University of Victoria
Department of Economics

Department Discussion Paper DDP1201

ISSN 1914-2838

National and Provincial Inflation in Canada: Experiences under Inflation Targeting

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Keywords: Inflation, Monetary Policy, Inflation Targeting, Forecasting

JEL Classifications: E31, E58

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National and Provincial Inflation in Canada: Experiences under Inflation Targeting*

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We examine the behaviour of national and provincial inflation in Canada under inflation targeting to determine the extent to which the inflation targeting regime adopted by the Bank of Canada in the 1990s has anchored inflation expectations. Inflation expectations are well anchored when there are no predictable departures of inflation from target at sufficiently distant horizons. To examine this condition, we consider the out of sample prediction of monthly inflation with specific focus on whether deviations from the 1-3% target band are consistently predictable. We find support for well anchored inflation expectations at the national level and some but not all provinces.

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Financial support from the Australian Research Council (DP 1093363) is gratefully acknowledged. Thanks to Glenn Otto for helpful comments.

1. Introduction

Canada adopted an inflation targeting regime in the early 1990s with the original intention of achieving a 1–3 percent target by the mid 1990s. This target range was achieved somewhat earlier than expected and since the early 1990s, the Bank of Canada has been viewed as operating a successful inflation targeting regime. The objective of this paper is to examine the outcomes of the national inflation targeting framework both at a national level and at a regional level by examining inflation across the provinces. In particular, we wish to assess the extent to which inflation expectations have been anchored under inflation targeting.

The Canadian economy is a diverse collection of regional economies, for purposes here represented by the provincial economies, that vary in terms of production sectors, trade intensity, and trade partners (among other features). This diversity raises the question as to whether a single national monetary framework is always suitable for all regions. This is a long standing question that may be asked of any country or collection of countries operating under a unified monetary environment, dating back to the seminal work of Mundell (1961). Mundell's contribution was to identify criteria for regions or national economies that, if met, supported the adoption of a common currency. Subsequent authors, see Sarno and Taylor (2002) for a discussion, complemented Mundell's analysis with further criteria, many of which have been applied in various contexts, most notably in the debate of the establishment of the Euro.[1] In this regard we are examining within the Canadian context a well established policy question.

The novel feature of our approach to this question is to re-frame the assessment within the inflation targeting framework. Specifically, we use the methods Rowe and Yetman (2002) developed to assess the success of inflation targeting. These authors note that a successful inflation targeting framework should ensure that expectations of inflation, sufficiently far into the future, should be centred on the inflation target and moreover observed deviations should not be predictable. The logic is straightforward; were deviations predictable, the central bank should move to prevent these deviations. We extend this reasoning to provincial inflation outcomes by asking if there are observed predictable deviations of provincial inflation from the inflation target. Evidence of such deviations would suggest that national monetary policy is not delivering a uniformly successful

[1] See also Dellas and Tavlas, 2009.

inflation targeting framework. Specifically, that inflation expectations are not uniformly anchored across the country.

In addition to extending Rowe and Yetman's to provincial inflation, we amend their analysis to account for the target *band* used by the Bank of Canada rather than a target point; that is, we examine the weaker condition relating to the predictability of deviations from the 1–3 percent target band used by the Bank of Canada in contrast to focusing on predictability of deviations from the mid-point of the band as done in Rowe and Yetman. This amendment turns out to be important in that while we easily reject the strict inflation targeting hypothesis with respect to the mid-point criteria for Canada, which contrasts with Rowe and Yetman's earlier work, we cannot do so once we allow for the target band. That is for Canada as a whole, there are no predictable deviations from the 1–3 percent target band. The focus on the target band also proves important when we consider the provincial results as well. What we observe is that for some provinces, there are predictable deviations outside of the target band, which suggests that the inflation targeting framework has not delivered the same stable inflation paths as observed nationally and in some of the other provinces.

2. Inflation Targeting

In simple terms, an inflation target involves the central bank operating monetary policy to ensure that inflation is consistent with its stated target π^*. Because monetary policy operates with a significant lag, however, a more accurate description of inflation targeting is that monetary policy operates to ensure that future inflation is expected to be consistent with the target rate of inflation. If we suppose that relative to time t, the horizon for which monetary policy has influence is $t+h,\ h \geq \bar{h}$, then inflation targeting requires:

$$E_t(\pi_{t+h} - \pi^*) = 0, \quad h \geq \bar{h} \tag{1}$$

where $\bar{h}$ denotes the horizon prior to which time t monetary policy actions cannot control inflation. If this condition is violated then it implies that the central bank is not using available information at time t to achieve its target. Another useful way to interpret condition (1) is that, if satisfied, then the inflation targeting regime has successfully anchored inflation expectations.

As it is written, condition (1) is a very strong form of inflation targeting. It can be derived formally as the first order condition for a central bank with a loss function that only weights deviations of inflation from target; see for example Svensson (1999, 2003). Svensson (1999) refers to this as *strict* or pure inflation targeting and in most instances it is unlikely to describe the behaviour of inflation targeting central banks. In practice, inflation targeting central banks are likely to have additional concerns or objectives, such as variations in output or interest rate volatility; see the discussion in Rudebusch and Svensson (1999), which presents a thorough summary of these issues. If this is the case, then the target condition is no longer as in (1) but will instead include additional variables that are of concern to policy makers. For example, if a central bank has a quadratic loss over inflation and the output gap then (under certain conditions) the condition would take the form:

$$E_t(\pi_{t+h} - \pi^* + \phi x_{t+h}) = 0, \quad h \geq \bar{h} \tag{2}$$

where x_{t+h} is the output gap. See Svensson (2003), for example. For Canada, Otto and Voss (2011) finds that conditions such as these fit the Canadian data quite well for the inflation targeting period for horizons of up to 18 months.

We can, however, make use of condition (1) — which has the advantage of being a very simple and intuitive description of inflation targeting — if we focus on sufficiently long horizons such that other concerns, for example output variability, are expected to be resolved. In other words, if we set the horizon high enough, $E_t x_{t+h}$ is zero and we obtain condition (1). This will be our approach here, where we will only consider horizons of twenty-four months, which we judge to be sufficient to allow us to focus exclusively on inflation relative to target.[2] Condition (1), at the two year horizon, is thus our testable condition of inflation targeting.

We have the additional objective to use conditions of this nature to examine monetary policy on a regional (provincial) basis. To be clear, it is helpful to extend the analysis explicitly to consider multiple regions. To a reasonable approximation, we can treat national inflation as the weighted

[2] Rowe and Yetman (2002) focus on the six and eight quarter horizon. Their justification is that this is a lag length consistent with Bank of Canada's views concerning the effects of monetary policy. Our choice of just the two year horizon is more conservative but can also be justified on the findings in Otto and Voss (2011), which finds some evidence of more complicated targets at the eighteen month, six quarter, horizon. Further support can be found for condition (1) in the *Monetary Policy Reports* of the Bank of Canada where inevitably the two year forecast for inflation is two percent.

average of provincial inflation.[3] In this case, condition (1) becomes

$$E_t(\sum_j \theta_j \pi_{j,t+h} - \theta_j \pi_j^*) = 0, \quad h \geq \bar{h} \tag{3}$$

where π_j refers to inflation for province j, π_j^* the provincial inflation target, and the weights θ_j sum to one. In addition to the approximation for national inflation, we also require $\sum_j \theta_j \pi_j^* = \pi^*$. A sufficient but not necessary condition for the above is for each province to satisfy its own inflation target:

$$E_t(\pi_{j,t+h} - \pi_j^*) = 0, \quad h \geq \bar{h} \tag{4}$$

Two aspects of the above condition relate to how the national target translates into a set of provincial targets. The first is the provincial target, π_j^*, the second is whether it is sensible to focus on this restricted (sufficient but not necessary) condition for the national target. We consider each of these in turn.

A natural starting point is to assume that the national inflation target should have a uniform inflation target across the provinces: $\pi_j^* = \pi^* \ \forall j$; moreover, this common target should be the published target of the Bank of Canada, 2%.[4] In practice, however, the national average rate of inflation in Canada over the inflation targeting period has been below 2% (inflation variously measured). Consistent with this, *estimates* of the inflation target in Rowe and Yetman (2002) and Otto and Voss (2011) are consistently below 2%; for example, using core inflation both papers have estimates in the 1.6-1.75 region. So, while $\pi^* = 2\%$ may be the official target there is little reason to impose this target in any estimation.

From a provincial perspective, it is also clear that imposing a common inflation target *a priori* is unlikely to be sensible as average inflation rates over the inflation targeting period vary substantially across provinces (as detailed in the following section). Nor is it a necessary feature of a well functioning national inflation target. If the principal objective is to anchor inflation expectations

[3]We emphasize that this is a convenient approximation and does not describe the actual relationship between national and provincial inflation rates the underlying price indices. Nonetheless, the approximation is very good. As we describe below, we consider two measures of inflation available nationally and provincially. For the samples of interest, 1996-2011, using year on year monthly inflation rates for both of these measures, we obtain R^2s from simple linear regressions of national inflation on provincial inflation that are in excess of 0.99.

