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# Indicator Models of Core Inflation for Canada

by

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# The Indicator Models of Core Inflation for Canada

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# Abstract

When there is uncertainty about estimates of the margin of unused capacity in the economy, examining a range of inflation indicators may help in assessing the balance of risks regarding the outlook for inflation. This paper tests a wide range of observable variables for their leading-indicator properties with respect to core inflation, including: commodity prices, cost indicators, measures of capacity pressures in labour and product markets, and components of the consumer price index (CPI) itself. After a preliminary screening of indicators using Granger causality tests, estimated bivariate indicator models generate post-sample static forecasts one quarter ahead and two quarters ahead over the period 1995(Q1)–1999(Q1). A ridge regression technique is used to optimally combine selected bivariate forecasts into multivariate forecasts. The root-mean-squared errors of both the bivariate and multivariate forecasts are compared with those of benchmark models—a Phillips curve, an autoregressive model, and two naive models. The results show that several indicator models generate lower forecast errors than the benchmark models over the post-sample period. Several CPI components, as well as the Bank of Canada commodity price index in U.S. dollars, the industrial product price index for electrical products, the average prices for resale housing in four major cities, and the ratio of unfilled orders to shipments in manufacturing are among the best predictors of core inflation. The paper also briefly discusses the limitations of indicator models, including the possibility that predictions from such models may not tell us much about the underlying pressure of demand on production capacity or the fundamental trend in inflation.



JEL classifications: E31, E37
Bank of Canada classification: Inflation and prices



# Résumé

Quand les estimations de la marge de capacités inutilisées dans l'économie sont entachées d'incertitude, l'examen d'une gamme d'indicateurs de l'inflation peut aider à évaluer les risques de hausse ou de baisse de l'inflation dans l'avenir. L'auteur de l'étude met à l'essai toute une série de variables observables — les prix des produits de base, des indicateurs de coûts, des mesures des pressions s'exerçant sur le marché des produits et le marché du travail et même des composantes de l'indice des prix à la consommation (IPC) — afin d'établir si ces variables sont des indicateurs avancés de l'inflation mesurée par l'indice de référence (l'IPC hors alimentation, énergie et effet des impôts indirects). Après avoir effectué une première sélection parmi ces indicateurs au moyen de tests de causalité à la Granger, l'auteur se sert des modèles indicateurs à deux variables estimés pour produire des prévisions hors échantillon dans un cadre statique aux horizons d'un trimestre et de deux trimestres pour la période allant du premier trimestre de 1995 au premier trimestre de 1999. Il fait appel à la technique de régression ridge pour combiner de façon optimale certaines des prévisions tirées des modèles à deux variables. Les erreurs quadratiques moyennes de toutes ces prévisions sont comparées à celles d'autres modèles servant de référence : un modèle représentant la courbe de Phillips, un modèle autorégressif et deux modèles très élémentaires. D'après les résultats, plusieurs modèles indicateurs sont assortis d'erreurs de prévision inférieures à celles générées par les modèles de référence au delà de la période d'estimation. Plusieurs composantes de l'IPC, de même que l'indice des prix (exprimés en dollars É.-U.) des produits de base établi par la Banque du Canada, la composante de l'indice des prix des produits industriels applicable aux produits électriques, les prix moyens de revente des maisons dans quatre grandes villes et le ratio des commandes en carnet aux expéditions de biens manufacturés figurent parmi les meilleurs indicateurs de l'inflation mesurée par l'indice de référence. L'auteur évoque brièvement les limites des modèles indicateurs, notamment la possibilité que les prévisions tirées de ces modèles nous apprennent peu de choses sur les pressions latentes de la demande sur les capacités de production ou la tendance fondamentale de l'inflation.



JEL: E31, E37: Classification de la banque: Inflation et prix

# Introduction

In monitoring the growth of the consumer price index (CPI), Bank of Canada economists spend a great deal of effort trying to assess the effects of shocks that affect individual price components in order to disentangle the transitory movements in inflation from the fundamental ones. In principle, indicator models, based on the signalling properties of observable variables, could play a role in forecasting inflation in the near term. As well, they could be helpful in evaluating the balance of risks with respect to the inflation forecasts that are based on such unobservable factors as the output gap and inflation expectations.

Past research on non-monetary inflation indicators has focussed on commodity prices, although a few studies have examined how well a wide range of nominal and real variables can predict inflation. The research presented in this paper pursues this same line of inquiry by testing a large variety of observable variables for their leading-indicator properties with respect to inflation. One novel aspect of this research involves systematically searching for indicators among the components of the CPI itself.

The results show that several indicators contain signalling information that might be useful for monitoring purposes. These include several CPI components: the Bank of Canada commodity price index in U.S. dollars, the industrial product price index (IPPI) for electrical products, the average prices for resale housing in four major cities, and the ratio of unfilled orders to shipments in manufacturing. However, the indicator models estimated in this study have severe limitations, and for this reason they should not be used in isolation. Relying on their forecasts would diminish neither the importance of judging the implications of new shocks that affect individual price components nor the need, when forecasting inflation, to rely on models that focus on the evolution of the output gap and other fundamental factors acting on inflation. At this stage, these indicator models must be seen as experimental, particularly the models based on CPI components. Monitoring their forecasting performance over time should improve our understanding of how they work, their strengths and their limitations.

The paper proceeds as follows. The first section summarizes the recent empirical literature on inflation indicators for Canada and the United States. The second section reports on tests and estimation models applied to 80 potential indicators for Canada. The third section compares the post-sample forecast errors of these bivariate models and those of combined forecasts from the best bivariate models to the errors arising from a battery of benchmark models. The fourth section discusses the limitations of indicator models as estimated in this study. The final section draws conclusions.

# 1. Earlier findings on inflation indicators

An inflation indicator is an observable variable that helps predict unobserved current and future inflation. Models of inflation suggest several potential indicators: commodity and asset prices that react faster than consumer prices to market conditions and to changes in inflation expectations; elements of costs such as industry selling price indexes, wages, unit labour costs, and import prices; measures of pressure in product or labour markets, such as capacity utilization rates, the ratio of unfilled orders to shipments, the employment ratio, and the unemployment rate; survey measures of inflation expectations; the money supply and other financial indicators. The bulk of past research on non-monetary indicators has focussed on commodity prices. Several Bank of Canada studies have examined the leading indicator properties of money and credit aggregates.

## 1.1 Commodity prices

Caramazza, Hostland, and Muller (1989) concluded that earlier studies had found that commodity price movements contained leading information about inflation in G-7 countries, but that this information was "empirically quite small," and that the relationship between commodity price movements and inflation tended to be unstable over time. Using lead–lag correlation analysis and Granger causality tests, they showed that movements in the Bank of Canada commodity price index (BCPI) contained leading information about quarterly growth in the Canadian GDP deflator over the 1964–87 period. This information, brought little improvement to autoregressive forecasts of inflation at the one-quarter-ahead horizon, but was more useful at the four-quarter-ahead horizon. There was little evidence for Canada of a loss in the information content of commodity prices in the 1980s relative to the 1970s, as the authors had found for the G-7 countries as a whole.

More recently, Garner (1995) found that the Commodity Research Bureau and Journal of Commerce indexes of commodity prices tended to lead the U.S. CPI inflation cycle, but with erratic fluctuations that could be misleading when trying to forecast turning points in inflation. For the 1983–94 period, neither commodity price index added predictive information to a regression model that contained lagged inflation and a measure of slack. Using vector autoregression (VAR) models, Blomberg and Harris (1995) found that the ability of all the traditional commodity price indexes to predict short-run changes in U.S. core CPI inflation diminished considerably starting in the mid-1980s. The loss was particularly large for those commodity prices that are influenced primarily by input demands (industrial materials). They argued that none of the channels through which commodity prices signal more generalized inflation were operating as well as they had previously: Commodities have become less important as an input to production, some of the inflation signals from commodity prices may be sterilized by offsetting monetary policy, and commodities have become less popular as an inflation hedge. Furlong and Ingenito (1996) also discovered through bivariate VARs that commodity prices (as measured by the Commodity Research Bureau index) have lost considerable predictive power with respect to CPI inflation since the early 1980s. Multivariate VARs incorporating the unemployment gap, the U.S. dollar exchange rate, the federal funds rate, and the spot price of crude oil showed that non-oil commodity prices had a more statistically robust relationship with inflation in the 1983–94 period than in the 1973–83 period, but that the added information content in commodity prices was limited.

