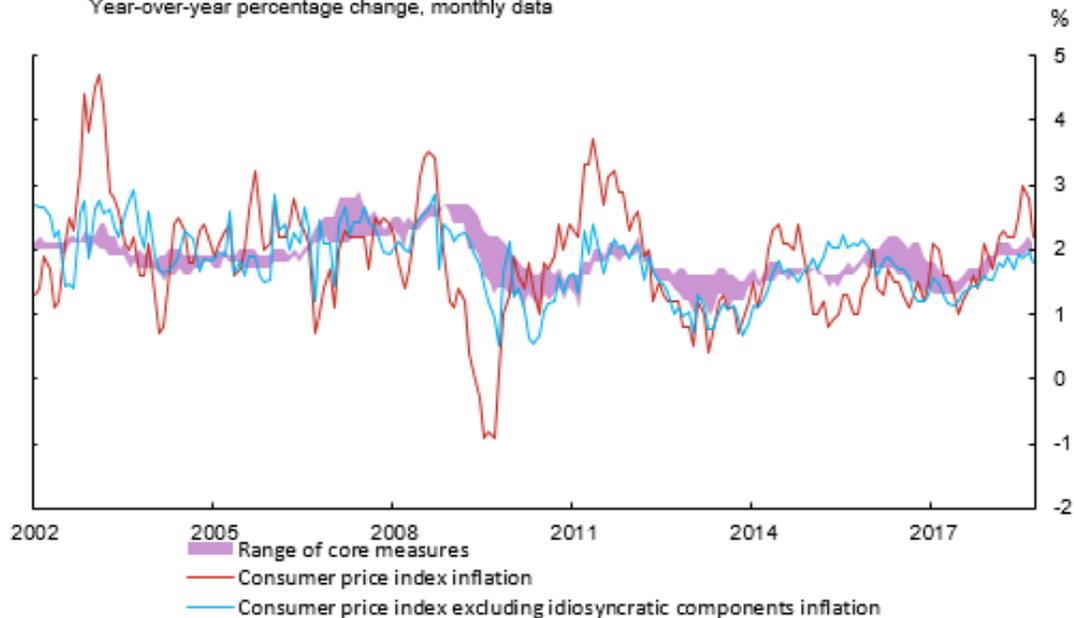


■ Impact of the output gap on the consumer price index inflation (right scale)
 ■ Impact of idiosyncratic components on the consumer price index inflation (right scale)
 — Consumer price index inflation (year-over-year percentage change, left scale)

Sources: Statistics Canada and Bank of Canada calculations

Last observation: 2018Q3

Chart 5: A measure of inflation excluding idiosyncratic components generally follows movements in core inflation, but sometimes exhibits more volatility
 Year-over-year percentage change, monthly data



Note: The range of core measures includes CPI-trim, CPI-median and CPI-common.
 Sources: Statistics Canada and Bank of Canada calculations

Last observation: 2018M9

Box 1: Investigation of Past Idiosyncratic Shocks

To test if SMIP can capture idiosyncratic movements, we investigate several idiosyncratic shocks on CPI components that were identified in past MPRs. **Chart 1-A** shows the idiosyncratic score for four CPI components: other auto expenses, electricity, meat and communications. The chart also shows the cut-off for being considered idiosyncratic, which is one standard deviation above the mean of the 55 scores each quarter.

Auto insurance (other auto expenses) prices: The inflation rate for auto insurance picked up in January 2002, reaching almost 31 per cent by January 2003 and remaining elevated until the beginning of 2004. At the time, this was said to mainly reflect a rise in the value of claims combined with recent low returns on portfolio investments.¹⁶ Other auto expenses, the component that includes auto insurance, is considered idiosyncratic by SMIP from the second quarter of 2002 to the second quarter of 2003. The score for other auto expenses in 2013 falls and remains lower for the rest of the sample. This is due to the rolling window: it stops influencing some of the criteria, such as volatility, 10 years after the 2002 episodes.

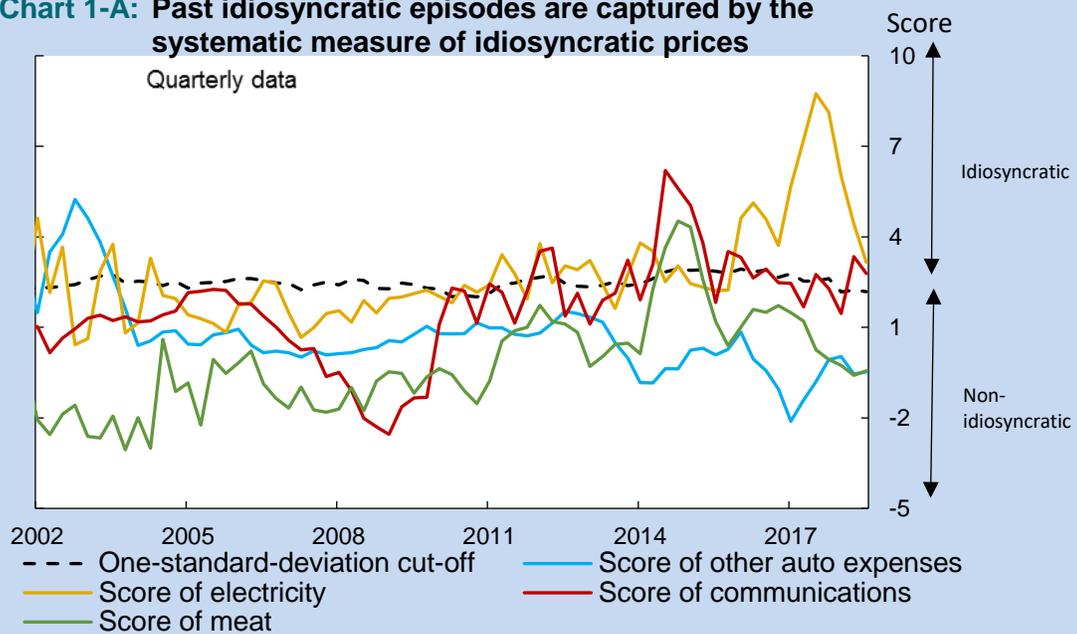
¹⁶ See Box 1 in the October 2002 *Monetary Policy Report*.