[4]Plus or minus one percent, a point which is considered in detail below.

then there is no requirement that the anchored rate be common across provinces (as long as the provincial targets together satisfy the national target). For example, consumers and firms in Alberta may reasonably recognize that a national target of 2% translates into a higher target for inflation in Alberta, around which inflation expectations are anchored, if in fact that is what the national inflation target has delivered. To summarize, there is little evidence to support imposing a 2% target in our empirical work, nationally or provincially. And there is little reason to impose a common target across provinces in assessing whether the national inflation target has anchored provincial inflation and provincial inflation expectations.

The second aspect is whether we are justified in assessing the national inflation target by a focus on condition (4), which is not necessary for the national inflation target to be satisfied. Our argument is that the condition, in and of itself, is the appropriate one because it gets directly at a key *objective* of inflation targeting: anchored inflation and inflation expectations (with flexibility across provinces as to the level at which these are anchored). One way to see this is to consider an alternative possibility within a successful national inflation target. Suppose it was the case that certain regions were predictably above target with others predictably below; then the national target can be achieved but inflation expectations are not anchored anywhere. So, not only are provinces poorly served but the national inflation target is not really successful in its goals either. A second perspective is to note that if condition (4) is violated for a particular province then in principle province specific monetary policy should have been able to achieve the target.

These arguments lead us to use conditions (1) and (4) as our principal means of assessing the national inflation target and the provincial outcomes under this national system respectively. A further attractive feature is that the conditions are essentially the same just applied at a different level of aggregation. To test either condition, we consider linear regressions of the following form:

$$\pi_{t+24} = c + z_t \beta + \epsilon_{t+24} \tag{5}$$

where z_t is a vector of variables known at time t when policy is set and inflation is either the national rate or a provincial rate. Conditions (1) and (4) imply that the slope coefficients are zero with $c = \pi^*$. For the reasons discussed above, we do not impose a particular value for c nor do we restrict it to be the same across provinces.

3. Empirical Analysis

Data

Our sample corresponds to the inflation targeting period of 1996:1–2010:4. While the Bank of Canada announced its move to inflation targeting in 1991, the initial target was a declining range with the current 1–3 percent target range to be in place by the end of 1995; consequently, we start our sample in 1996. For details of the implementation of the target, see Bank of Canada (1995).

We measure inflation as the Bank of Canada does for its inflation target, monthly year on year changes. To see why this might matter, consider the following comparison of monthly versus year on year inflation targeting. The Bank's inflation target is, setting aside issues of uncertainty, the following:

$$\pi_t \equiv p_t - p_{t-12} = \pi^*$$

where p_t is the log price level. This can be expressed in terms of the monthly inflation rates:,

$$\pi_t = \Delta p_t + \Delta p_{t-1} + \ldots \Delta p_{t-11}$$

Now an inflation target specified in terms of π_t does not impose an inflation target on each of the month to month changes in the price index; rather it restricts the sum of the monthly inflation rates over the relevant period.

It is worth considering this a bit further, as it relates to the issue of price level targeting and whether bygones are bygones. Suppose the Bank is looking forward at inflation twelve months from now and, for simplicity, assume that monetary policy has a six month lag. We then have,

$$\pi_{t+12} = (\Delta p_{t+12} + \ldots \Delta p_{t+7}) + (\Delta p_{t+6} + \ldots \Delta p_{t+1})$$

The second bracketed sum consists of inflation rates beyond the current control of the Bank — they are *bygones* given the lags of monetary policy. If this bracketed term is (expected to be) above target then monetary policy must respond to ensure that the first bracketed term, which is under the control of the Bank, is below the target so that π_{t+12} is on target. This is a very different prescription compared to a monthly inflation target, which would ignore the near term inflation outcomes (bygones are bygones) and focus on the individual elements of the first term. In effect, through the year the Bank has a price level target for π_{t+12}. Similar issues arise when considering alternative frequencies of data; for example, it is not strictly correct to suppose that the year on year monthly inflation target applies to quarterly inflation rates.

The next consideration is which price index to use. The Bank of Canada's inflation target is specified in terms of All Items CPI inflation. As an operational guide to monetary policy, however, the Bank uses a measure of core inflation. The definition of core inflation has changed but the purpose is to have a measure of inflation that excludes volatile components. Prior to 2001, the core measure was the CPI excluding food, energy and the effect of indirect taxes. Since 2001, the core measure is constructed from the CPI by excluding the eight most volatile items as well as the effects of indirect taxes. It is very evident from the Bank's publications that core inflation is what is *de facto* targeted by the Bank and so for national inflation we focus on the two core measures used.[5] For provincial inflation, though, we do not have directly comparable measures. We can, however, come reasonably close using provincial CPI measures excluding food and energy; a comparable measure is also available at the national level. The principal limitation of this index is that it does not have the effects of indirect taxes excluded.

For purposes of comparison among the different CPI measures, Figure 1 presents the inflation rates for the three series we have for Canada: Core inflation as currently used by the Bank of Canada (labelled Core); CPI inflation ex Food and Energy and Indirect Taxes (past definition of core inflation, labelled CPI XFET); and CPI ex Food and Energy inflation (comparable to available provincial measures, labelled CPI XFE). Although the series do move closely together for much of the sample, there are some differences. Notably, the current core measure is less volatile than the other two measures and breaches the 1–3 percent target range less frequently and by smaller amounts. The other notable feature is that the three series appear to be less correlated since 2008, with Core inflation not exhibiting the same persistent extreme low values as the other two series in recent years. For our purposes, where we have to rely on the CPI XFE measure for the provinces,

[5] For a discussion of the use of core inflation measures in monetary policy, and the measures used by the Bank of Canada, see Macklem, 2001.

the implication is that the series we focus on are likely more volatile than a comparable provincial core measure. This qualification is considered further when we examine the specific results.

A second related qualification is that the series we focus on for the provinces does not exclude the effect of indirect taxes, which is clearly something that monetary policy should not be focused upon and so should not properly be targeted. For our analysis, however, which relies on examining whether inflation is forecastable, this may not be a significant concern. While the inflation effects of changes in indirect taxes may often be well anticipated based on pending tax changes, they are unlikely to be forecasted by the macroeconomic time series variables and the horizons we consider when assessing the inflation target. As such, these effects should just generate noise. Nonetheless, this qualification need also be borne in mind.

The provincial inflation series for CPI XEF are presented in Figures 2 and 3; in each case, the national CPI XEF inflation rate is plotted as well for purposes of comparison. A number of points of comparison are immediate. First, the eastern maritime provinces (NL, PE, NS, and NB) are notable for having relatively volatile patterns of inflation. New Brunswick is probably the most extreme; it witnessed a steep rise in inflation throughout the late 1990s, peaking in 2002-3 and dramatically moving down to centre on the one percent target band with some notable and quite persistent drops in inflation below zero. (Some part of this might be explained by changes in taxes but this is unlikely to explain the pattern of inflation over several years.) The provinces in the centre of the country (QC, ON, and MB) tend to follow patterns fairly similar to the national inflation measure. For Ontario, this is not too surprising since it gets a significant weight in the national measure. Finally, SA, AB and BC differ quite substantially from the national inflation rate, though not all in the same way. AB and SA (to a slightly lesser extent) alone among the provinces have seen two significant and relatively persistent breaches of the upper target band. In contrast, BC is notable for almost always having an inflation rate below the national measure with sustained periods below the one percent band. Overall, the figures clearly demonstrate significant differences across the provinces in inflation behaviour and for some provinces significant differences from national inflation.

Summary sample statistics for all inflation measures are reported in Table 1, providing some further insights into the patterns of inflation in Canada and across the provinces. First, as noted in the previous section, mean inflation rates for Canada as a whole are below the 2% mid-point. For Core inflation, the current focus of the Bank of Canada's target, the mean is 1.75%; the other national measures are slightly below this. Notice that this is not, by itself, evidence against a 2% inflation target. The sample mean is an estimate of the unconditional mean of the series. But, consistent with condition (1) above, a better description of the inflation target is in terms of the *conditional* mean of inflation, which may differ for a variety of reasons. Most obviously, the Bank is explicitly forward looking and not, at least formally, targeting a price level path, which means that an episode of above 2% inflation is not necessarily followed by an episode of below 2% inflation.[6] Consequently, within a particular sample we might expect average inflation to differ from the inflation target; it certainly is not inconsistent with a forward looking inflation target. To further investigate this, we estimate the *conditional* mean for Core inflation over the same sample, 1996:M1–2011:M3 to be 1.74% with a standard error of 0.03.[7] So, in this case, the sample and conditional mean give the same story: evidence that the Bank of Canada *de facto* target is slightly below its mid-point. Similar estimates, though with slightly different samples, arise in Rowe and Yetman (2002) and Otto and Voss (2011).

Looking across the provinces, we see again that with the exception of Alberta, mean inflation rates are all below 2%. The lowest mean rate of inflation is BC at 1.1 percent, the highest is Alberta at 2.2 percent. This variation across provinces and the low values are, as explained in the previous section, reasons against imposing *a priori* the two percent target.