## 1.2 Producer prices

One would expect the chain of production and sales to link movements in producer prices to subsequent movements in consumer prices. However, conceptual differences between the two sets of prices weaken their links. The CPI covers the prices of services and reflects the effects of sales taxes; producer prices exclude these elements. Consumer prices reflect import prices but aggregate manufacturer prices incorporate the prices of goods destined to foreign markets. Changes in consumer prices may deviate from changes in producer prices for finished goods because of variations in retail, wholesale, or transportation margins. Within the production chain, productivity improvements, variations in the prices of labour and capital and in the markup of product prices over costs may affect the degree of cost pressures arising from changes in input prices. Thus, how consumer prices respond to various producer prices along the chain of production and sales may vary considerably over time.

Laflèche (1994) added changes in the growth rate of the industrial product price index to the list of regressors in a Phillips curve aiming at explaining changes in core inflation over the 1968(Q4)–88(Q4) period. She found that the IPPI variable had a significant positive sign, particularly if a variable for crude oil price changes, already included in the Phillips curve, was excluded. The long-run elasticity came out at between 0.10 and 0.15.

Davies (1997) compared the time and size of monthly changes in consumer prices for individual goods and for durables, semi-durables, and non-durables as groups with the time and size of monthly changes in comparable manufacturers' prices over the 1982–93 period. For durables in general, about one-quarter of the monthly change in the CPI can be related to the monthly change in the corresponding manufacturing prices with a one-month lag. For semi-durables, about half of the change in the CPI seems to be associated with the change in manufacturing prices, again with a one-month lag. Finally, for non-durables, about one-third of the change in the CPI can be ascribed to the change in manufacturing prices, but with no lag.

For the U.S., Blomberg and Harris (1995) found that the producer price index (PPI) for finished goods was of no help in predicting changes in core CPI inflation over the 1987–94 period. Clark (1995) reached roughly similar conclusions: Adding PPI information to a VAR that already included GDP growth, the Treasury bill rate, and wage growth led to a worsening of core inflation forecasts over the 1986–89 and 1991–94 periods.

## 1.3 Unit labour costs

Recent U.S. studies present mixed results on the leading indicator properties of unit labour costs. Emery and Chang (1996) ran in-sample causality tests that showed that, before 1980, lagged growth rates of unit labour costs in the non-farm business sector had information content for core inflation but not for overall CPI inflation. After 1980, this information vanished. Moreover, error-correction models that included unit labour costs generally fared worse than univariate models in post-sample forecasts of CPI inflation and core inflation over the 1990–94 period.

Lown and Rich (1997), on the other hand, found that, from late 1993 onwards, the inclusion in a traditional price Phillips curve of lagged growth rates of unit labour costs in the non-farm business sector prevented the model from breaking down. The enriched Phillips curve tracked core CPI inflation much more accurately than the traditional one over the 1992–96 period and showed no significant evidence of instability.

## 1.4 Capacity utilization

Using data for 15 OECD countries, de Kock and Nada-Vicens (1996) asked, “Does manufacturing-sector capacity utilization provide a signal about future inflation beyond the information provided by economy-wide measures of inflationary pressure?” Results from VARs including core CPI inflation, an official measure of capacity utilization in manufacturing, and deviations of GDP and the unemployment rate from their respective Hodrick-Prescott trends revealed that capacity pressures provide a signal about future inflation at the 5 per cent level for Canada, the U.S., Japan, and Germany.

Relying on a price Phillips curve that uses lagged industrial capacity utilization as the measure of slack in the economy, Emery and Chang (1997) found evidence that the industrial capacity utilization rate had significant predictive power for changes in U.S. CPI inflation before 1983, but none in the 1983–96 period. They speculated that this loss of power might be due to measurement problems, an increasingly global economy, or the offsetting response of monetary policy.

Stock and Watson (1998), on the other hand, found that the capacity utilization rate in manufacturing outperformed the unemployment rate as a measure of slack in a price Phillips curve for the United States. This finding held uniformly across price series and sample periods. Reliance on capacity utilization rates led to lower out-of-sample forecasts of inflation over both the 1970–83 and 1984–96 periods.

### 1.5 Monetary aggregates

Hostland, Poloz, and Storer (1988) compared the information content of alternative monetary aggregates with respect to real GDP, nominal GDP, and the GDP deflator for Canada over the 1971–85 period. For this purpose, they used single-equation indicator models, which explain output growth or price inflation in terms of their lagged values and movements in monetary aggregates. They found significant leading information in monetary aggregates. In particular, they established that the monetary aggregate M2 was a good contemporaneous and leading indicator of prices.

As part of his extensive study on the leading indicator properties of financial variables with respect to measures of nominal spending, real output, and prices for Canada, Patrice Muller (1990) found that money and credit aggregates, in particular M2, contained useful information for predicting price inflation, including CPI inflation, during the 1980s. For this purpose, he used single-equation indicator models, which explain inflation in terms of its lagged values and movements in financial variables.

Armour et al. (1996) used a vector error-correction model (VECM) developed by Hendry (1995) to forecast CPI inflation in Canada. This VECM focusses on the effects of deviations of the monetary aggregate M1 from its long-run demand on the inflation rate. The model also includes, in addition to lagged endogenous variables, a short-term U.S. interest rate, the Canada–U.S. exchange rate, and a simple measure of the output gap. The authors found that the VECM, in particular the deviations of M1 from its long-run demand, provides significant leading information about inflation.

## 2. Indicator models of core inflation for Canada

This study focusses on core inflation, defined here as the quarterly change at annual rate in the seasonally adjusted CPI excluding food, energy, and the effect of indirect taxes. It considers a range of indicators to forecast core inflation: Bank of Canada commodity price indexes in U.S. dollars (BCPIs); Bank of Canada commodity price indexes in Canadian dollars; resale housing prices in major cities; IPPIs; forward-looking new wage settlements; all wage agreements in force;[1] unit labour costs; the unemployment rate and employment/population ratio; capacity

1. New and outstanding wage settlements represent weighted averages of the mean year-over-year rates of change over the contract life in the base wage rates for all employees covered by new and outstanding major collective bargaining agreements, respectively. New wage settlements, and to a lesser extent wage agreements in force, convey, to some degree, future wage changes rather than past or current changes. The choice of these “wage” variables for this study reflects the lack of reliable alternative time series on underlying wage movements. These agreements pertain to bargaining units involving 500 or more employees and their coverage represents about 20 per cent of non-agricultural paid employment. The same bargaining units in the private sector account for about 10 per cent of private non-agricultural paid employment.

utilization rates; and the ratio of unfilled orders to shipments in manufacturing, both excluding and including the volatile aircraft component. It also tests the signalling effect of more than 40 components[2] of the CPI itself, seasonally adjusted where appropriate. In principle, the relationship between lagged changes in individual CPI components and current inflation could be positive or negative. When inflation is low and stable, one would expect to find more cases of significant negative correlation between past movements in individual CPI components and current core inflation than when inflation is high and non-stationary. The 80 potential indicators appear on the left side of Tables 1A and 1B.

Our model estimation and testing of indicators apply to data starting only in the mid-1980s, for two reasons. Several potentially useful indicators were not measured prior to the early 1980s. Moreover, in the interest of model simplicity and stability, it seems wise not to combine in the same estimation period regimes with different characteristics regarding the presence or lack thereof of a unit root in the inflation process. Work by Ricketts and Rose (1995) and Fillion and Léonard (1997) as well as visual inspection of the data suggest that the 1984–98 period comprises two regimes. Each one is characterized by a different mean level of core inflation and by the fact that core inflation tends to revert to this mean over time—in contrast with the 1974–82 period, when a unit root in inflation was found.

Unit root tests applied to core inflation over the period 1984(Q1)–98(Q1) marginally accept the null hypothesis of a unit root (see Tables 1A and 1B), presumably because these tests cannot discriminate between the manifestations of a unit root and those of a shift in mean inflation.[3] Several CPI, IPPI, and unit labour cost series, expressed in first differences of the log, as well as wage settlements and the measures of pressure in the labour and product markets all appear to have a unit root according to the Augmented Dickey-Fuller test.[4] Again, one must take these results with some reservations, as the movements of several of these price and cost series may exhibit the sort of shift in the mean shown by core inflation. Moreover, the errors that would be generated by models linking core inflation to these presumed non-stationary variables could themselves be I(0) due to cointegration or to the fact that distributed lags on the variables may effectively difference them and therefore make them I(0). Finally, the Phillips-Perron test leads to a universal rejection of the unit root hypothesis, except for wage settlements and the market pressure variables.

2. These include prices at different levels of aggregation: for example, both clothing, one of the 54 components of the CPI, and men's clothing, a subcomponent, are tested. The food and energy components of the CPI are not tested in this study.
3. Perron (1990) showed that integration tests may be biased to statistically support the unit-root hypothesis when applied to series with changing mean.
4. Note that these results apply to the specification that excludes a time trend. Regressing the first difference of core inflation and the other variables on a constant term results in a coefficient that is not significantly different from 0, implying an absence of persistent trends in the variables.