Electricity prices: The Ontario government introduced rebates in January 2017, May 2017 and July 2017. Electricity is considered idiosyncratic by SMIP before 2017 (**Chart 1.A**), although its score in 2017 increases, suggesting that it is relatively more idiosyncratic than before.

Meat prices: The inflation rate for meat picked up at the beginning of 2014 and reached a high of almost 14 per cent in January 2015. It was strong until the end of 2015. This was probably a combination of positive effects from past depreciation of the Canadian dollar as well as increases in commodity prices. Meat is slightly delayed in showing up as idiosyncratic, although it is finally captured by SMIP (**Chart 1.A**) in the third quarter of 2014. It remains idiosyncratic until the first quarter of 2015.

Communication prices: A large one-time increase in communication prices occurred in August 2014 due to higher costs for both telephone and Internet services, which kept the year-over-year percentage change of the component elevated for a year. Although communication prices before August 2014 are already considered intermittently idiosyncratic, SMIP seems to capture this episode as the score for communication increases significantly in the third quarter of 2014 and remains above the cut-off for one year (**Chart 1-A**).

Chart 1-A: Past idiosyncratic episodes are captured by the systematic measure of idiosyncratic prices



Source: Bank of Canada calculations

Last observation: 2018Q3

Summary of what is idiosyncratic in the third quarter of 2018

As explained in **Section 1**, deviations of CPI inflation from the 2 per cent target are usually decomposed through three main macroeconomic factors: commodity prices, ERPT and the output gap. The remaining unexplained divergence is called “other factors.” In the October MPR, the net impact of temporary factors was estimated at about 0.7 pps in the third quarter of 2018 (a combination of the effect of commodity price movements, ERPT and the other factors, see **Table 1**). Over recent quarters, the narrative in the MPRs suggested that these temporary factors mostly reflected the fact that elevated gasoline prices, a temporary spike in the inflation rate of intercity transportation prices (in the third quarter) and the effect of increases to the minimum wage were more than offsetting below-average inflation in food purchased from stores prices and past electricity rebates (electricity rebates fell off the year-over-year calculation in the third quarter of 2018).¹⁷

	2017Q3	2017Q4	2018Q1	2018Q2	2018Q3
Deviation of CPI inflation from target	-0.6	-0.2	0.1	0.3	0.7
Temporary factors (commodity prices + ERPT + “other factors”)	-0.5	-0.1	0.1	0.3	0.7
Impact of components captured by SMIP	-0.2	0.2	0.2	0.2	0.6

How does this compare with what is captured by SMIP? **Table 2** shows the CPI components that are considered idiosyncratic in the third quarter of 2018 and their current effect (+ / -) on the deviation of CPI inflation from target. Eight components that make up about 13 per cent of CPI inflation are captured by SMIP in the third quarter of 2018. In the third quarter of 2018, idiosyncratic components put upward pressure on CPI inflation, with a net impact of about 0.6 pps (in deviation from mean). The components captured by SMIP with the largest impact in the quarter are gasoline (+0.4 pps), intercity transportation (+0.2 pps), communications (-0.1 pps) and natural gas (-0.1 pps). Gasoline and intercity transportation are two of the main temporary factors that are in the October MPR narrative.

¹⁷ In the October 2018 MPR, airfares are mentioned as a temporary factor that pushed CPI inflation up in the third quarter of 2018. Intercity transportation is the component that includes airfares.

Table 2: Idiosyncratic components in the third quarter of 2018		
Gasoline (+)	Electricity (+)	Communications (-)
Intercity transportation (+)	Operation of recreational vehicles (+)	Natural gas (-)
Fuel oil and other fuels (+)	Health care services (-)	

(+) means that this component has a positive effect on CPI inflation in the third quarter of 2018 (in deviation from mean), while (-) represents a negative effect.

On net, the impact on CPI inflation of the components captured by SMIP is slightly below what was estimated for the third quarter of 2018 in the October MPR. However, SMIP does not capture two important factors: below-average inflation in food, partly reflecting past heightened competition, and increases to the minimum wage that came into effect at the beginning of 2018 (no food components or components affected by minimum wages can be found in **Table 2**).¹⁸ SMIP considers some other components idiosyncratic, such as communications and natural gas, suggesting that more work should be done to better understand their recent behaviour.