Also evident in Table 1 is substantial variation in the variability of inflation across the provinces. A number of provinces have standard deviations for inflation in excess of one percent (PE, NB, and AB), which in the context of the ±1% bounds that the Bank of Canada uses to describe its inflation target is quite large. The lowest variability is for Manitoba, just over 0.5 percent, which is close to the standard deviation of the comparable national measure. Finally, Table 1 also reports the first six autocorrelations for each of the inflation series. Evidently, all of these series exhibit a great deal of persistence. This is in large part an artefact of the year on year measure of inflation, which generates a significant moving average process. (Month to month inflation or quarter to

[6] For empirical evidence about the extent of price level targeting in Canada, see Ruge-Murcia (2009).

[7] Estimated using the continuously updating GMM estimator of Hansen, Heaton, and Yaron (1996) with instruments as described in the final set of estimates in Table 5 and an HAC (Bartlett) robust covariance matrix estimator with lag length chosen following Newey and West (1994).

quarter inflation, for example, exhibit much less persistence.) This has two practical implications. First, it suggests that some of these series may be non-stationary, which would be strong evidence against the inflation targeting hypothesis as specified in conditions such as (1). Second, even if the series are stationary, it is suggestive that the inflation rate series may be predictable, also evidence against the inflation targeting hypothesis.

The strong persistence of these series suggests that we should properly test for unit roots. These are reported in Table 2. In all cases, the test regressions have a constant and no trend, as we are interested in the hypothesis that the inflation rates are stationary around a constant mean, as opposed to trend stationary. Trend stationary or difference stationary inflation rates are not consistent with the inflation targeting hypothesis.

Table 2 reports a variety of test statistics for unit roots. The first set uses Elliot et al (1996) DF-GLS test statistics for maximum lag lengths of 36. We report the statistic, denoted μ, chosen by the modified AI criteria due to Ng and Perron (2000). In no cases using this criteria is it necessary to go beyond 36 lags. Based on these statistics, we reject the unit root hypothesis at the 10 percent significance level for all of the national inflation rates and all but three of the provinces: Prince Edward Island, Ontario, and Manitoba. If we consider the KPSS statistic with the null hypothesis that the series are stationary, then we reject stationarity (again at the 10% significance level) in two cases: Quebec and Manitoba.

Since it is quite possible that the tests may not perform very well in the presence of innovations with a long-lived moving average component, we consider a simple alternative approach. To a very good approximation, annual inflation rates are equal to the average of the year on year monthly inflation rates. We reason that if the annual rates are stationary then this is very suggestive that the underlying components are themselves stationary.[8] The former has the advantage of having dynamics that are much easier to model and the associated unit root tests provide complementary evidence to the year on year test results. These are also reported in Table 1. In this case, we only have Manitoba providing evidence of a unit root but only for the KPSS statistic.

In summary, all of the national inflation measures appear to be stationary, as do the inflation measures for all provinces but Prince Edward Island, Quebec, and Manitoba. We do stress that the

[8] For similar issues, MacKinnon (1996) also uses annual inflation when examining unit roots in Canadian inflation.

dynamics of these series and the relatively short span of data make testing for unit roots difficult and qualify any conclusions. Notably, using annual data only corroborates the unit root hypothesis in one case, Manitoba. On this basis, one could argue that these provinces, in particular Manitoba, can be dropped from further analysis since we have evidence in these cases against the inflation targeting hypothesis. Since there is some doubt, though, we opt instead to include them in the subsequent analysis, recognizing that the possible non-stationarity qualifies some of the subsequent inference.

Inflation Targeting

We now turn to explicit tests of the inflation targeting hypothesis using the test regression given in equation (5), which for convenience is repeated here:

$$\pi_{t+24} = c + z_t\beta + \epsilon_{t+24}$$

For each national inflation measure and provincial inflation measure we estimate the above and test the joint hypothesis $\beta = 0$. As there are many possible variables one could include in the vector z_t, we proceed as follows. We identify a large set of possible variables (monthly frequency), which can be broken down into two subsets. The first includes province-specific measures, the second national measures. It seems of some interest to determine if there are province specific influences for inflation; moreover, this allows us to tailor the set of variables for each province (e.g. using province wage inflation rather than some national average for wage inflation). The second aspect of our estimation strategy is to consider each of the variables in both subsets individually. The first reason for doing so are concerns about multi-collinearity and degrees of freedom. The second is that some variables may be important for some provinces and not for others. By examining the role of each variable we can get a good sense of what if anything is likely to forecast national and provincial inflation rates. After examining each variable individually, we then consider richer specifications.

For each variable included in z_t, we include six lags. As we are forecasting two years ahead, there seems little reason to include further lags than this; moreover, as we shall see, this lag structure does a reasonable job forecasting inflation. We ensure that the lags included are information available at time t; that is, we take into account specific release lags associated with each of these variables. For the region specific variables, we have inflation, wage inflation, employment growth, unemployment and changes in unemployment. For the common variables, we have commodity prices, the exchange rate, money growth, and national output growth. The specific details of the variables and the lags due to release dates are all summarized in Table 8.

All inference is based upon the Newey and West (1987) HAC robust covariance estimator with autocorrelation lag order of twenty-three. This lag order choice reflects the nature of the forecast equation being estimated, twenty-four months ahead for which there is likely to be a moving average structure of order one less; Hansen and Hodrick (1980). The first set of results use province specific predictors, one at a time, and are reported in Table 3; Table 4 does the same but with common predictors. For each variable, we report the R^2, the F-statistic for the joint hypothesis that $\beta = 0$, and the associated p-value.

Consider first the results for Core inflation, which can be viewed as testing whether or not national inflation has successfully met our criteria. These results are directly comparable to Rowe and Yetman (2002), which generally finds support for the inflation targeting hypothesis. Our results, however, are not as supportive. Looking at the test regression that uses six lags of Core inflation as possible predictor, for example, we reject the null hypothesis $\beta = 0$ with a marginal significance level of 0.04. It's worth emphasizing what this is saying: currently available core inflation measures are able to predict, to some extent, core inflation twenty-four months in the future. Similar results hold for employment growth, unemployment, changes in unemployment (all reported in Table 3) as well as commodity price growth, money growth, and output growth (reported in Table 4). And only two of the variables we consider fail as statistically significant predictors of Core inflation: wage growth (Table 3) and changes in the exchange rate (Table 4).

One might reasonably ask, however, as to the extent of information provided by these predictors. The R^2s provide some information in this regard. For the most part, these are quite small (less than 15 percent) but for output growth it is quite large at 30 percent. Similar conclusions hold for the other two national inflation rates. So a strict interpretation of these results would be that at a national level, Canada does not satisfy a strict inflation target at the two year horizon. We return to this conclusion, which we think to be too strong, after we consider the provincial results.

The provincial results reported in Tables 3 and 4 are similar to those for the national inflation rates in that for each province there is one or more predictor the lags of which are jointly significant. To take a particularly strong example, British Columbia, lags of inflation, wage growth, employment growth, the exchange rate, and money growth are all significant predictors of BC inflation (at the 10% marginal significance level or better). Ontario is a further strong example with inflation similarly predicted by most of the variables considered in Tables 3 and 4. However the information available from these variables as measured by the R^2s is usually quite a bit less than it is for core inflation, typically no higher than 20 percent and usually below 10 percent. The exception in this regard is, somewhat surprisingly, the measure of national output growth, which is as high as 39 percent (NB) and never below 10 percent (though the lags are not jointly statistically significant in the cases of QC, AB, and BC).

As noted, this last result is quite unexpected. Since the analysis in Tables 3 and 4 is in no way structural, it is not possible to extract any real information about the underlying forces of inflation in Canada. Nonetheless, it is highly suggestive that common aggregate demand shocks are important drivers of inflation across the regions of Canada. There is also limited evidence of how the regions differ across Canada as well. The weakest role (again in terms of R^2s) for national GDP occurs in the three most western provinces, SK, AB, and BC.[9]

Table 5 extends these test regressions to include multiple variables with the objective to seeing the full extent to which inflation is predictable. The choice of variable sets is based upon the single variable regressions, which identify a number of variables that consistently predict inflation nationally and across provinces. The variables are identified in the table. The first set comprise variables that are specific to each province (or to Canada): inflation, wage growth, and employment growth. In all cases, we overwhelmingly reject the joint hypothesis that the coefficients on all variables at all lags are zero. Three provinces stand out: Ontario, Alberta, and BC all have R^2s greater than 25%, which is comparable to the national Core result (22%). The next set of results drops provincial employment in favour of national GDP growth. Again, in all cases we have variables that consistently predict inflation and, with the exception of Saskatchewan, all of the R^2s are in excess of 25%. Finally, we drop wage inflation in favour of commodity price inflation and in

[9]Unfortunately, provincial GDP is only available at an annual frequency.

this case the R^2s are all in excess of 20%. Typically, as with the other sets of variables, the R^2s are between 30 and 40 percent. Evidently, we can easily reject the inflation targeting hypothesis for Canada's Core inflation rate (and its earlier version) and for all of the provincial inflation rates. Notably, this conclusion differs from earlier work for Canada by Rowe and Yetman (2002).