The uncertain results and implications of the unit root tests suggest testing the indicators under three settings. The first one links core inflation ( $\Delta lcpixfet$ ) to the first difference of the presumed I(1) nominal series ( $INDIC_j,\ j = 1\ldots m$ ). The second setting relates core inflation to the second difference of the presumed I(2) nominal series and to the first difference of the I(1) market pressure variables ( $\Delta INDIC_j,\ j = 1\ldots n$ ). The third setting links the first difference of core inflation ( $\Delta^2 lcpixfet$ ) to the first difference of the presumed I(1) nominal series ( $INDIC_j,\ j = 1\ldots m$ ) as well as the second difference of the presumed I(2) nominal series and the first difference of the I(1) market pressure variables ( $\Delta INDIC_j,\ j = 1\ldots n$ ). This study reports the forecasting performance of each indicator under only one setting for each of two horizons: one quarter ahead and two quarters ahead. The selection of a particular setting rests on its post-sample forecasting performance relative to competing settings. In the case of wage settlements and the market pressure variables, the choice is between settings 2 and 3, given that these variables are clearly I(1).[5]

Testing market pressure variables in the context of indicator models necessarily leaves out their unobservable equilibrium values; in so doing it reduces their potency as measures of gaps in the labour or product markets, unless these variables are stationary, which is not the case here. Distributed lags in these variables, whether in level or first difference form, implicitly impose a combination of past values of these variables as the equilibrium level, and therefore imply some hysteresis.

A preliminary screening of the indicators involved running Granger causality tests in each of the three settings to see if the lagged values of a particular indicator provided information useful to explain core inflation beyond that already incorporated in the lagged values of core inflation itself and a time trend. Both the Akaike information criteria and the Schwarz information criteria pointed to a lag length of 3 for the level of core inflation and 2 for its first difference. For the indicators, the lag length ran from 6 to 1 sequentially. An indicator was discarded if the null hypothesis that its coefficients are zero could not be rejected at around the 5 per cent significance level for all lag sequences.

A first set of indicator models aims at forecasting core inflation *one period ahead* with the following specifications:

First setting:

$$\Delta lcpixfet_{j,t} = c_1 \cdot D3 + c_2 \cdot D4 + \sum_{i=1}^{3} \alpha_i \cdot \Delta lcpixfet_{j,t-i} + \sum_{i=1}^{k_j} \beta_{ij} \cdot INDIC_{j,t-i} + \varepsilon_{j,t}$$
$$j = 1\ldots m,$$

5. The possibility that these variables might be cointegrated with core inflation is ignored.

Second setting:

$$\Delta lcpixfet_{j,t} = c_1 \cdot D3 + c_2 \cdot D4 + \sum_{i=1}^{3} \alpha_i \cdot \Delta lcpixfet_{j,t-i} + \sum_{i=1}^{k_j} \beta_{ij} \cdot \Delta INDIC_{j,t-i} +$$

$$j = 1 \ldots n,$$

Third setting:

$$\Delta^2 lcpixfet_{j,t} = c_1 \cdot D3 + c_2 \cdot D4 + \sum_{i=1}^{2} \alpha_i \cdot \Delta^2 lcpixfet_{j,t-i} + \sum_{i=1}^{k_j} \beta_{ij} \cdot INDIC_{j,t-i} + \varepsilon_{j,t}$$
$$j = 1 \ldots m,$$

$$\Delta^2 lcpixfet_{j,t} = c_1 \cdot D3 + c_2 \cdot D4 + \sum_{i=1}^{2} \alpha_i \cdot \Delta^2 lcpixfet_{j,t-i} + \sum_{i=1}^{k_j} \beta_{ij} \cdot \Delta INDIC_{j,t-i} + \varepsilon_{j,t}$$
$$j = 1 \ldots n,$$

with *k* varying between 1 and 6 and *j* referring either to *m* potentially I(0) components or to *n* potentially I(1) components. The dummy variables D3 and D4, taken from Fillion and Léonard, purport to partially capture the shift in mean inflation that occurs during the estimation period. Over the sample period that starts in 1984, D3 and D4 take values of 1 and 0 respectively until mid-1991, and values of 0 and 1 respectively after 1992(Q4). In the transition period between mid-1991 and the end of 1992, D3 diminishes gradually and D4 increases so as to maintain the sum of D3 and D4 equal to 1.

The second set of models aims at forecasting core inflation *two periods ahead* with the following specifications:

First setting:

$$\Delta lcpixfet_{j,t} = c_1 \cdot D3 + c_2 \cdot D4 + \sum_{i=1}^{3} \alpha_i \cdot \Delta lcpixfet_{j,t-i} + \sum_{i=2}^{k_j+1} \beta_{ij} \cdot INDIC_{j,t-i} + \varepsilon_{j,t}$$
$$j = 1 \ldots m,$$

Second setting:

$$\Delta lcpixfet_{j,t} = c_1 \cdot D3 + c_2 \cdot D4 + \sum_{i=1}^{3} \alpha_i \cdot \Delta lcpixfet_{j,t-i} + \sum_{i=2}^{k_j+1} \beta_{ij} \cdot \Delta INDIC_{j,t-i} + \varepsilon_{j,t}$$
$$j = 1 \ldots n,$$

Third setting:

$$\Delta^2 lcpixfet_{j,t} = c_1 \cdot D3 + c_2 \cdot D4 + \sum_{i=1}^{2} \alpha_i \cdot \Delta^2 lcpixfet_{j,t-i} + \sum_{i=2}^{k_j+1} \beta_{ij} \cdot INDIC_{j,t-i} + \varepsilon_{j,t}$$
$$j = 1 \ldots m,$$
$$\Delta^2 lcpixfet_{j,t} = c_1 \cdot D3 + c_2 \cdot D4 + \sum_{i=1}^{2} \alpha_i \cdot \Delta^2 lcpixfet_{j,t-i} + \sum_{i=2}^{k_j+1} \beta_{ij} \cdot \Delta INDIC_{j,t-i} + \varepsilon_{j,t}$$
$$j = 1 \ldots n.$$

To forecast current core inflation, each of the latter models relies on actual values lagged two quarters or more and *on the forecast of the dependent variable for the last quarter* that was generated by the corresponding one-quarter-ahead forecasting model. In the first setting, for instance, the forecast picks up $\hat{\alpha}_1 \cdot \Delta lcpixfet^F_{t-1}$ instead of $\hat{\alpha}_1 \cdot \Delta lcpixfet_{t-1}$. This procedure ensures that no more information is used than is available in a monitoring context.

Estimation of the forecasting models ranges from around mid-1984 to 1994(Q4). Post-sample static simulations are run from 1995(Q1) to 1999(Q1) with root-mean-squared errors (RMSEs) calculated for various sub-periods. Five forecasts provide benchmarks for comparison purposes. The first one is a "naive" forecast of no change in core inflation: the RMSE of such a forecast is the classical denominator of Theil's *U* statistic. The second one is also a naive forecast, but of no deviation of current core inflation from lagged CPIX, which is a statistical measure of trend inflation calculated by the Bank of Canada. This measure excludes the eight most volatile components of the CPI over history and the effect of changes in indirect taxes[6] on the remaining components. The third benchmark is a forecast from an autoregressive model of core inflation:

$$\Delta lcpixfet_t = c_1 \cdot D3 + c_2 \cdot D4 + \sum_{i=1}^{3} \alpha_i \cdot \Delta lcpixfet_{t-i} + \varepsilon_t$$

The fourth and fifth forecasts are drawn from the Fillion-Léonard (1997) Phillips curve model of core inflation. This model allows for changes in inflation regime over time, based on empirical results obtained from a Markov regime-switching model of core inflation. In a first setting, the Fillion-Léonard model is estimated only once, over the 1968(Q1)–94(Q4) period, and rolling, quarter-by-quarter dynamic simulations over a horizon of two quarters generate static one-quarter-ahead forecasts and dynamic two-quarter-ahead forecasts over the 1995(Q1)–99(Q1) period. In a second setting, each quarter adds one observation to the estimation period that begins with 1968(Q1)–94(Q3), so that not only new data but also new estimators contribute to new one-quarter- and two-quarter-ahead forecasts every quarter over the period 1995(Q1)–99(Q1).

## 3. Predictive performance of indicator models

For each indicator, Tables 1A and 1B compile the best one-quarter-ahead and two-quarter-ahead forecasts out of the competing settings, based on their post-sample root-mean-squared errors. Testing indicator models of inflation for the United States, Cecchetti (1995. 12) found that "whether a model fits well in-sample tells us virtually nothing about its out-of-sample forecasting ability;" hence the focus in this study on post-sample results, and this over a sufficiently long period of time to judge consistency. Two columns identify the setting for each selected model. The selection of models for two-quarter-ahead forecasts being independent of the selection for one-quarter-ahead forecasts, it turns out that in the case of a few indicators the pair of selected models

6. For more details on the construction and properties of CPIX, see Laflèche (1997) and Johnson (1999).

belong in different settings. In general, however, the best forecasting models for each horizon are to be found in the first setting.