The impact on CPI inflation for the third quarter of 2018 from SMIP is slightly below the MPR assessment, but still reinforces the view that CPI inflation is above target due to temporary factors. **Table 1** shows that this is not the case in 2017 because SMIP suggests a more positive impact from the idiosyncratic components of CPI than what was in the MPR. This could reflect the fact that SMIP does not properly captured below-average inflation in food purchased from stores because most of the food components are not considered idiosyncratic over that period.

3. Conclusion

In this note, we present a new systematic measure of idiosyncratic prices. Every quarter, this measure regroups the components of CPI that are characterized as the most idiosyncratic based on a list of selected criteria. The components captured by SMIP each quarter account for a large amount of the deviation of CPI inflation from the 2 per cent target over our sample period (the fourth quarter of 2001 to the third quarter of 2018).

In the third quarter of 2018, the contribution of components captured by SMIP to the deviation of CPI inflation from target is slightly below what was considered unrelated to

¹⁸ Such components are food purchased from restaurants, child care and housekeeping services and personal care services (see April 2018 MPR). Looking at the evolution of their score, in the first quarter of 2018, their individual scores increases significantly, but not enough to surpass the one-standard-deviation cut-off. In the third quarter of 2018, their scores remain elevated relative to before the increase in the minimum wage (see **Appendix B**).

capacity at time of the October MPR. Nevertheless, the results from SMIP in the third quarter of 2018, in terms of the components and their contribution to the deviation of inflation from target, reinforce the MPR narrative that CPI inflation is currently above target due to temporary factors. Furthermore, this is in line with the view in the October MPR that CPI inflation will return to close to 2 per cent in early 2019 and up to the end of the projection horizon, once prices have fully adjusted to incorporate the effects of temporary factors and the associated upward pressures on inflation have faded. Using SMIP as an alternative way to assess idiosyncratic movements in CPI inflation is valuable because it could highlight components that might not have been considered otherwise.

Some potential avenues to improve this measure are the following: a better isolation of the idiosyncratic part in each CPI component (currently we make a strong assumption that all deviations from mean are idiosyncratic) and an improved mapping between what is captured by SMIP and the other factors in the MPR decomposition (what is not explained by commodity prices, ERPT and the output gap).

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Appendix A: Alternative specifications

We test alternative specifications around the base specification. To evaluate the performance of these alternative specifications, we consider different aspects:

1. Root mean square deviation (RMSD): to evaluate the performance of each alternative specification in explaining the deviation of CPI inflation from target once we account for the estimated effect of the output gap.
2. The simplicity of the method used to evaluate each criterion and to construct the score.
3. The flexibility of SMIP to capture historical changes in the behaviour of a component.
4. Ability of SMIP to capture some past episodes of idiosyncratic shocks.

Our base specification is relatively robust across alternative specifications, although it outperforms the alternatives in terms of RMSD.

A.1 Sensitivity around the criteria specifications

As discussed in the main text, we also test alternative specifications for all criteria. A summary of the testing follows.

Volatility: As an alternative to the standard deviation, we use the coefficient of variation (ratio of the standard deviation to the mean). This is usually used for data sets with different units or widely different means. Because results are relatively similar we kept the standard deviation, which is simpler and in line with what was used to evaluate core inflation measures.

Persistence: We test autocorrelation as an alternative to AR processes. Results are similar and do not mitigate the issue of the rolling-window estimation.

Common movements across CPI components: We select CPI-common among the three measures of core inflation because of its estimation method, which tracks the common price changes across categories in the CPI basket. We construct alternative SMIPs with the correlation with CPI-trim and CPI-median instead of CORR COMM, and results are similar.

Correlation with the output gap: We initially select up to four lags for this criteria for different reasons: to remain consistent with what we find for CPI inflation (relationship is at its peak almost contemporaneously) and because we could assume after one year that an important part of the effect of the output gap should have already started influencing