This strong rejection of the inflation targeting hypothesis is, though, unduly harsh since it is based upon a very strict interpretation of the inflation target and one that is not consistent with the Bank of Canada's actual inflation target. The latter has a mid-point of 2% with a range of plus or minus one percent. While the above results suggest that there are predictable deviations of inflation from its average value, they do not test whether there are predictable deviations outside of the target band. A further criticism is that the test is within sample when the reality faced by the central bank is one of forecasting out of sample.[10] To address both of these issues, we construct the following exercise.

Based on the results in Table 5, we specify our information set as $z_t = (\pi_{t-2},\ \Delta_{12}p^{cm}_{t-3},\ \Delta_{12}y_{t-2})$, which fits uniformly well across the provinces as well as for Canada as a whole. We then estimate a set of regressions for each region and construct a set of out of sample two-year ahead forecasts that can be compared to the target bands. We are primarily interested in instances when these forecasts correctly predict inflation outcomes outside of the bands.

The specifics of the exercise are as follows. First, let the full sample of data, 1996M1–2011M3, be denoted $1 \dots T$, 183 observations. Second, re-write the regression model for a sub-sample $1...T_j$ in terms of lags of the right hand side variables:

$$\pi_t = c_j + z_{t-24}\beta_j + \epsilon_t \quad t = 1...T_j \tag{6}$$

where we have indicated sample specific parameters with the subscript j. We start the forecasting exercise with T_1 set to 1999M12, four years of data giving 48 observations, and continue until

[10] Of course, this suggests that one should be using real time data, which is not available. We are also still stacking the deck against the hypothesis in that we are using full sample information: the results from Table 3 and 4 that identify a useful set of regressors. Based on the results below, we don't believe either of these to be significant issues.

$T_M = T - 24$, corresponding to 2009M3. The set of forecasts we obtain is summarized as,

$$\hat{\pi}_{T_j+24} = \hat{c}_j + z_{T_J}\hat{\beta}_{T_j} \quad T_j = T_1 \ldots T_M \tag{7}$$

That is, we now have a set of 2-year ahead forecasts (112 in all) for 2001M12–2011M3 forecast models estimated on samples ending 1999M12—2009M3.

Table 6 provides a summary of the results from this exercise. In the table, we note the frequency of events of interest: (1) the number of instances over the forecast horizon 2001M12–2011M3 for which inflation breaches the lower or upper band; (2) the number of instances where such breaches are coincident with a *point* forecast also breaching the lower or upper band; and (3) the number of instances where such breaches are coincident with the 95% confidence interval for the forecast breaching the lower or upper band. In the case of the latter, this is a strong indication of predictable deviations from the inflation target.

Although this is a somewhat unusual way to present out of sample forecasts, it seems most in keeping with an explicit examination of the inflation targeting hypothesis in the presence of target bands. One concern is that it is possible that the forecasts may be consistently forecasting inflation outside of the band and by chance picking up incidents of actual inflation exceeding the band. To provide some indication as to when this may be a problem we also report the frequency of false predictions, both in terms of point forecasts as well as the confidence intervals.

To get a sense of the results, consider first those for core inflation for Canada. There are three instances (monthly observations) of core inflation breaching the target band, one below and two above. In all three instances, the breaches are not forecasted correctly, either in terms of the 95% confidence interval or the point estimate. Despite the failure to predict these extremes, overall the model is forecasting reasonably well in that false predictions, either in terms of the 95% confidence interval or the point estimate, are relatively rare (1 and 7 times out of 112 forecasts respectively). Since core inflation is of primary interest, the pattern of forecasts are also presented graphically in Figure 4. The conclusion from this is that while it is possible to find a number of variables that forecast two year ahead inflation ahead well (Tables 4 and 5), this does not imply predictable deviations for the 1–3 percent target band used by the Bank of Canada. On this basis, we are unable to reject the the (weaker) inflation targeting hypothesis for core inflation in Canada.

One possible concern is that the target bands are centred on the stated target of 2%. However, as is well documented, core inflation averages less than this, 1.75% over our full sample. If this average is understood to be the implicit inflation target then a proper assessment is arguably with respect to 1.75% $\pm$ 1%. Table 7 re-does the above analysis but in terms of this implicit target band. In this case, we get no breaches of the lower band and four of the upper band (of 2.75%). One of these breaches is predicted in terms of point forecast but not in terms of the confidence interval. (As before, the number of false predictions is relatively minor suggesting the model is doing a relatively good job.) The relatively few breaches along with the general lack of predictability means we again conclude that there is little evidence against the inflation targeting hypothesis.

Results for the two other measures of Canadian inflation are also reported, CA XEFT and CA XEF. Both exhibit more breaches of the 1–3 percent target bands than does core. For CA XEFT, the old definition of core inflation, there are 17 breaches, four of which are predicted in terms of point forecasts (18% of the forecasts), in all cases for breaches of the lower band. Although there is not much in it, this does provide some support for the Bank's decision to go to the newer core measure, which is evidently more stable. For CA XEF, the 18 breaches recorded are not predicted. This provides some re-assurance for using this measure for provincial inflation rates. Even though it is more volatile than actual core, it is not predictably so at the national level. When we consider the targets defined in terms of deviations from mean, reported in Table 7, we get stronger results: there are no predictable deviations from the target bands.

Looking at the provincial results, from Table 6 we first observe that there are, in most cases, many more breaches of the lower bound across the provinces than for the comparable CA XEF number. The largest number is for NB at 45 out 112 months, or 40% of the observation. Only Ontario and Saskatchewan have numbers of breaches comparable to the national level. In terms of the upper band, the notable provinces are Saskatchewan and Alberta.

An assessment of the results in Table 6 is notably subjective — there is no clear standard to use. But we would argue that there is a set of provinces that distinguishes itself by having relatively large numbers of breaches as well as a significant number of predicted breaches (20 percent or higher). These provinces are PEI (23% of breaches correctly forecasted), Newfoundland (27%), Alberta (29%) and BC (30%). For these provinces, with this rate of predictive success, we would argue that inflation expectations are not anchored that well to the 1–3 percent band. Notably for Alberta and BC, there are 2 and 1 instances of the CI being outside of the band, so in these cases there is strong predictive evidence against the inflation targeting hypothesis. For the other provinces, while there are certainly instance of predictable deviations from target, they do not seem to suffer to the same extent as the other four provinces.

These conclusions are qualified to some extent by the relative large number of false predictions, particularly for Alberta and BC, which is in part related to the concerns that the 1–3% bands are not centred appropriately. If we are willing to accept different rates of average inflation across the provinces as anchors we are then interested in knowing whether deviations outside the ±1% bands centred on the respective means are predictable.

From Table 7, we first note that in this case there are fewer deviations from the target band, as we would expect. And the group with successfully predicted breaches in excess of 20% is much smaller, now including only Ontario and Alberta; we might also again include PEI, which, at 18%, comes close to our arbitrary 20% cutoff. Of these, however, Ontario has relatively few actual breaches and Alberta and PEI are really the main standouts, particularly Alberta. On balance, we would identify these two provinces, Alberta and PEI, as the two that have inflation targets that are not well anchored under the national inflation targeting regime. Interestingly, when we adjust for the provincial mean BC has no predicted deviation; that is, once we adjust for the low average inflation, BC has a stable and well anchored path of inflation. It still remains, however, something of a mystery as to why BC has such a consistently low rate of inflation relative to the rest of the country.

Conclusions

The analysis above examines national and provincial inflation in Canada under the current inflation targeting framework. One set of results pertain to the patterns of inflation across the country where we observe more variation than one might expect. Another set of results emerge when we examine regional inflation through the lens of what we refer to as the inflation targeting hypothesis, a condition identified by Rowe and Yetman (2002) that a successful inflation target will meet.

When we examine the patterns of inflation across the country, we find first that for both Canada and all but one of the provinces, mean core rates of inflation are below the 2% target mid-point. The lone exception above 2% is Alberta. Secondly, for our measure of core inflation, there is considerable dispersion across the provinces. There is also considerable differences across provinces in the variability of inflation as well as the extent of its persistence. So although one might argue that inflation is well anchored nationally under the inflation targeting framework there is still considerable variation across the provinces.

Following Rowe and Yetman (2002), we also examine the extent to which the national inflation target anchors inflation expectations by examining whether inflation is forecastable at longer horizons, specifically two years. We extend their approach in two directions; first, we amend it to condition forecasts on current information and second to allow for the 1–3 percent target bands used by the Bank of Canada. Once these amendments are taken into account, we find no meaningful predictability of national inflation and no meaningful predictability of provincial inflation with the exception of New Brunswick and Alberta. For these two provinces, there are enough instances of forecastable deviations of inflation from the target band to argue that inflation expectations are not well anchored. At this point it is also worth noting the possible unit root in the Manitoba inflation, which is itself a strong rejection of the inflation targeting hypothesis.