## 3.1 Bivariate forecasts

For each horizon, the RMSEs appear for five periods: 1995(Q1)–99(Q1); 1995(Q1)–99(Q1)*, which excludes the outliers 1997(Q3), 1997(Q4), and 1999(Q1); 1995(Q1)–97(Q1); 1997(Q2)–99(Q1); and 1997(Q2)–99(Q1)*, which again excludes 1997(Q3), 1997(Q4); and 1999(Q1).[7]

A few general remarks on the predictive performance of the models are in order. The RMSEs tend to be lower at the one-quarter-ahead horizon than at the two-quarter-ahead horizon, but only to a modest extent. They also tend to be lower for the 1995(Q1)–97(Q1) period than for the 1997(Q2)–99(Q1) period, but only because the latter includes the outlier observations. Indeed, most of the models perform best at both horizons over the 1997(Q2)–99(Q1)* period, well beyond the end of the estimation period. Finally, several indicator models outperform the autoregressive model, the two versions of the Fillion-Léonard Phillips curve and the naive models, at both horizons and in virtually each sub-period. Note that among these benchmark models, the autoregressive model performs best at both horizons. It allows for richer dynamics than the naive models and, in regimes of mean-stationary core inflation, these dynamics appear to be more robust than those of the Fillion-Léonard Phillips curve.

Some of the best-performing indicators include the Bank of Canada commodity price index in U.S. dollars, the IPPI for electrical products, the average resale housing prices in four major cities, and the ratio of unfilled orders to shipments in manufacturing. The labour market and capacity utilization variables perform rather well in one-quarter-ahead forecasts if one excludes the outlier observations. At the two-quarter-ahead horizon, however, they lead to a considerable over-prediction of inflation in the 1997(Q2)–99(Q1) period.

Several CPI components appear to contain useful information for predicting core inflation one or two quarters ahead. Clothing, health care, personal care supplies, homeowners' maintenance, and repair and purchase of recreational vehicles are among the best predictors. The last one, with a positive sign, seems to anticipate the next movements of core inflation; the first four seem to work by signalling coming reversals in the direction of core inflation, since they have negative signs at both horizons. Somewhat surprisingly, the "regulated" CPI,[8] also with a negative sign at both horizons, turns out to be among the best indicators, particularly at the two-quarter-ahead horizon.

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7. The profile of core inflation can be seen in Table 3.
8. The "regulated" CPI comprises components whose prices are imposed by governments or subject to governmental review or regulation: for example, tuition fees, electricity, property taxes, cablevision, and alcoholic beverages. The regulated CPI represents more than 20 per cent of total CPI.

One may wonder whether part of the forecasting ability of the CPI components stems from their ability to forecast themselves, since by construction they are part of the core prices. This is highly dubious, because the forecasting ability of the CPI components is not related to their weight in core prices. Men's clothing, for instance, predicts just as well as total clothing, and personal care supplies, a very small component, is one of the best predictors.

## 3.2 Multivariate forecasts

Relying on a single indicator to monitor core inflation, however good and stable its predictive performance, entails risks of large errors from time to time as a result of idiosyncratic shocks to this indicator. Combining several bivariate forecasts that reflect a portfolio of idiosyncratic shocks may help to reduce these risks. The mean or the median of a set of bivariate forecasts provides such a combination procedure. Alternatively, the weight of each bivariate forecast ($\omega_i$) can be determined by regression:

$$\pi_t = \sum_{i=1}^{n} \omega_i f_{it} + \varepsilon_t ,$$

where $f_{it}$ refers to the forecast of inflation at time *t* ($\pi_t$) by indicator model *i*. Stock and Watson (1998) reckon that OLS estimation of this equation generally produces poor results as *n* grows. They propose instead to obtain the weights from a modified ridge regression[9] estimator of the vector $\omega = (\omega_1 \ldots \omega_n)'$, which they write as:

$$\hat{\omega}_{rr} = \left( cI_n + \sum_{s=1}^{t} F_s F_s' \right)^{-1} \left( \sum_{s=1}^{t} F_s \pi_s + c/n \right)$$

where $F_s = (f_{1,s} \ldots f_{n,s})'$ and $c = k \cdot TR\left( n^{-1} \sum_{s=1}^{t} F_s F_s' \right)$.

The parameter *k* determines the degree to which the weights differ from each other. With $k = 10$, they are almost identical so that the combination procedure effectively yields an unweighted average. As *k* falls, the variance of the weights increases and may reach a point at which one or more of the weights start turning negative. For a given *k*, the probability that this occurs increases with *n*. For $n = 10$ and with the current data set, this threshold level emerges

9. In a more general context, the ridge regression method offers a purely statistical solution to the multicolinearity problem. The solution it proposes to the problem of a $X'X$ matrix that is almost singular when multicolinearity is serious is to multiply each diagonal element by $(1 + d)$, where *d* is small (Maddala 1977). The ridge estimator is biased but has a smaller mean-squared error than do ordinary least squares. These considerations do not matter for the problem at hand.

with *k* slightly below 0.2. Thus, the selection of a particular value of *k* between 10 and 0.2 implies more or less the choice of a particular point along the line of trade-off between risk reduction ($k = 10$) and forecasting accuracy ($k = 0.2$).

Table 2 presents the RMSEs from 10 of the best models and from their combined forecasts. The selected models span a fairly wide range of different indicators. Their combined forecasts deliver less variance in errors than the individual forecasts and, in most cases, a lower level of errors. To illustrate, Table 2 shows the weights for $k = 0.5$.

The indicator models estimated in this study have significant inertia, which reduces the degree to which idiosyncratic shocks to a given indicator translate into large forecasting errors from it. Partly for this reason, the variance of the forecasting errors across the best models is relatively small. As a result, the tracking performance of the combined forecasts that appear in Table 2 shows little sensitivity to variations in the value of *k*.

### 3.3 Patterns of prediction

Table 3 shows the actual forecasts of core inflation generated by the previously selected models over two periods of large variations in the inflation rate: 1995(Q1)–95(Q4) and 1997(Q1)–99(Q1). These models perform consistently over time because they anticipate the evolving trend in core inflation, not its sharp gyrations from quarter to quarter. Predicted values indeed show much less variance than actual values. Some models do predict core inflation rather well during specific episodes: clothing (one quarter ahead) and the BCPI (both one and two quarters ahead), during the 1997(Q1)–99(Q1) period; and regulated CPI (two quarters ahead) during the 1995(Q1)–95(Q4) period. Health care (one quarter ahead) anticipates well the drop in core inflation from 1995(Q3) to 1995(Q4). In general, however, the indicator models might be useful not so much to help analysts to avoid surprises as to signal the path of future underlying inflation.

## 4. Limitations of the indicator models

Indicator models as estimated in this study raise several issues. First, they have no clear underlying structure in general. Thus, one cannot easily relate their forecasts or their forecast errors to the factors that underpin our vision of the inflation process and, in particular, to the underlying pressure of the demand on production capacity for the economy as a whole. In these circumstances, it is difficult to have confidence in the predictions of these models, however reliable they may have been in the past. If an indicator's forecasting potency arises from the fact that it captures changes in inflation expectations or statistical regularities in the pattern of shocks affecting price components, then predictions from such an indicator may not convey much information about the underlying pressure of demand on production capacity or the fundamental trend in inflation.[10] Moreover, the forecasting performance of indicator models may change quickly, as Table 2 suggests. For instance, regulated CPI predicts core inflation extremely well two quarters ahead all through 1995. However, its forecast errors almost double over the 1997(Q2)–99(Q1) period. Clearly, the use of indicator models would not diminish the importance for monitoring purposes of judging the effects of new shocks that affect individual price components in order to disentangle transitory from fundamental movements in inflation.

Second, the short horizon of the indicator models, one or two quarters ahead, provides little lead time to anticipate a change in inflationary pressures. The potential usefulness of such models rather lies in helping to monitor the balance of risks with respect to current longer-range inflation forecasts, which would reflect the expected evolution of the output gap and other fundamental factors acting on inflation.

Third, although some models anticipate rather well significant changes in core inflation during specific episodes, they generally fail to predict abrupt changes that might arise if excess demand were to trigger a non-linear response of inflation. For example, they may under-predict the acceleration of inflation. On the other hand, the inertia shown by some models based on CPI components risks signalling unwarranted persistence of recent shocks to core inflation when such shocks are transitory. The very recent experience of core inflation illustrates this problem. Core inflation dropped much below trend in 1999(Q1) and rebounded well above trend in 1999(Q2). Indicator models based on CPI components fail to anticipate the drop in 99(Q1) and, in general, predict lower core inflation in 1999(Q2) than in 1999(Q1) because past core inflation influences their forecasts. Over the two quarters 1999(Q1)–99(Q2), these forecasts in many instances average out to values fairly close to the mean of core inflation.