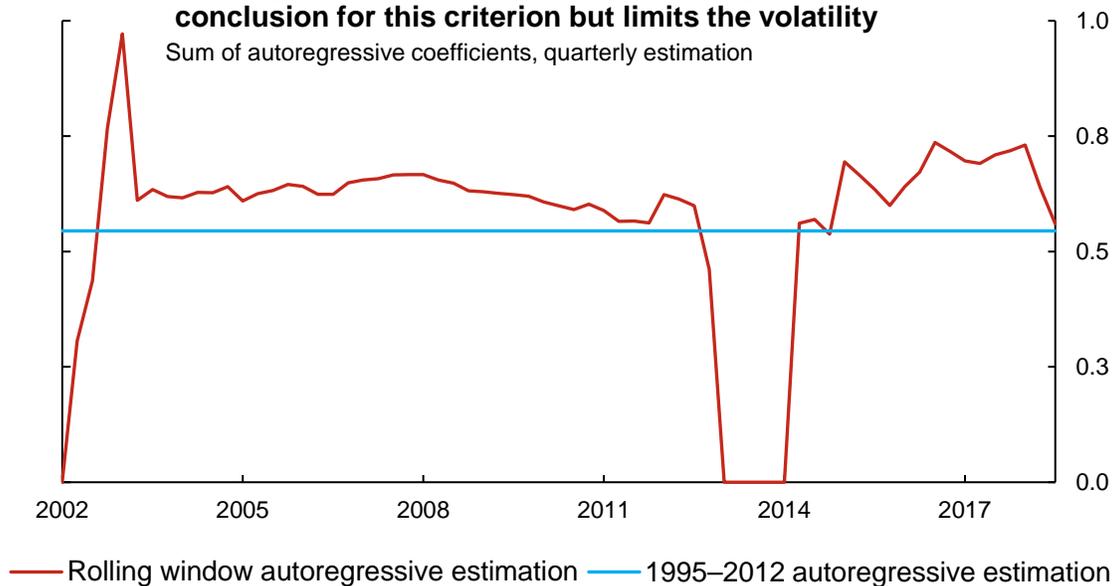
the components. We also test up to eight lags of the output gap and find that there are no significant differences in the results.

Current period: We calculate the DEV criterion using the quarter-over-quarter percentage change of the seasonally adjusted price index. The impact of the components captured by SMIP in that case is similar over our sample to our base case. However, one major difference is that, in general, components are captured by SMIP for a shorter period. We prefer using DEV calculated with the year-over-year percentage change given that the impact of SMIP is ultimately defined using the year-over-year percentage change in CPI.

A.2 Impact of estimating the AR criterion over a fixed period rather than a rolling window

The AR criterion is estimated over 1995–2012¹⁹ and is kept constant throughout all quarters. If the AR is estimated using a rolling window, there is a large amount of volatility in the sum of the coefficients. Some of this volatility comes from the AR criterion interpreting large unidirectional idiosyncratic movements that last for more than one period as persistence. When this happens, the higher AR makes the component

Chart A-1: Using a fixed-window for the other auto expenses autoregressive estimation does not change the general conclusion for this criterion but limits the volatility



Source: Bank of Canada calculations

Last observation: 2018Q3

¹⁹ CPI inflation has an average 2 per cent over this period.

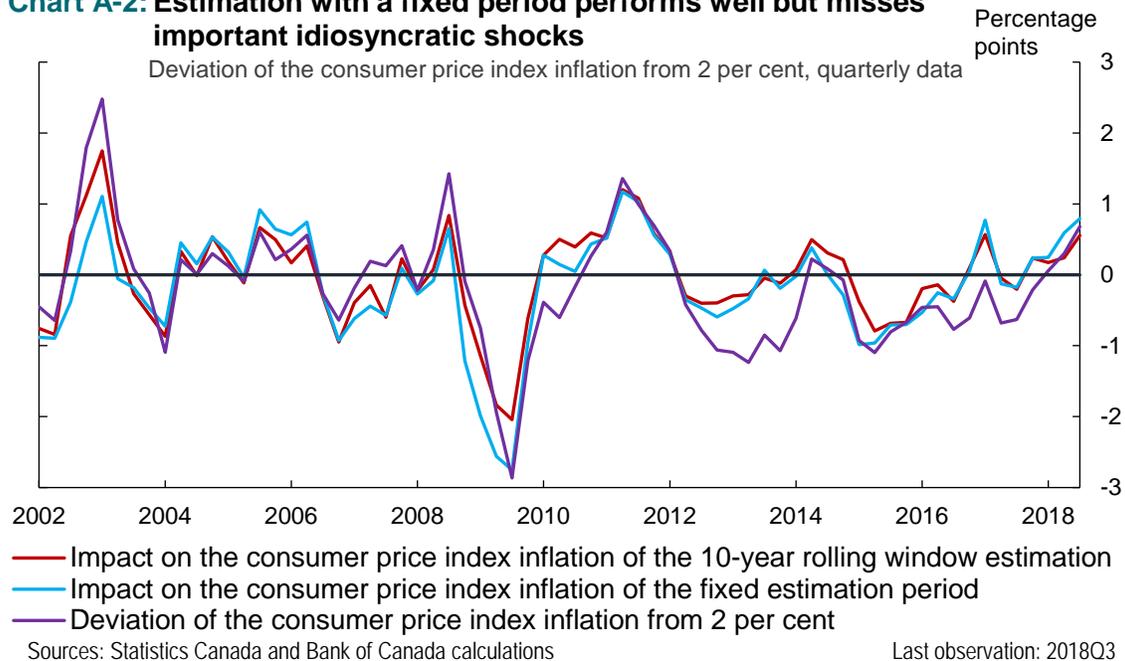
seem less idiosyncratic, the opposite of what we think is probably happening. **Chart A-1** shows the AR criterion for other auto expenses, which includes car insurance. As explained in **Box 1**, there was a dramatic increase in the inflation of this series starting in 2002, when we see the AR criterion jump from 0 to 0.97. We find that the AR estimated over a fixed window is an appropriate solution because it provides very similar results for the overall idiosyncrasy of the component as the rolling window does, while removing these large and unnecessary jumps. Furthermore, we think it is justified to keep this criterion because it is a way to evaluate the historical behaviour of a component, in line with a criterion used to evaluate the core inflation measures, and removing it leads to a worse-performing SMIP in terms of RMSD.