One motivation for our approach is to examine whether or not the unified national monetary policy for Canada — which we interpret as the inflation target — delivers similar outcomes to the provinces in terms of anchoring inflation and inflation expectations. In this regard, the results are somewhat mixed. First, there are significant differences in mean inflation and variation of inflation across provinces. These differences, however, do not seem to put any stress on the system; they seem compatible with a stable national inflation target framework. Second, the system for the most part seems to have anchored inflation expectations reasonably well. Only for two of the provinces is there some evidence that a province-specific monetary policy, with the same objectives as the current inflation target, would have pursued a different monetary policy.

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Table 1: Summary Statistics

1996:M1–2011:M3

	Core	XEFT	CPI XEF										
	CA	CA	CA	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
Sample Statistics													
Mean	1.75	1.56	1.60	1.47	1.58	1.65	1.41	1.39	1.72	1.62	1.86	2.23	1.10
S.D.	0.42	0.51	0.57	0.91	1.02	0.89	1.16	0.67	0.61	0.56	0.78	1.35	0.68
ρ_1	0.85	0.88	0.91	0.86	0.92	0.91	0.95	0.90	0.86	0.81	0.90	0.97	0.87
ρ_2	0.76	0.79	0.83	0.78	0.85	0.84	0.90	0.82	0.73	0.69	0.79	0.92	0.81
ρ_3	0.67	0.75	0.78	0.70	0.78	0.80	0.84	0.74	0.66	0.57	0.68	0.87	0.73
ρ_4	0.59	0.66	0.69	0.65	0.69	0.74	0.76	0.65	0.58	0.46	0.56	0.81	0.65
ρ_5	0.50	0.58	0.62	0.59	0.61	0.68	0.67	0.57	0.51	0.34	0.47	0.74	0.63
ρ_6	0.42	0.53	0.55	0.52	0.54	0.61	0.59	0.50	0.43	0.22	0.39	0.67	0.61

Notes: Core is the current core measure of inflation for Canada; XEFT is the earlier definition. All other measures are CPI XEF. See text for details.

Table 2: Tests for Non-Stationarity

1996:M1–2011:M3

	Core	XEFT	CPI XEF										
	CA	CA	CA	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
GLS Dickey-Fuller Statistics													
μ (max. lag =36, $n = 146$)	-2.19	-2.15	-2.09	-1.84	-0.91	-2.23	-2.14	-1.75	-1.50	0.71	-1.85	-2.32	-1.65
Lag	13	13	12	25	26	1	16	14	13	36	12	12	24
Conclusion (10%)	I(0)	I(0)	I(0)	I(0)	I(1)	I(0)	I(0)	I(0)	I(1)	I(1)	I(0)	I(0)	I(0)
KPSS Statistics													
κ	0.150	0.145	0.212	0.103	0.228	0.174	0.181	0.426	0.223	0.727	0.120	0.131	0.327
Bandwidth Lag	10	10	10	10	10	10	10	10	10	9	9	10	10
Conclusion (10%)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(1)	I(0)	I(1)	I(0)	I(0)	I(0)
GLS Dickey-Fuller Statistics — Annual Frequency													
μ	-3.25	-3.42	-2.08	-2.45	-2.46	-2.30	-2.45	-1.79	-2.57	-2.25	-3.05	-3.73	-1.63
Lag	1	1	0	0	0	0	0	0	0	0	0	1	0
Conclusion (10%)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
κ	0.129	0.109	0.145	0.086	0.136	0.124	0.126	0.255	0.169	0.579	0.145	0.118	0.160
Bandwidth lag	2	2	2	2	2	2	2	2	2	2	2	2	2
Conclusion (10%)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(1)	I(0)	I(0)	I(0)

Notes: Core is the current core measure of inflation for Canada; XEFT is the earlier definition. All other measures are CPI XEF. See text for details. μ is the Elliot, Rothenberg, and Stock (1996) Dickey-Fuller statistic using GLS estimation of the deterministic component. Lag length is chosen using Ng and Perron's (2005) modified AI criteria. Critical values for μ are: -1.950 (5%); and -1.610 (10%), taken from Cheung and Lai (1995) as reported in *Stata 11*. κ is the Kwiatkowski et al (1992) test statistic for the null hypothesis of stationarity. Critical values (approximate) are: 10%: 0.347; 5%: 0.463, from Kwiatkowski et al (1992) as reported in *Stata 11*. Bandwidth for the Bartlett kernel used for this statistic was selected based on the procedures in Newey and West (1994).

Conclusions are based upon a 10% marginal significance level and the assessment presented in the text. I(0) implies stationary; and I(1) non-stationary.

Table 3: Prediction Regressions Single Region-Specific Variable

$\pi_{t+24} = \alpha + \sum_{j=0}^{5} \beta_j z_{t-j} + u_t$

	Core	XEFT	CPI XEF										
	CA	CA	CA	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
$z_t = \pi_{t-2}$													
R^2	0.143	0.216	0.050	0.029	0.011	0.045	0.008	0.006	0.091	0.060	0.020	0.229	0.083
$F(6, 176)$	2.237	4.256	6.814	3.974	1.045	2.507	1.020	0.582	2.398	1.277	1.353	2.118	6.947
p-value	0.042	0.000	0.000	0.001	0.398	0.024	0.414	0.744	0.030	0.270	0.236	0.053	0.000
$z_t = \Delta_{12} w_{t-3}$													
R^2	0.005	0.017	0.031	0.026	0.073	0.007	0.103	0.089	0.077	0.037	0.018	0.003	0.181
$F(6, 176)$	0.511	1.213	1.631	0.712	3.055	0.857	0.958	2.818	7.406	0.898	0.593	0.177	5.700
p-value	0.800	0.302	0.141	0.640	0.007	0.528	0.455	0.012	0.000	0.497	0.736	0.983	0.000
$z_t = \Delta_{12} e_{t-2}$													
R^2	0.086	0.022	0.060	0.049	0.041	0.047	0.016	0.048	0.175	0.084	0.023	0.127	0.140
$F(6, 176)$	3.542	2.233	1.666	1.473	0.486	0.896	0.302	1.332	2.477	0.915	0.314	1.499	5.425
p-value	0.002	0.042	0.132	0.190	0.818	0.499	0.935	0.245	0.025	0.486	0.929	0.181	0.000
$z_t = un_{t-2}$													
R^2	0.106	0.029	0.013	0.014	0.013	0.006	0.021	0.012	0.038	0.207	0.021	0.057	0.018
$F(6, 176)$	4.332	1.278	1.643	1.272	1.030	0.889	0.642	0.960	1.357	11.971	0.995	1.025	1.366
p-value	0.000	0.270	0.138	0.272	0.407	0.504	0.697	0.454	0.235	0.000	0.430	0.410	0.231
$z_t = \Delta_{12} un_{t-2}$													
R^2	0.098	0.126	0.113	0.018	0.066	0.004	0.027	0.079	0.224	0.049	0.010	0.079	0.012
$F(6, 176)$	2.665	3.205	2.324	1.031	0.954	0.411	1.178	0.961	10.807	2.053	1.155	0.554	0.713
p-value	0.017	0.005	0.035	0.407	0.458	0.871	0.320	0.453	0.000	0.061	0.333	0.766	0.640

Notes: See data appendix for details of variable construction. F tests are calculated using a Newey and West (1987) HAC robust covariance estimator with smoothing parameter set to 23.

Table 4: Prediction Regressions Single Common Variable

$\pi_{t+24} = \alpha + \sum_{j=0}^{5} \beta_j z_{t-j} + u_t$

	Core	XEFT	CPI XEF										
	CA	CA	CA	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
$z_t = \Delta_{12} p^{cm}_{t-2}$													
R^2	0.113	0.096	0.070	0.102	0.016	0.120	0.051	0.017	0.039	0.011	0.146	0.186	0.034
$F(6,176)$	3.375	6.504	1.392	5.128	0.451	2.472	1.036	0.506	1.615	0.472	1.848	2.222	1.209
p-value	0.004	0.000	0.220	0.000	0.844	0.025	0.404	0.804	0.146	0.829	0.092	0.043	0.304
$z_t = \Delta_{12} p^{cmx}_{t-2}$													
R^2	0.092	0.022	0.050	0.038	0.005	0.046	0.035	0.061	0.085	0.047	0.014	0.116	0.016
$F(6,176)$	1.888	0.422	1.207	2.070	0.455	1.223	1.122	1.329	1.807	1.071	1.018	0.638	1.084
p-value	0.085	0.864	0.305	0.059	0.841	0.296	0.351	0.247	0.100	0.382	0.415	0.700	0.374
$z_t = \Delta_{12} s_{t-1}$													
R^2	0.023	0.013	0.059	0.084	0.054	0.043	0.039	0.099	0.167	0.140	0.017	0.045	0.038
$F(6,176)$	1.007	1.827	2.502	1.914	1.768	1.273	2.717	4.482	9.233	2.478	1.419	1.178	5.159
p-value	0.422	0.096	0.024	0.081	0.108	0.272	0.015	0.000	0.000	0.025	0.210	0.320	0.000
$z_t = \Delta_{12} m_{t-2}$													
R^2	0.138	0.021	0.027	0.054	0.050	0.019	0.031	0.010	0.088	0.067	0.032	0.053	0.063
$F(6,176)$	2.836	1.306	1.013	3.275	2.165	0.568	0.921	0.724	2.727	1.718	2.051	0.932	1.889
p-value	0.012	0.257	0.418	0.004	0.049	0.755	0.481	0.631	0.015	0.119	0.061	0.473	0.085
$z_t = \Delta_{12} y_{t-4}$													
R^2	0.294	0.393	0.403	0.274	0.304	0.391	0.313	0.260	0.354	0.201	0.107	0.188	0.100
$F(6,176)$	2.733	7.870	4.753	1.997	3.396	4.057	4.798	1.132	4.763	4.133	2.316	1.763	1.206
p-value	0.015	0.000	0.000	0.069	0.003	0.001	0.000	0.346	0.000	0.001	0.035	0.109	0.305

Notes: See data appendix for details of variable construction. F tests are calculated using a Newey and West (1987) HAC robust covariance estimator with lag order of 23.