## 5. Conclusions

Testing an extensive range of indicator models for their post-sample predictive accuracy regarding core inflation one and two periods ahead suggests that several indicators contain signalling information that might be useful for monitoring purposes. These include several CPI components, the Bank of Canada commodity price index in U.S. dollars, the industrial product price index for electrical products, the average resale housing prices in four major cities, and the ratio of unfilled orders to shipments in manufacturing. Many of these indicator models outperform a battery of benchmark models over both the one-quarter and the two-quarter horizons and across various post-sample sub-periods. Moreover, combining bivariate forecasts from a wide range of indicators tends to reduce the level and the variance of the errors.

10. Sill (1999) argues that if an indicator is driven by market expectations of inflation, it may respond not only to changes in underlying causes of inflation, such as the output gap, but also to factors unrelated to future inflation, and therefore not be a reliable guide to monetary policy.

Indicator models as estimated in this study have severe limitations, however, and for this reason they should not be used in isolation. Reliance on their forecasts would not diminish the importance of judging the implications of new shocks that affect individual price components, nor the need to use models that focus on the evolution of the output gap and other fundamental factors, for forecasting inflation. At this stage they must be seen as experimental, particularly the models based on CPI components. Monitoring their performance over time will, I hope, improve our understanding of how they work, and their strengths and limitations.

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# Table 1A

| Model | Unit Root Tests on variables p-value | | Post-Sample Static Forecast Errors: Core Inflation — Root-Mean-Squared Errors — One Quarter Ahead | | | | | | Two Quarters Ahead | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ADF | PP | Setting | 95q1-99q1 | 95q1-99q1* | 95q1-97q1 | 97q2-99q1 | 97q2-99q1* | Setting | 95q1-99q1 | 95q1-99q1* | 95q1-97q1 | 97q2-99q1 | 97q2-99q1* |
| **Fillion-Leonard model** | | | | 0.79 | 0.65 | 68 | 0.9 | 0.6 | | 0.88 | 0.73 | 0.77 | 1 | 0.65 |
| **Fillion-Leonard model - rolling regressions** | | | | 0.78 | 0.67 | 0.72 | 0.85 | 0.56 | | 0.92 | 0.79 | 0.87 | 0.97 | 0.61 |
| **Core inflation - autoregressive formulation** | 0.1306 | 0.1139 | 1 | 0.59 | 0.49 | 0.54 | 0.64 | 0.38 | 1 | 0.63 | 0.53 | 0.6 | 0.65 | 0.36 |
| **Naive forecast -based on core inflation** | | | | 0.63 | 0.53 | 0.56 | 0.7 | 0.47 | | 0.78 | 0.69 | 0.8 | 0.75 | 0.42 |
| **Naive forecast - based on CPIX** | | | | 0.77 | 0.53 | 0.6 | 0.92 | 0.37 | | 0.92 | 0.77 | 0.93 | 0.92 | 0.28 |
| **Indicator models based on:** | | | | | | | | | | | | | | |
| **CPI components**** | | | | | | | | | | | | | | |
| Non-alcoholic beverages | 0 | 0.002 | 1 | 0.68 | 0.54 | 0.66 | 0.71 | 0.19 | 1 | 0.6 | 0.53 | 0.62 | 0.59 | 0.31 |
| Food purchased from restaurant | 0 | 0.001 | 1 | 0.58 | 0.48 | 0.56 | 0.61 | 0.32 | 1 | 0.62 | 0.49 | 0.56 | 0.68 | 0.33 |
| Homeowners maintenance and repair | 0 | 0.001 | 1 | 0.54 | 0.55 | 0.53 | 0.54 | 0.59 | 1 | 0.56 | 0.57 | 0.36 | 0.72 | 0.82 |
| Communications | 0.1365 | 0 | 1 | 1 | 0.9 | 0.78 | 1.21 | 1.09 | 1 | 0.7 | 0.6 | 0.68 | 0.73 | 0.44 |
| Telephone services | 0.0424 | 0 | 1 | 0.97 | 0.88 | 0.77 | 1.16 | 1.05 | 1 | 0.69 | 0.6 | 0.68 | 0.7 | 0.42 |
| Postal and other communication services | 0.1555 | 0.001 | | | | | | | | | | | | |
| Household chemical products | 0.2411 | 0 | 2 | 0.64 | 0.47 | 0.48 | 0.78 | 0.45 | 1 | 0.63 | 0.52 | 0.58 | 0.68 | 0.39 |
| Paper, plastic, foil suplies | 0.0014 | 0.027 | 1 | | | | | | 1 | | | | | |
| Furniture and household textiles | 0.345 | 0 | 1 | 0.64 | 0.56 | 0.65 | 0.63 | 0.35 | 1 | 0.71 | 0.58 | 0.66 | 0.76 | 0.42 |
| Furniture | 0.4565 | 0 | | | | | | | | | | | | |
| Household equipment | 0 | 0.006 | 1 | 0.66 | 0.53 | 0.6 | 0.72 | 0.35 | 1 | 0.71 | 0.56 | 0.42 | 0.94 | 0.76 |
| Household appliances | 0.4803 | 0.001 | 2 | 0.67 | 0.48 | 0.48 | 0.83 | 0.49 | 1 | 0.64 | 0.55 | 0.56 | 0.73 | 0.52 |
| Services related to household furnishings | 0.0193 | 0.001 | 1 | 0.67 | 0.62 | 0.65 | 0.69 | 0.56 | 1 | 0.7 | 0.66 | 0.7 | 0.7 | 0.59 |
| Clothing | 0 | 0.001 | 1 | 0.47 | 0.42 | 0.49 | 0.45 | 0.24 | 1 | 0.61 | 0.5 | 0.54 | 0.68 | 0.41 |
| Women's clothing | 0.0015 | 0 | | | | | | | | | | | | |
| Men's clothing | 0.2875 | 0.003 | 1 | 0.45 | 0.42 | 0.48 | 0.42 | 0.3 | 1 | 0.61 | 0.46 | 0.49 | 0.72 | 0.39 |
| Children's clothing | 0.0022 | 0.001 | 1 | 0.46 | 0.38 | 0.41 | 0.5 | 0.31 | 1 | 0.64 | 0.53 | 0.6 | 0.68 | 0.38 |
| Footwear | 0.0017 | 0 | 1 | 0.68 | 0.53 | 0.61 | 0.75 | 0.34 | 3 | 0.68 | 0.58 | 0.64 | 0.71 | 0.44 |
| Drycleaning services | 0.0805 | 0 | 1 | 0.67 | 0.57 | 0.66 | 0.69 | 0.33 | 1 | 0.69 | 0.51 | 0.55 | 0.82 | 0.42 |
| Laundry services | 0.0098 | 0.012 | 1 | 0.68 | 0.64 | 0.63 | 0.74 | 0.65 | 1 | 0.7 | 0.68 | 0.71 | 0.68 | 0.62 |
| Local and commuter transportation | 0.0642 | 0.002 | 1 | 0.71 | 0.54 | 0.55 | 0.86 | 0.51 | 3 | 0.62 | 0.51 | 0.59 | 0.64 | 0.33 |
| Air Transportation | 0 | 0.001 | 1 | 0.64 | 0.61 | 0.73 | 0.53 | 0.32 | 1 | 0.68 | 0.67 | 0.8 | 0.51 | 0.31 |
| Inter-city transportation | 0 | 0.001 | 1 | 0.62 | 0.58 | 0.7 | 0.51 | 0.29 | 3 | 0.62 | 0.58 | 0.67 | 0.56 | 0.38 |
| Health care | 0.2592 | 0.045 | 1 | 0.51 | 0.44 | 0.5 | 0.52 | 0.3 | 1 | 0.62 | 0.52 | 0.55 | 0.69 | 0.45 |
| Medicinal and pharmaceutical products | 0.4261 | 0.028 | 1 | 0.6 | 0.54 | 0.6 | 0.59 | 0.39 | 1 | 0.67 | 0.63 | 0.74 | 0.57 | 0.36 |
| Dental care | 0.4623 | 0.001 | 2 | 0.64 | 0.47 | 0.48 | 0.78 | 0.45 | 3 | 0.78 | 0.61 | 0.71 | 0.84 | 0.36 |
| Personal care supplies | 0 | 0.001 | 1 | 0.53 | 0.43 | 0.45 | 0.6 | 0.4 | 1 | 0.54 | 0.43 | 0.47 | 0.61 | 0.36 |
| Personal care services | 0 | 0.001 | 1 | 0.62 | 0.49 | 0.57 | 0.67 | 0.26 | 1 | 0.74 | 0.57 | 0.64 | 0.83 | 0.39 |
| Cosmetics and toilet preparations | 0 | 0.001 | 1 | 0.53 | 0.44 | 0.44 | 0.61 | 0.44 | 1 | 0.74 | 0.57 | 0.64 | 0.83 | 0.39 |
| Traveller accommodation | 0.3328 | 0.001 | 2 | 1.03 | 0.92 | 0.92 | 1.15 | 0.92 | 3 | 1.45 | 1.16 | 1.17 | 1.7 | 1.13 |
| Home entertainment equipment and services | 0.0177 | 0.001 | 1 | 0.62 | 0.48 | 0.46 | 0.75 | 0.52 | 1 | 0.63 | 0.52 | 0.46 | 0.77 | 0.61 |
| Purchase of recreational vehicles | 0.0558 | 0.001 | 1 | 0.47 | 0.42 | 0.48 | 0.47 | 0.28 | 1 | 0.61 | 0.32 | 0.35 | 0.8 | 0.26 |
| Recreational equipment and services | 0.0382 | 0.002 | 1 | 0.75 | 0.79 | 0.85 | 0.63 | 0.68 | 1 | 0.67 | 0.72 | 0.81 | 0.46 | 0.52 |
| Travel tours | 0 | 0.001 | 1 | 0.72 | 0.71 | 0.69 | 0.76 | 0.75 | 1 | 0.63 | 0.58 | 0.67 | 0.59 | 0.36 |
| Cablevision and pay TV | 0 | 0 | 1 | 1.05 | 0.87 | 0.93 | 1.16 | 0.75 | 1 | 0.94 | 0.69 | 0.78 | 1.1 | 0.49 |
| Reading material and other print matter | 0 | 0.002 | 3 | 0.7 | 0.62 | 0.69 | 0.7 | 0.45 | 3 | 0.65 | 0.52 | 0.55 | 0.74 | 0.47 |
| Served alcoholic beverages | 0 | 0.001 | 1 | 0.67 | 0.44 | 0.46 | 0.85 | 0.39 | 1 | 0.66 | 0.42 | 0.46 | 0.83 | 0.33 |
| Alcoholic beverage purchased from stores | 0.2656 | 0.005 | 2 | 0.69 | 0.5 | 0.48 | 0.87 | 0.52 | | | | | | |
| Regulated CPI | 0.1294 | 0.011 | 1 | 0.56 | 0.48 | 0.5 | 0.62 | 0.45 | 1 | 0.53 | 0.37 | 0.35 | 0.68 | 0.41 |
| Purchase and leasing of cars and trucks | 0 | 0.002 | 3 | 0.64 | 0.57 | 0.62 | 0.66 | 0.45 | 3 | 0.66 | 0.54 | 0.59 | 0.73 | 0.43 |
| Rental of automotive vehicles | 0 | 0.002 | 1 | 0.59 | 0.5 | 0.54 | 0.64 | 0.41 | 1 | 0.63 | 0.56 | 0.64 | 0.63 | 0.39 |