A.3 Constant estimation period

To test the sensitivity of our results to the rolling-window estimation, SMIP is calculated using a constant period over 1992–2014.²⁰ Many of the components considered idiosyncratic by the fixed period are those that appear in most periods in the rolling window (footwear, electricity, purchase of recreational vehicles, gasoline, natural gas, fuel oil, etc.). As a result, the impact of the rolling window and the fixed period on CPI inflation are quite similar. **Chart A-2** shows that without the rolling window, SMIP does not capture important idiosyncratic movements that were identified in the past, mainly the shock to auto insurance inflation in 2002. We find that the rolling window can explain more of the deviation of inflation from 2 per cent (once we control for the effect of the output gap) and believe it is important for the idiosyncratic components to be able to change over time.

²⁰ We chose the periods from 1992 to 2014 to match the analysis done by Khan, Morel and Sabourin (2015).

Chart A-2: Estimation with a fixed period performs well but misses important idiosyncratic shocks



A.4 Testing the sensitivity of the one-standard-deviation cut-off

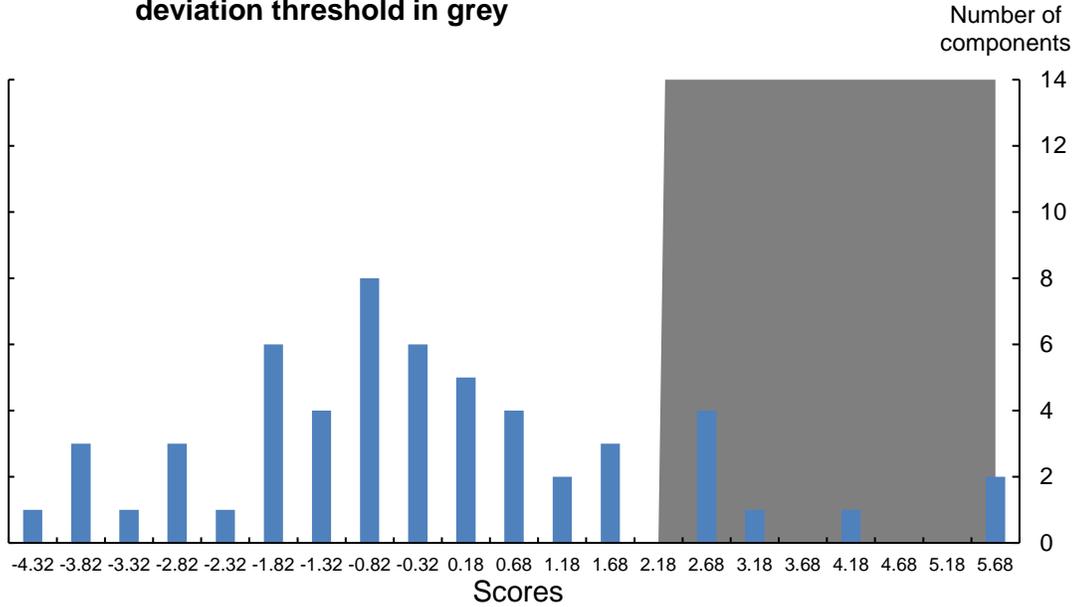
We consider components idiosyncratic when they have a score above one standard deviation of the mean of the 55 scores in a given quarter. **Chart A-3** illustrates this with the distribution of scores in the third quarter of 2018. The standard deviation of the scores in the third quarter of 2018 is 2.18.

We also consider increasing the threshold for idiosyncratic scores from one standard deviation to 1.5 or 2 standard deviations to test the sensitivity of our threshold. **Chart A-4** shows the degree to which each of the three cut-offs affects the consideration of idiosyncratic components that have an impact on CPI inflation. We find that there are significant differences in the impact on CPI inflation from changing the threshold, although the one-standard-deviation cut-off is best able to explain the deviation of CPI inflation from 2 per cent over the sample, once we account for the impact of the output gap. **Chart A-5** shows the number of components captured in each quarter with the different thresholds. While it would be ideal to have a measure that considers no components idiosyncratic in some quarters, the inability of the two-standard-deviation cut-off to capture important idiosyncratic shocks makes it a non-viable option.

Additionally, we test calculating the one-standard-deviation cut-off using the entire sample and a 10-year rolling window of the scores as alternatives to the standard deviation in the current quarter. This method does not significantly affect the cut-off. The