Table 5: General Prediction Regressions

$\pi_{t+24} = \alpha + \sum_{j=0}^{5} \beta_{1j} z_{1t-j} + \sum_{j=0}^{5} \beta_{2j} z_{2t-j} + \sum_{j=0}^{5} \beta_{3j} z_{3t-j} + u_t$

	Core	XEFT	CPI XEF										
	CA	CA	CA	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
$z_t = (\pi_{t-2},\ \Delta_{12}w_{t-3},\ \Delta_{12}e_{t-2})$													
R^2	0.222	0.302	0.156	0.113	0.130	0.092	0.139	0.173	0.387	0.165	0.072	0.268	0.263
$H_0 : \beta_{1j} = 0; F(6, 176)$	3.548	4.102	3.241	3.673	1.088	1.681	0.638	0.520	6.704	1.362	0.849	2.013	4.481
p-value	0.002	0.001	0.005	0.002	0.372	0.129	0.700	0.792	0.000	0.233	0.534	0.067	0.000
$H_0 : \beta_{2j} = 0; F(6, 176)$	0.075	0.729	0.781	0.800	3.227	0.704	0.980	2.745	6.851	0.953	1.157	0.562	1.938
p-value	0.998	0.627	0.586	0.571	0.005	0.646	0.440	0.014	0.000	0.459	0.332	0.760	0.078
$H_0 : \beta_{3j} = 0; F(6, 176)$	2.139	0.812	1.191	1.052	0.628	1.655	0.769	1.923	2.398	1.024	0.511	0.660	3.402
p-value	0.052	0.562	0.314	0.394	0.708	0.135	0.596	0.080	0.030	0.412	0.800	0.682	0.003
$H_0 : \beta_{kj} = 0; F(18, 164)$	10.067	6.732	5.088	1.851	2.617	2.738	1.653	4.356	14.687	2.726	1.699	2.555	8.072
p-value	0.000	0.000	0.000	0.023	0.001	0.000	0.053	0.000	0.000	0.000	0.044	0.001	0.000
$z_t = (\pi_{t-2},\ \Delta_{12}w_{t-3},\ \Delta_{12}y_{t-2})$													
R^2	0.360	0.537	0.425	0.327	0.370	0.441	0.436	0.355	0.441	0.284	0.131	0.383	0.323
$H_0 : \beta_{1j} = 0; F(6, 176)$	2.813	3.077	0.760	2.230	1.675	1.387	1.803	4.719	2.586	2.322	0.757	1.809	5.965
p-value	0.012	0.007	0.602	0.043	0.130	0.223	0.101	0.000	0.020	0.035	0.605	0.100	0.000
$H_0 : \beta_{2j} = 0; F(6, 176)$	1.310	2.764	2.128	1.081	2.065	0.948	1.394	3.746	2.176	1.213	0.737	1.900	5.878
p-value	0.255	0.014	0.053	0.376	0.060	0.462	0.220	0.002	0.048	0.302	0.621	0.084	0.000
$H_0 : \beta_{3j} = 0; F(6, 176)$	4.630	4.365	3.082	3.150	3.174	4.056	4.367	4.286	2.554	4.734	1.028	1.316	1.311
p-value	0.000	0.000	0.007	0.006	0.006	0.001	0.000	0.000	0.022	0.000	0.409	0.253	0.255
$H_0 : \beta_{kj} = 0; F(18, 164)$	12.035	21.554	5.922	2.403	3.374	3.886	4.204	10.292	15.510	6.299	2.394	3.135	10.534
p-value	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000
$z_t = (\pi_{t-2},\ \Delta_{12}p^{cm}_{t-3},\ \Delta_{12}y_{t-2})$													
R^2	0.391	0.557	0.436	0.344	0.339	0.459	0.339	0.317	0.443	0.289	0.224	0.478	0.216
$H_0 : \beta_{1j} = 0; F(6, 176)$	4.130	2.857	1.084	3.123	1.325	1.049	2.688	6.065	2.814	2.720	1.374	2.498	5.414
p-value	0.001	0.011	0.374	0.006	0.249	0.396	0.016	0.000	0.012	0.015	0.228	0.024	0.000
$H_0 : \beta_{2j} = 0; F(6, 176)$	1.876	5.435	1.325	4.108	0.472	2.116	1.717	0.722	2.717	0.290	1.596	4.485	1.577
p-value	0.088	0.000	0.249	0.001	0.828	0.054	0.120	0.633	0.015	0.941	0.151	0.000	0.157
$H_0 : \beta_{3j} = 0; F(6, 176)$	3.170	2.649	2.485	3.448	2.405	5.585	2.282	1.643	4.050	6.247	2.321	0.716	1.153
p-value	0.006	0.018	0.025	0.003	0.030	0.000	0.038	0.138	0.001	0.000	0.035	0.637	0.334
$H_0 : \beta_{kj} = 0; F(18, 164)$	12.311	12.353	5.627	7.037	3.833	4.558	6.712	6.461	8.027	7.793	4.446	7.724	13.012
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: See data appendix for details of variable construction. F tests are calculated using a Newey and West (1987) HAC robust covariance estimator with lag order of 23.

TABLE 6: OUT OF SAMPLE FORECASTS

	Core	XEFT	CPI XEF										
	CA	CA	CA	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
<u>Breach of Lower Bound</u>													
$\pi < 1\%$	1	17	10	41	37	31	45	38	15	26	12	19	31
$\pi < 1\%$ and $\hat{\pi} < 1\%$	0	4	0	11	12	7	8	4	1	0	1	7	10
$\pi < 1\%$ and 95% $\hat{\pi}$ CI $< 1\%$	0	0	0	0	0	2	2	0	0	0	0	2	1
<u>Breach of Upper Bound</u>													
$\pi > 3\%$	2	5	8	13	15	13	14	9	5	4	23	37	2
$\pi > 3\%$ and $\hat{\pi} > 3\%$	0	0	0	1	0	0	0	0	1	0	0	9	0
$\pi > 3\%$ and 95% $\hat{\pi}$ CI $> 3\%$	0	0	0	0	0	0	0	0	1	0	0	0	0
Proportion of Correct Predictions	0.00	0.18	0.00	0.22	0.23	0.16	0.14	0.09	0.10	0.00	0.03	0.29	0.30
<u>False Predictions</u>													
$\pi \in [1\%, 3\%]$ and $\hat{\pi} \notin [1\%, 3\%]$	7	10	8	22	20	18	28	18	2	7	10	33	44
$\pi \in [1\%, 3\%]$ and $\hat{\pi}$ 95% CI $\notin [1\%, 3\%]$	1	0	2	4	1	2	3	1	0	0	4	7	21
Total Number of forecasts = 112													

Table 7: Out of Sample Forecasts — Deviations from Sample Means

	Core	XEFT	CPI XEF										
	CA	CA	CA	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
Breach of Lower Bound													
$\pi < \bar{x} - 1\%$	0	1	0	4	20	10	22	3	2	8	7	27	10
$\pi < \bar{x} - 1\%$ and $\hat{\pi} < \bar{x} - 1\%$	0	0	0	0	7	1	1	0	0	0	0	14	0
$\pi < \bar{x} - 1\%$ and 95% $\hat{\pi}$ CI $< \bar{x} - 1\%$	0	0	0	0	0	0	0	0	0	0	0	4	0
Breach of Upper Bound													
$\pi > \bar{x} + 1\%$	4	7	12	18	19	15	19	11	9	5	24	36	13
$\pi > \bar{x} + 1\%$ and $\hat{\pi} > \bar{x} + 1\%$	1	0	0	2	0	0	0	0	3	1	0	8	0
$\pi > \bar{x} + 1\%$ and 95% $\hat{\pi}$ CI $> \bar{x} + 1\%$	0	0	0	0	0	0	0	0	2	0	0	0	0
Proportion of Correct Predictions	0.25	0.00	0.00	0.09	0.18	0.04	0.02	0.00	0.27	0.08	0.00	0.35	0.00
False Predictions													
$\pi \in [\bar{x} - 1\%, \bar{x} + 1\%]$ and $\hat{\pi} \notin [\bar{x} - 1\%, \bar{x} + 1\%]$	9	1	3	25	17	13	23	7	3	4	11	27	7
$\pi \in [\bar{x} - 1\%, \bar{x} + 1\%]$ and $\hat{\pi}$ 95% CI $\notin [\bar{x} - 1\%, \bar{x} + 1\%]$	0	0	0	0	0	0	0	0	0	0	3	11	4
Total Number of forecasts = 112													