****Expressed in first difference of the log**

# Table 1B

| Model | Unit Root Tests on variables p-value | | Post-Sample Static Forecast Errors: Core Inflation Root-Mean-Squared Errors | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | One Quarter Ahead | | | | | | Two Quarters Ahead | | | | | |
| | ADF | PP | Setting | 95q1-99q1 | 95q1-99q1* | 95q1-97q1 | 97q2-99q1 | 97q2-99q1* | Setting | 95q1-99q1 | 95q1-99q1* | 95q1-97q1 | 97q2-99q1 | 97q2-99q1* |
| **Fillion-Leonard model** | | | | 0.79 | 0.65 | 68 | 0.9 | 0.6 | | 0.88 | 0.73 | 0.77 | 1 | 0.65 |
| **Fillion-Leonard model - rolling regressions** | | | | 0.78 | 0.67 | 0.72 | 0.85 | 0.56 | | 0.92 | 0.79 | 0.87 | 0.97 | 0.61 |
| **Core inflation - autoregressive formulation** | 0.1306 | 0.1139 | 1 | 0.59 | 0.49 | 0.54 | 0.64 | 0.38 | 1 | 0.63 | 0.53 | 0.6 | 0.65 | 0.36 |
| **Naive forecast -based on core inflation** | | | | 0.63 | 0.53 | 0.56 | 0.7 | 0.47 | | 0.78 | 0.69 | 0.8 | 0.75 | 0.42 |
| **Naive forecast - based on CPIX** | | | | 0.77 | 0.53 | 0.6 | 0.92 | 0.37 | | 0.92 | 0.77 | 0.93 | 0.92 | 0.28 |
| **Indicator models based on:** | | | | | | | | | | | | | | |
| **BCPI total - US dollars**** | 0 | 0.001 | 1 | 0.47 | 0.43 | 0.49 | 0.44 | 0.3 | 1 | 0.52 | 0.49 | 0.59 | 0.42 | 0.22 |
| Non-energy | 0.1117 | 0.001 | 1 | 0.57 | 0.57 | 0.59 | 0.54 | 0.52 | 1 | 0.59 | 0.59 | 0.63 | 0.54 | 0.51 |
| Industrial materials | 0.0596 | 0.001 | 1 | 0.56 | 0.49 | 0.51 | 0.6 | 0.43 | 1 | 0.6 | 0.53 | 0.56 | 0.65 | 0.48 |
| Forest products | 0.0063 | 0.001 | 1 | 0.62 | 0.62 | 0.66 | 0.58 | 0.53 | 1 | 0.63 | 0.61 | 0.66 | 0.6 | 0.51 |
| Metals | 0 | 0.002 | 1 | 0.53 | 0.38 | 0.39 | 0.65 | 0.34 | 1 | 0.56 | 0.43 | 0.41 | 0.69 | 0.46 |
| Base metals | 0 | 0.003 | 1 | 0.55 | 0.38 | 0.4 | 0.67 | 0.34 | 1 | 0.58 | 0.43 | 0.42 | 0.72 | 0.44 |
| **BCPI total - Canadian dollars**** | 0 | 0.001 | 1 | 0.5 | 0.48 | 0.52 | 0.47 | 0.38 | 1 | 0.59 | 0.57 | 0.68 | 0.46 | 0.28 |
| Industrial materials | 0.0324 | 0.001 | 1 | 0.59 | 0.56 | 0.57 | 0.62 | 0.53 | 1 | 0.61 | 0.57 | 0.59 | 0.62 | 0.53 |
| Forest products | 0.0087 | 0.001 | 1 | 0.71 | 0.69 | 0.76 | 0.66 | 0.55 | 1 | 0.75 | 0.74 | 0.83 | 0.64 | 0.53 |
| Metals | 0 | 0.002 | 1 | 0.53 | 0.41 | 0.44 | 0.63 | 0.37 | 1 | 0.58 | 0.47 | 0.45 | 0.69 | 0.5 |
| Base metals | 0 | 0.003 | | | | | | | | | | | | |
| **Average resale housing price - H,T,C, V**** | 0 | 0.001 | 3 | 0.58 | 0.5 | 0.57 | 0.59 | 0.37 | 3 | 0.62 | 0.52 | 0.57 | 0.67 | 0.42 |
| Average resale housing price - Toronto | 0.177 | 0.03 | 1 | 0.75 | 0.53 | 0.51 | 0.95 | 0.56 | 1 | 0.76 | 0.59 | 0.51 | 0.97 | 0.72 |
| **IPPI - total**** | 0 | 0.002 | 1 | 0.6 | 0.55 | 0.62 | 0.59 | 0.39 | 1 | 0.64 | 0.59 | 0.67 | 0.6 | 0.37 |
| Finished goods | 0.168 | 0 | 1 | 0.63 | 0.53 | 0.6 | 0.66 | 0.37 | 1 | 0.66 | 0.56 | 0.63 | 0.7 | 0.4 |
| Intermediate goods | 0.0198 | 0.049 | | | | | | | | | | | | |
| Excluding food, beverage and energy | 0.0036 | 0.016 | | | | | | | | | | | | |
| First transformation | 0.183 | 0.04 | 1 | 0.59 | 0.54 | 0.6 | 0.56 | 0.4 | 1 | 0.71 | 0.66 | 0.73 | 0.69 | 0.49 |
| Second transformation | 0 | 0.007 | | | | | | | | | | | | |
| Clothing | 0.2 | 0.04 | 2 | 0.71 | 0.51 | 0.49 | 0.9 | 0.54 | 1 | 0.69 | 0.54 | 0.58 | 0.79 | 0.47 |
| Motor vehicles & parts | 0.3186 | 0 | 1 | 0.57 | 0.45 | 0.53 | 0.62 | 0.28 | 1 | 0.63 | 0.51 | 0.58 | 0.68 | 0.34 |
| Furniture | 0.041 | 0.004 | | | | | | | | | | | | |
| Electrical products | 0.0591 | 0.007 | 1 | 0.59 | 0.55 | 0.57 | 0.6 | 0.5 | 1 | 0.58 | 0.59 | 0.65 | 0.49 | 0.47 |
| Primary metals | 0.0092 | 0.025 | 1 | 0.85 | 0.88 | 0.99 | 0.66 | 0.65 | 1 | 0.9 | 0.93 | 1.07 | 0.65 | 0.59 |
| **Wage settlements - new, total** | 0.375 | 0.352 | 2 | 0.68 | 0.53 | 0.54 | 0.81 | 0.52 | 3 | 0.66 | 0.57 | 0.63 | 0.69 | 0.43 |
| Wage settlements - new, private | 0.378 | 0.437 | 2 | 0.59 | 0.52 | 0.59 | 0.59 | 0.38 | | | | | | |
| **Wage settlements - outstanding, total** | 0.4238 | 0.207 | 2 | 0.63 | 0.46 | 0.48 | 0.76 | 0.43 | | | | | | |
| Wage settlements - outstanding, private | 0.427 | 0.307 | 2 | 0.6 | 0.47 | 0.51 | 0.68 | 0.39 | | | | | | |
| **Unit labour costs - total**** | 0.1458 | 0.009 | 1 | 0.62 | 0.50 | 0.55 | 0.69 | 0.4 | 1 | 0.65 | 0.54 | 0.62 | 0.69 | 0.37 |
| Business | 0.3923 | 0.005 | 3 | 0.68 | 0.54 | 0.65 | 0.71 | 0.25 | 3 | 0.63 | 0.53 | 0.5 | 0.76 | 0.58 |
| Business - goods | 0 | 0.005 | 1 | 0.8 | 0.64 | 0.57 | 0.99 | 0.76 | 1 | 0.81 | 0.67 | 0.65 | 0.97 | 0.71 |
| Business - services | 0.0236 | 0.003 | 1 | 0.59 | 0.59 | 0.59 | 0.6 | 0.58 | 1 | 0.55 | 0.58 | 0.58 | 0.52 | 0.59 |
| Manufacturing | 0 | 0.003 | 1 | 0.65 | 0.58 | 0.6 | 0.71 | 0.52 | 1 | 0.62 | 0.54 | 0.62 | 0.61 | 0.34 |
| **Employment-population ratio** | 0.1293 | 0.483 | 2 | 0.69 | 0.5 | 0.48 | 0.87 | 0.52 | 2 | 0.86 | 0.63 | 0.57 | 1.1 | 0.73 |
| Unemployment rate | 0.1069 | 0.426 | 2 | 0.54 | 0.54 | 0.54 | 0.53 | 0.53 | 2 | 1.14 | 1.06 | 1.26 | 1 | 0.56 |
| **Unfilled orders/shipments - manufacturing** | 0.214 | 0.136 | 2 | 0.59 | 0.51 | 0.57 | 0.62 | 0.38 | 2 | 0.83 | 0.61 | 0.56 | 1.06 | 0.7 |
| Unfilled orders/shipments -man. excl. aircrafts | 0.426 | 0.202 | 2 | 0.66 | 0.5 | 0.58 | 0.74 | 0.32 | 2 | 0.62 | 0.53 | 0.62 | 0.63 | 0.31 |
| **CAPU - non-farm goods ex. energy** | 0.2451 | 0.231 | 2 | 0.64 | 0.47 | 0.48 | 0.78 | 0.45 | 2 | 0.85 | 0.62 | 0.56 | 1.08 | 0.72 |
| CAPU - manufacturing | 0.4874 | 0.394 | 2 | 0.72 | 0.51 | 0.49 | 0.91 | 0.55 | | | | | | |