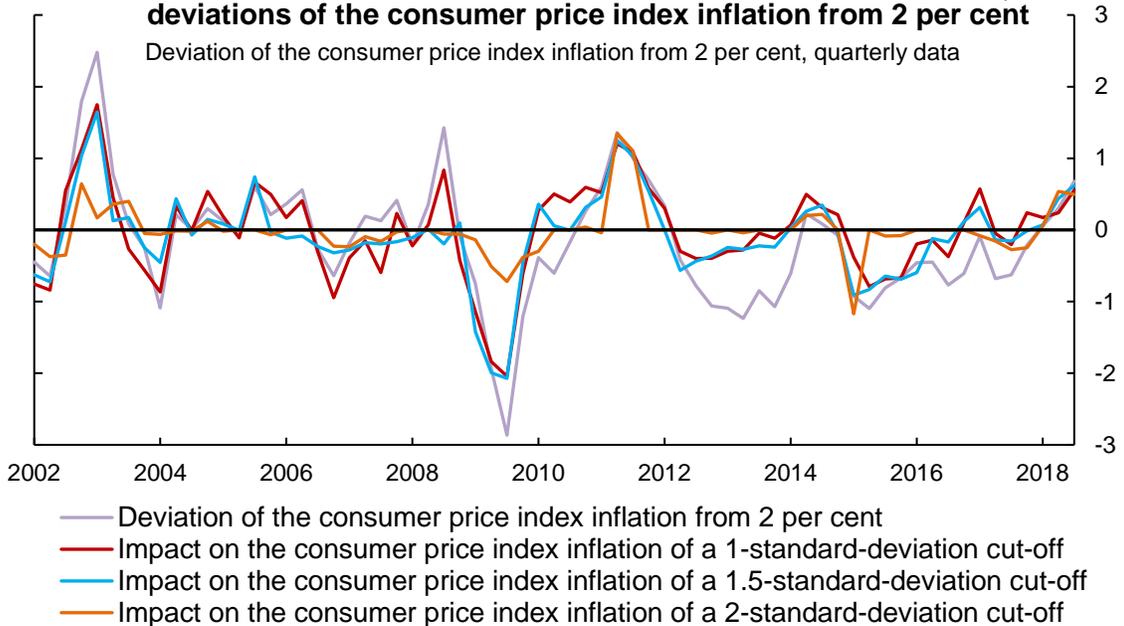
impact on CPI inflation for idiosyncratic components is therefore very similar across cut-offs.

Chart A-3: Distribution of the 55 scores in 2018Q3 and the one-standard-deviation threshold in grey



Note: Each bar represents a 0.5-wide bin, starting with the value that is underneath it on the horizontal axis.
Source: Bank of Canada calculations

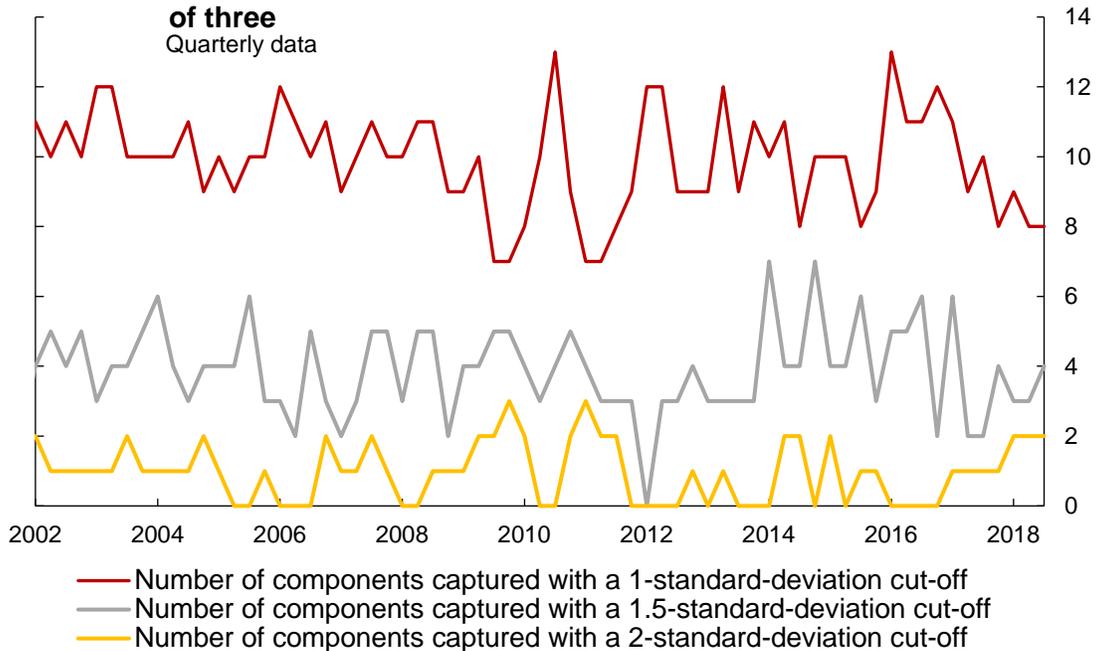
Chart A-4: There are significant differences with the alternative cut-offs, although the one-standard-deviation cut-off best explains the deviations of the consumer price index inflation from 2 per cent



Sources: Statistics Canada and Bank of Canada calculations

Last observation: 2018Q3

Chart A-5: A cut-off of two standard deviations captures zero components in some quarters, but captures a maximum of three Quarterly data



Source: Bank of Canada calculations

Last observation: 2018Q3

A.5 Alternative weights on the criteria

In the base case, the score puts equal weight on each of the five criteria. We choose this method because we believe that each criterion is equally important in evaluating whether a component is idiosyncratic or not. Testing this choice allows us to evaluate the relative importance of each criterion in the overall score.