Table 8: Data Source

Series Defintions	Series	Release Lag (months)
Price Indices (π)		
(1) CPI XEF: CPI All Items excluding Food and Energy (2002=100)	see below	2
(2) Core: Core CPI (2002=100)	v41693242	2
(3) CPI XEFT: CPI ex. food, energy and indirect taxes (2002=100)	v41755376	2
Wages (w)		
(4) Industrial agg. ex. unclassified businesses	see below	3
Employment (e)		
(5) Persons; Both sexes; 15+; Seas. adj.	see below	2
Unemployment (un)		
(6) Rate; Both sexes; 15+; Seas. adj.	see below	2
Exchange Rate (s)		
(7) US dollar, noon spot rate, average	v37426	1
Commodity Price Indices		
(8) Total (p^{cm})	v52673496	2
(9) Total ex. energy (p^{cmx})	v52673497	2
GDP (y)		
(10) Canada; Seas. adj. ann. rates; 2002 constant prices; All industries	v41881478	4
Money Supply (m)		
(11) M2 (gross)	v41552796	2

National and provincial series codes

	CA	NL	PE	NS	NB	QC	ON	MB	SK	AB	BC
(1)	v41691233	v41691369	v41691503	v41691638	v41691773	v41691909	v41692045	v41692181	v41692317	v41692452	v41692588
(4)	v1597104	v1597132	v1597160	v1597185	v1597210	v1597238	v1597266	v1597295	v1597322	v1597350	v1597378
(5)	v2062811	v2063000	v2063189	v2063378	v2063567	v2063756	v2063945	v2064134	v2064323	v2064512	v2064701
(6)	v2062815	v2063004	v2063193	v2063382	v2063571	v2063760	v2063949	v2064138	v2064327	v2064516	v2064705

Notes: All series are from CANSIM Database; data vintage is October 2011. Country and province codes are: CA: Canada; NL: Newfoundland; PE: Prince Edward Island; NS: Nova Scotia; NB: New Brunswick; QC: Quebec; ON: Ontario; MB: Manitoba; SK: Saskatchewan; AB: Alberta; BC: British Columbia