****Expressed in first difference of the log**

## Table 2

# Post-Sample Forecast Errors: Core Inflation

### Root-Mean-Squared Errors

### One Quarter Ahead

| Forecasts from: | | 95q1-99q1 | 95q1-99q1* | 95q1-97q1 | 97q2-99q1 | 97q2-99q1* |
|---|---|---|---|---|---|---|
| Fillion-Leonard model | | 0.79 | 0.65 | 68 | 0.9 | 0.6 |
| Fillion-Leonard model - rolling regressions | | 0.78 | 0.67 | 0.72 | 0.85 | 0.56 |
| Autoregressive model | | 0.59 | 0.49 | 0.54 | 0.64 | 0.38 |
| Naive forecast - based on core inflation | | 0.63 | 0.53 | 0.56 | 0.7 | 0.47 |
| Naive forecast - based on CPIX | | 0.77 | 0.53 | 0.6 | 0.92 | 0.37 |
| 10 selected indicator models: | | | | | | |
| | weights for k = 0.5 | | | | | |
| CPI - Clothing | 0.07 | 0.47 | 0.42 | 0.49 | 0.45 | 0.24 |
| CPI - Health care | 0.11 | 0.51 | 0.44 | 0.5 | 0.52 | 0.3 |
| CPI - Purchase of recreational vehicles | 0.09 | 0.47 | 0.42 | 0.48 | 0.47 | 0.28 |
| BCPI total - US dollars | 0.12 | 0.47 | 0.43 | 0.49 | 0.44 | 0.3 |
| Average resale housing price | 0.13 | 0.58 | 0.5 | 0.57 | 0.59 | 0.37 |
| CPI - Personal care supplies | 0.1 | 0.53 | 0.43 | 0.45 | 0.6 | 0.4 |
| CPI - Homeowners maintenance and repair | 0.09 | 0.54 | 0.55 | 0.53 | 0.54 | 0.59 |
| Unfilled orders/shipments - manufacturing | 0.09 | 0.59 | 0.51 | 0.57 | 0.62 | 0.38 |
| IPPI - electrical products | 0.13 | 0.59 | 0.55 | 0.57 | 0.6 | 0.5 |
| Wage settlements - new private | 0.07 | 0.59 | 0.52 | 0.59 | 0.59 | 0.38 |
| **Combined forecasts from 10 models:** | | | | | | |
| | k = 10 | 0.5 | 0.48 | 0.54 | 0.46 | 0.34 |
| | k = 1 | 0.5 | 0.48 | 0.54 | 0.45 | 0.33 |
| | k = 0.5 | 0.49 | 0.47 | 0.54 | 0.44 | 0.32 |
| | k = 0.2 | 0.48 | 0.46 | 0.53 | 0.42 | 0.3 |

### Two Quarters Ahead

| Forecasts from: | | 95q1-99q1 | 95q1-99q1* | 95q1-97q1 | 97q2-99q1 | 97q2-99q1* |
|---|---|---|---|---|---|---|
| Fillion-Leonard model | | 0.88 | 0.73 | 0.77 | 1 | 0.65 |
| Fillion-Leonard model - rolling regressions | | 0.92 | 0.79 | 0.87 | 0.97 | 0.61 |
| Autoregressive model | | 0.63 | 0.53 | 0.6 | 0.65 | 0.36 |
| Naive forecast - based on core inflation | | 0.78 | 0.69 | 0.8 | 0.75 | 0.42 |
| Naive forecast - based on CPIX | | 0.92 | 0.77 | 0.93 | 0.92 | 0.28 |
| 10 selected indicator models: | | | | | | |
| | weights for k = 0.5 | | | | | |
| Regulated CPI | 0.15 | 0.53 | 0.37 | 0.35 | 0.68 | 0.41 |
| CPI - Personal care supplies | 0.1 | 0.54 | 0.43 | 0.47 | 0.61 | 0.36 |
| BCPI total - US dollars | 0.09 | 0.52 | 0.49 | 0.59 | 0.42 | 0.22 |
| CPI - Clothing | 0.13 | 0.61 | 0.5 | 0.54 | 0.68 | 0.41 |
| Unfilled orders/shipments - man. excl. aicrafts | 0.07 | 0.62 | 0.53 | 0.62 | 0.63 | 0.31 |
| CPI - Non-alcoholic beverages | 0.09 | 0.6 | 0.53 | 0.62 | 0.59 | 0.31 |
| IPPI - electrical products | 0.06 | 0.58 | 0.59 | 0.65 | 0.49 | 0.47 |
| Unit labour costs - total | 0.07 | 0.65 | 0.54 | 0.62 | 0.69 | 0.37 |
| CPI - Health services | 0.06 | 0.62 | 0.52 | 0.55 | 0.69 | 0.45 |
| Average resale housing price | 0.18 | 0.62 | 0.52 | 0.57 | 0.67 | 0.42 |
| **Combined forecasts from 10 models:** | | | | | | |
| | k = 10 | 0.59 | 0.49 | 0.56 | 0.61 | 0.34 |
| | k = 1 | 0.57 | 0.48 | 0.54 | 0.6 | 0.33 |
| | k = 0.5 | 0.56 | 0.46 | 0.52 | 0.6 | 0.33 |
| | k = 0.2 | 0.53 | 0.43 | 0.48 | 0.59 | 0.32 |