We calculate alternative SMIPs attributing 50 per cent to one criterion and splitting the remaining 50 per cent equally across the four other criteria. This way, we are evaluating whether one criterion has more valuable information about the deviation of CPI inflation from target (after controlling for the output gap) than the others. Putting half the weight on the volatility is the best performing alternative measure. However, putting half of the weight to the correlation of the output gap is the worst performing alternative in terms of RMSD. However, none performs better than the base case.

Lastly, given that all alternative weight options were leading to relatively worse RMSDs than the base case, this could suggest that each criterion is important and probably contributes relatively the same amount to the performance of our base case.

Appendix B: Additional charts

Chart B-1: The scores for components affected by the rise in the minimum wage in Ontario have increased sharply since the beginning of 2018, although they were not considered idiosyncratic

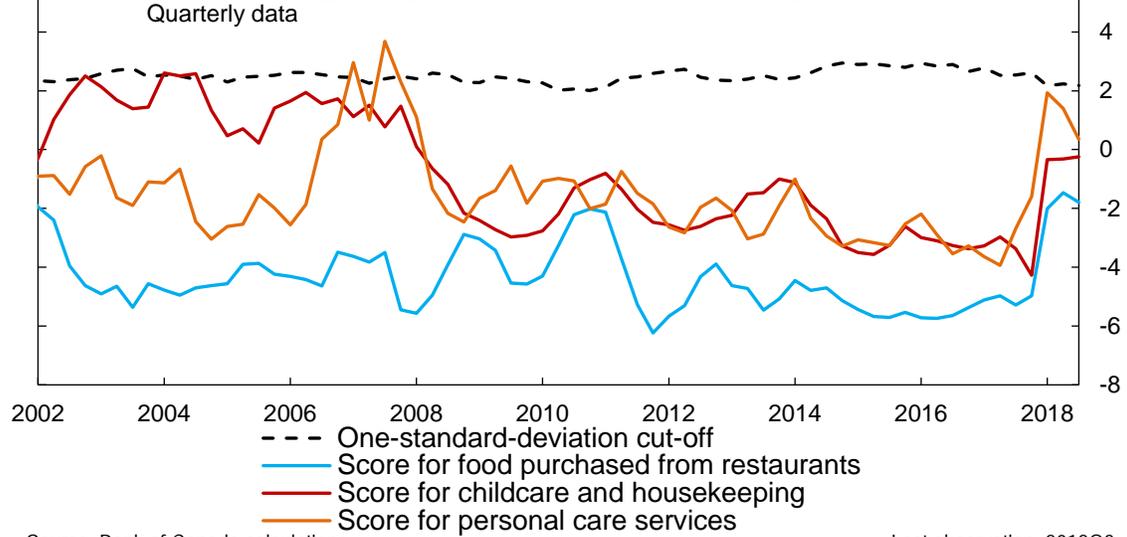


Chart B-2: Natural gas and gasoline are considered idiosyncratic for most of the sample. Natural gas was considered non-idiosyncratic for the first time in 2016Q4