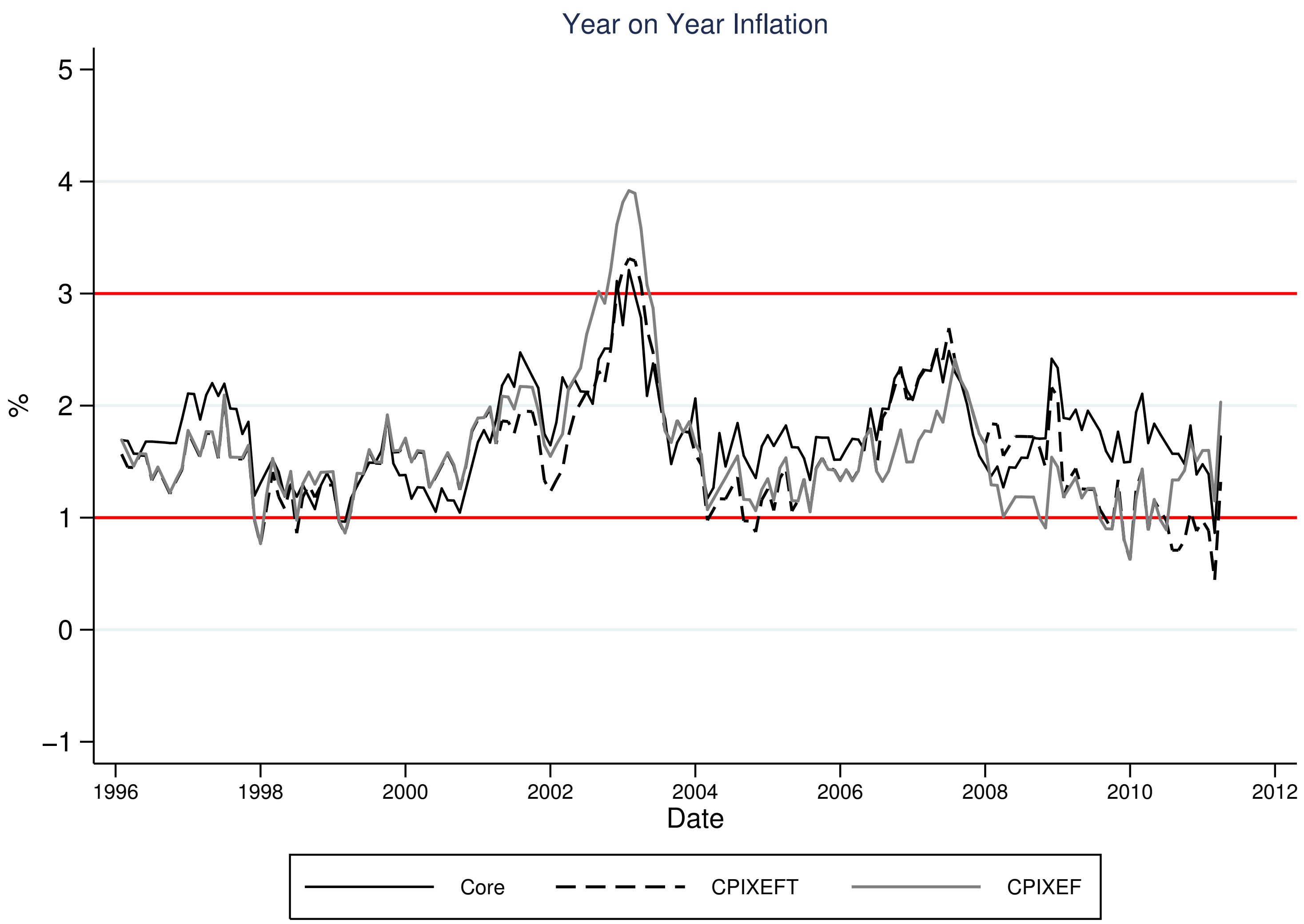

Figure 1: Canada

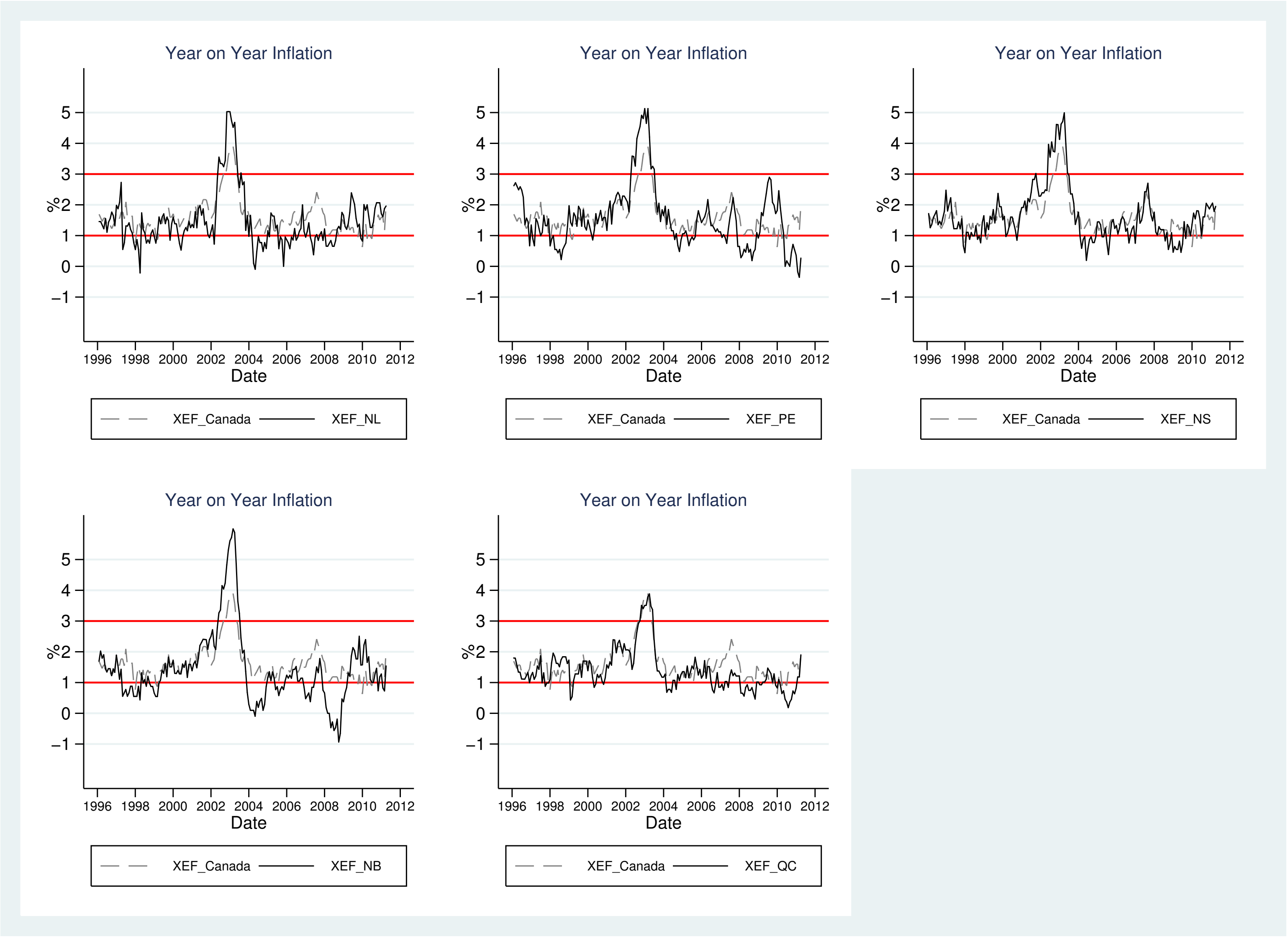

Figure 2: Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick, and Quebec

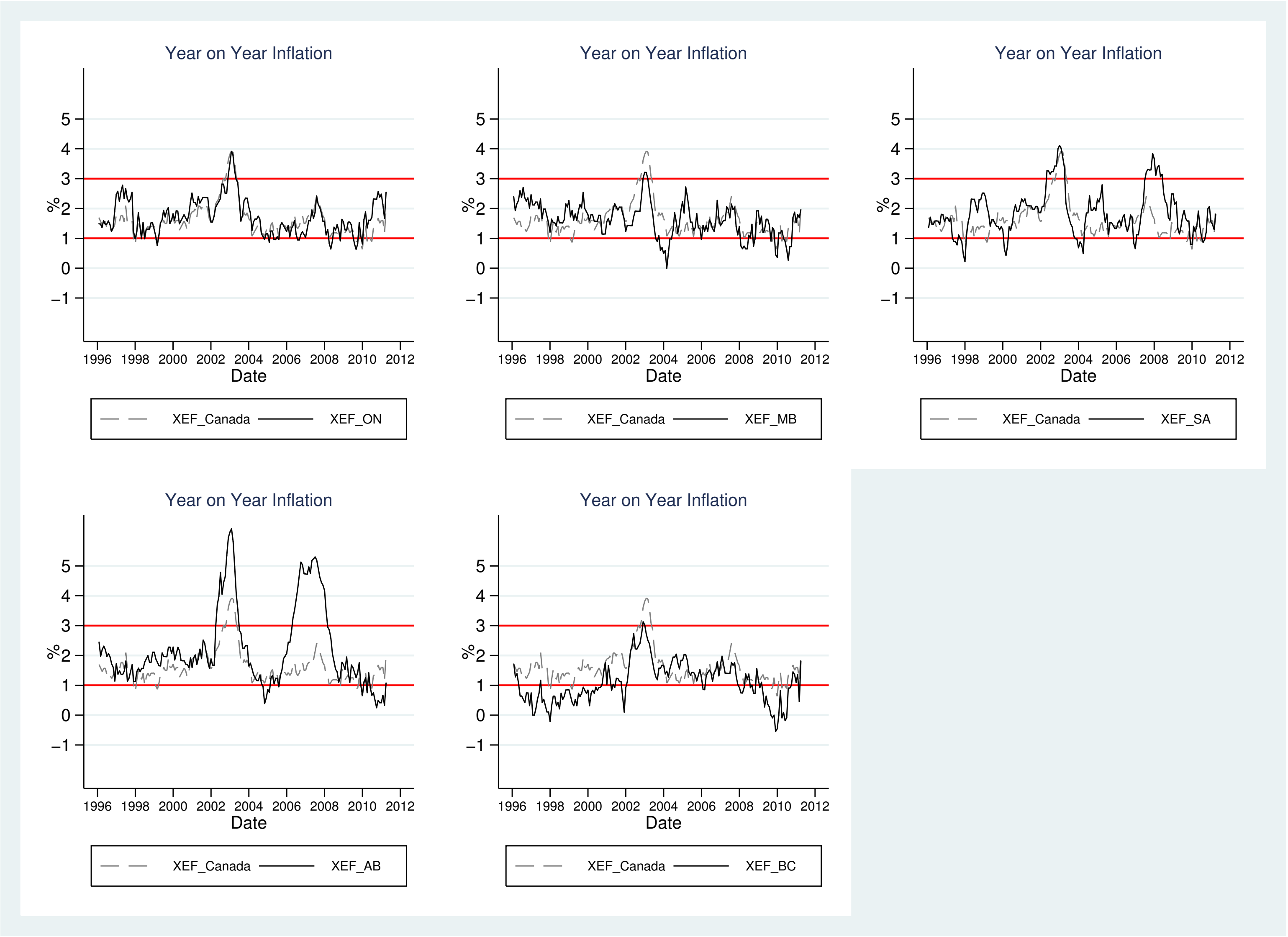

Figure 3: Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia

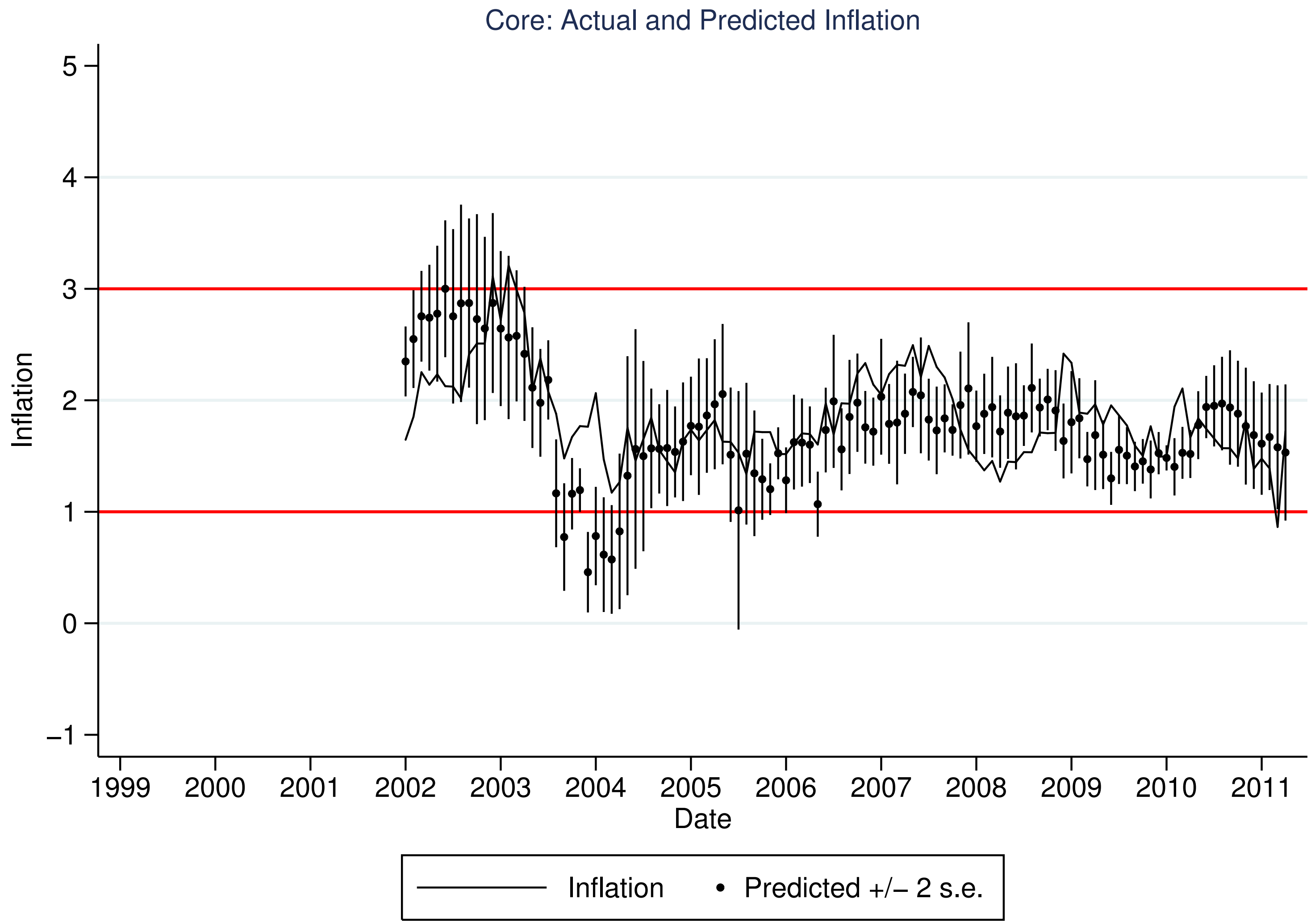

Figure 4: Two-year Ahead Out of Sample Forecasts for Core Inflation