## Table 3
# Post-Sample Forecasts: Core Inflation

### Quarterly percentage change at annual rates

### One Quarter Ahead

| | 95q1 | 95q2 | 95q3 | 95q4 | 97q1 | 97q2 | 97q3 | 97q4 | 98q1 | 98q2 | 98q3 | 98q4 | 99q1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Actual core inflation** | 2.56 | 2.45 | 1.92 | 1.41 | 1.21 | 2.02 | 0.62 | 0.62 | 1.21 | 1.3 | 1.48 | 1.24 | 0.31 |
| **Forecasts from:** | | | | | | | | | | | | | |
| Fillion-Leonard model | 0.92 | 2.21 | 2.29 | 1.79 | 1.51 | 1.25 | 1.28 | 1.44 | 1.31 | 1.88 | 1.79 | 2.11 | 2.2 |
| Fillion-Leonard - rolling regressions | 0.92 | 2.42 | 2.51 | 1.97 | 1.61 | 1.31 | 1.35 | 1.49 | 1.27 | 1.91 | 1.76 | 2.02 | 2.04 |
| Autoregressive model | 1.58 | 1.64 | 1.5 | 1.37 | 1.56 | 1.31 | 1.62 | 1.22 | 1.4 | 1.6 | 1.53 | 1.52 | 1.44 |
| Naive - based on core inflation | 1.98 | 2.56 | 2.45 | 1.92 | 2.07 | 1.21 | 2.02 | 0.62 | 0.62 | 1.21 | 1.3 | 1.48 | 1.24 |
| Naive - based on CPIX | 2.29 | 3.21 | 2.47 | 2.02 | 2.34 | 2.32 | 2.93 | 0.94 | 0.88 | 1.5 | 1.44 | 1.04 | 1.11 |
| 10 selected indicator models: | | | | | | | | | | | | | |
| CPI - Clothing | 1.82 | 1.69 | 1.62 | 1.65 | 1.39 | 1.61 | 0.99 | 1.07 | 1.3 | 1.46 | 1.8 | 1.2 | 1.31 |
| CPI - Health care | 1.42 | 1.71 | 2.17 | 1.52 | 1.55 | 1.41 | 1.29 | 1.13 | 1.46 | 1.29 | 1.43 | 1.42 | 1.31 |
| CPI - Purchase of recreational vehicles | 1.84 | 1.49 | 1.5 | 1.44 | 1.51 | 1.57 | 1.36 | 1.16 | 1.38 | 1.7 | 1.52 | 1.31 | 1.03 |
| BCPI total - US dollars | 1.82 | 1.8 | 1.64 | 1.61 | 1.51 | 1.52 | 1.42 | 1.15 | 1.25 | 1.12 | 1.09 | 1.27 | 0.77 |
| Average resale housing price | 1.66 | 2.43 | 1.72 | 2.27 | 1.56 | 1.71 | 1.63 | 1.14 | 0.88 | 1.09 | 0.83 | 1.37 | 1.24 |
| CPI - Personal care supplies | 1.92 | 1.77 | 1.69 | 1.54 | 1.48 | 1.19 | 1.5 | 1.15 | 1.34 | 1.53 | 1.46 | 1.42 | 1.35 |
| CPI - Homeowners maintenance and repair | 2.32 | 1.91 | 1.3 | 0.75 | 0.79 | 0.86 | 0.69 | 0.62 | 0.75 | 1.18 | 1.14 | 0.99 | 1.09 |
| Unfilled orders/shipments - manufacturing | 1.51 | 1.58 | 1.44 | 1.33 | 1.48 | 1.23 | 1.53 | 1.16 | 1.31 | 1.53 | 1.47 | 1.47 | 1.41 |
| IPPI - electrical products | 1.81 | 2.04 | 1.54 | 1.34 | 0.99 | 1.14 | 1.4 | 0.51 | 0.63 | 1.06 | 1.83 | 1.27 | 1.31 |
| Wage settlements - new private | 1.48 | 1.55 | 1.41 | 1.28 | 1.47 | 1.22 | 1.52 | 1.12 | 1.3 | 1.5 | 1.43 | 1.43 | 1.34 |
| **Combined forecasts from 10 models:** k = 0.5 | 1.73 | 1.72 | 1.44 | 1.34 | 1.35 | 1.35 | 1.1 | 1.16 | 1.27 | 1.42 | 1.25 | 1.23 | 1.04 |

### Two Quarters Ahead

| | 95q1 | 95q2 | 95q3 | 95q4 | 97q1 | 97q2 | 97q3 | 97q4 | 98q1 | 98q2 | 98q3 | 98q4 | 99q1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Actual core inflation** | 2.56 | 2.45 | 1.92 | 1.41 | 1.21 | 2.02 | 0.62 | 0.62 | 1.21 | 1.3 | 1.48 | 1.24 | 0.31 |
| **Forecasts from:** | | | | | | | | | | | | | |
| Fillion-Leonard model | 0.82 | 1.7 | 2.21 | 1.9 | 1.33 | 1.34 | 1.04 | 1.64 | 1.56 | 1.91 | 1.97 | 2.2 | 2.47 |
| Fillion-Leonard model - rolling regressions | 0.68 | 1.7 | 2.5 | 2.23 | 2.39 | 1.48 | 1.09 | 1.76 | 1.61 | 1.93 | 1.98 | 2.12 | 2.35 |
| Autoregressive model | 1.48 | 1.44 | 1.37 | 1.31 | 1.47 | 1.41 | 1.44 | 1.47 | 1.49 | 1.61 | 1.59 | 1.53 | 1.5 |
| Naive - based on core inflation | 1.57 | 1.98 | 2.56 | 2.45 | 1.78 | 2.07 | 1.21 | 2.02 | 0.62 | 0.62 | 1.21 | 1.3 | 1.48 |
| Naive - based on CPIX | 1.28 | 2.29 | 3.21 | 2.47 | 2.26 | 2.34 | 1.32 | 2.93 | 0.94 | 0.88 | 1.5 | 1.44 | 1.04 |
| 10 selected indicator models: | | | | | | | | | | | | | |
| Regulated CPI | 2.06 | 2.28 | 1.95 | 1.54 | 1.52 | 1.23 | 1.31 | 1.49 | 1.51 | 1.49 | 1.52 | 1.51 | 1.61 |
| CPI - Personal care supplies | 1.94 | 1.68 | 1.52 | 1.51 | 1.45 | 1.36 | 1.33 | 1.4 | 1.45 | 1.57 | 1.58 | 1.49 | 1.43 |
| BCPI total - US dollars | 1.52 | 1.46 | 1.54 | 1.47 | 1.23 | 1.75 | 1.24 | 1.35 | 1.26 | 1.25 | 1.1 | 1.35 | 0.82 |
| CPI - Clothing | 1.61 | 1.65 | 1.53 | 1.45 | 1.48 | 1.28 | 1.64 | 1.26 | 1.25 | 1.57 | 1.53 | 1.73 | 1.52 |
| Unfilled orders/shipments - man. excl. aicrafts | 1.27 | 1.62 | 1.4 | 1.27 | 1.16 | 1.65 | 1.43 | 1.44 | 1.61 | 1.26 | 1.91 | 1.36 | 1.46 |
| CPI - Non-alcoholic beverages | 1.43 | 1.3 | 1.46 | 1.66 | 1.46 | 1.41 | 1.3 | 1.23 | 1.21 | 1.45 | 1.51 | 1.53 | 1.51 |
| IPPI - electrical products | 1.86 | 1.42 | 1.78 | 1.18 | 0.97 | 1.15 | 0.77 | 0.92 | 0.88 | 1.24 | 1.89 | 0.94 | 1.15 |
| Unit labour costs - total | 1.48 | 1.4 | 1.34 | 1.32 | 1.52 | 1.48 | 1.53 | 1.51 | 1.53 | 1.65 | 1.64 | 1.63 | 1.55 |
| CPI - Health services | 1.43 | 1.72 | 1.61 | 1.81 | 1.51 | 1.73 | 1.46 | 1.42 | 1.95 | 1.33 | 1.88 | 1.69 | 1.52 |
| Average resale housing price | 1.73 | 1.87 | 1.6 | 0.58 | 1.33 | 1.32 | 1.76 | 1.25 | 1.83 | 2 | 2.02 | 1.45 | 1.36 |
| **Combined forecasts from 10 models:** k = 0.5 | 1.69 | 1.77 | 1.63 | 1.51 | 1.52 | 1.35 | 1.47 | 1.24 | 1.32 | 1.5 | 1.44 | 1.45 | 1.42 |

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