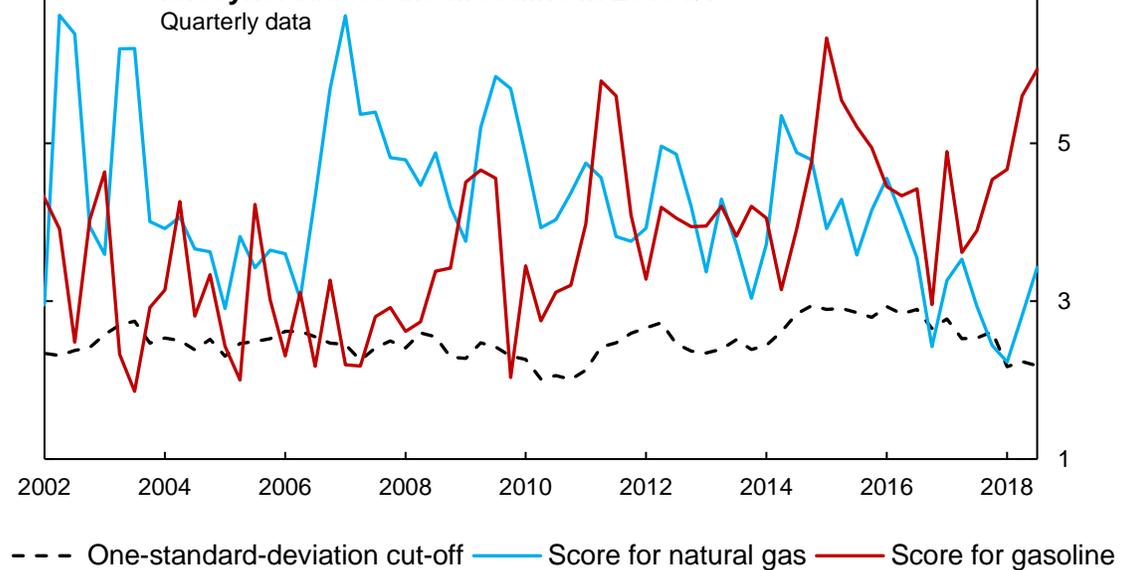
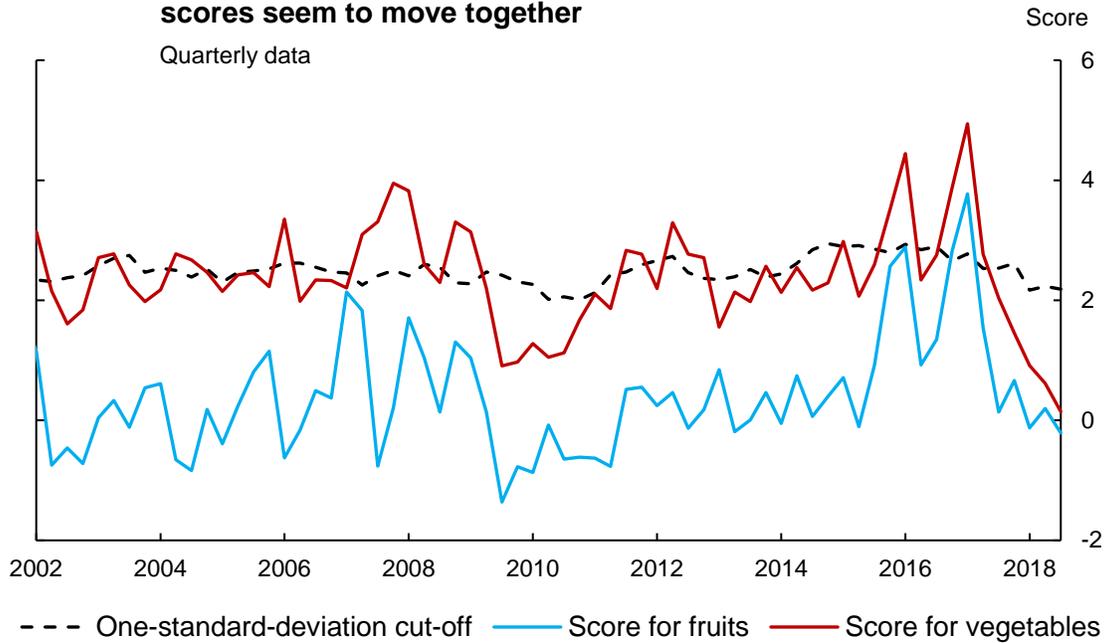


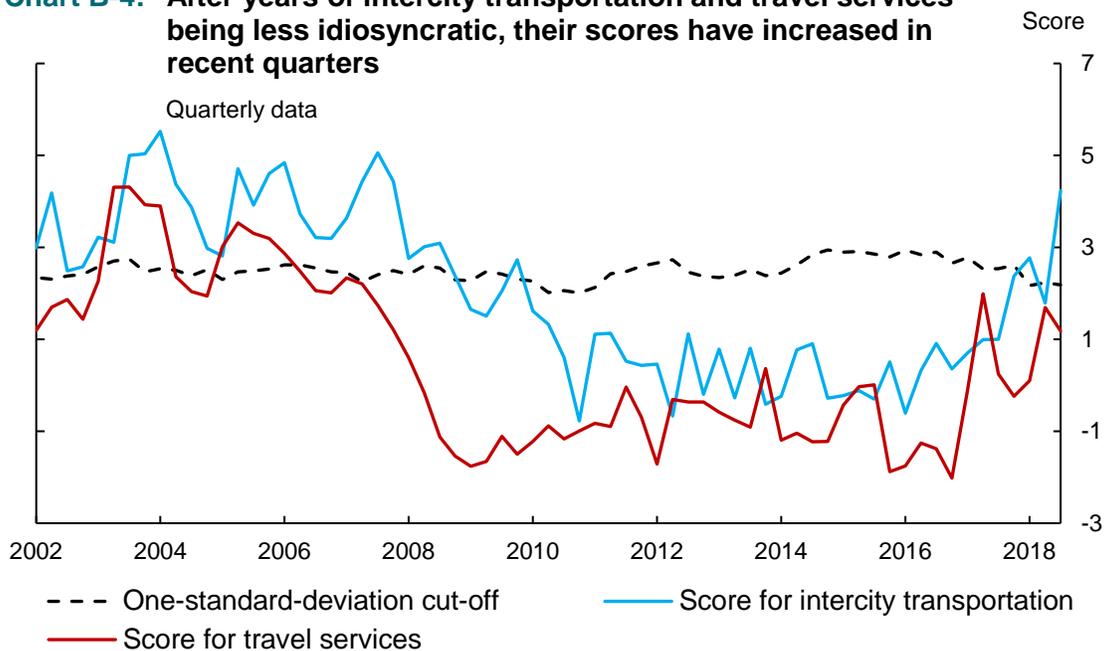
Chart B-3: Fruits are less idiosyncratic than vegetables, although their scores seem to move together



Source: Bank of Canada calculations

Last observation: 2018Q3

Chart B-4: After years of intercity transportation and travel services being less idiosyncratic, their scores have increased in recent quarters



Source: Bank of Canada calculations

Last observation: 2018Q3