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Shifting Drivers of Inflation—Canada versus the U.S.

With growing indications that the Canadian economy is pulling out of recession, there has been increasing attention paid to what this means for the inflation outlook. A heightened scrutiny of the inflation outlook has also been prompted by recent Canadian core inflation numbers that have been coming in stronger than expected. Expectations for a lower rate of inflation were largely based on the assumption that significant slack built up through the recession, as measured by the output gap (i.e., the difference between actual level of GDP and the level of GDP associated with the full utilization of all resources), would exert continued downward pressure on inflation. In contrast, U.S. core inflation numbers have surprised on the downside and are currently running at about one half of the comparable Canadian inflation rate. This paper looks at the significance of the output gap measure in determining core inflation in Canada and the U.S. and whether its impact has changed over time.

The main findings of the paper are that the output gap has played a less significant role in the setting of inflation¹ in Canada since the 1990s relative to the 1980s. Offsetting this diminished effect from the output gap, inflationary expectations have been playing a greater role. Projecting forward the inflation outlook, this does not necessarily imply the emergence of worrying inflation pressures as long as inflation expectations remain anchored close to the Bank of Canada's mid-range target of 2%. Rather, it implies less deviation from this rate. So although the output gap didn't put as much trend pressure on inflation as expected, a move into excess demand should not translate into a jump in inflation. An analysis of the U.S. also implies that the output gap has become a less significant factor over the period starting in 1990 versus the prior 10-year period. Expectations have similarly started to play a greater role in how inflation has evolved. However, one difference is that in the U.S. the impact of the output gap remains of greater significance compared to Canada. Assuming relatively similar inflationary expectations in the U.S. and Canada, this implies the greater likelihood for U.S. inflation to trend below Canadian inflation as long as an output gap in the U.S. economy persists. The latter seems likely to remain in effect over the next couple of years given the relatively severe decline in U.S. output through the recent recession.

¹For the purposes of this paper, inflation is calculated using a "core" measure for both Canada and the U.S. For Canada this implies the Bank of Canada core measure that eliminates the impact of both eight volatile series and indirect taxes. (The impact of indirect taxes is only available back 1984.) In the U.S. core inflation is defined as excluding the impact of the food and energy components.

The Canadian Model

Inflation for most industrialized economies can largely be viewed as a function of inflationary expectations and slack in the economy, which is often proxied by the output gap. In other words,

$$p = f(p^{\text{exp}}, \text{output gap})$$

For this analysis, we estimated a simple Phillips curve type relationship between core inflation growth, the output gap and inflation expectations for both Canada and the U.S. We then estimated these models separately over the periods from 1980q4 to 1990q4 and 1991q1 to 2009q4. The reason for establishing the break-point between samples in the first-quarter of 1991 is because inflation-targeting was adopted as an official Bank of Canada policy mandate in February of 1991. Although there was no direct policy change in the U.S. in 1991, we estimated the U.S. model over the same time periods as the Canadian model to see how the role of the various drivers of U.S. inflation may have changed over similar time-periods. The 1991 break-point also generally coincides with the stabilization of inflation expectations in the U.S. following the run-up in prices over the first half of the 1980s.

We defined the inflation process in Canada based on the following simple Phillips curve type relationship²:

$$1) \quad \pi_t = c + \beta_0 y_{t-1} + \beta_1 i_{t-1} + z_t + \varepsilon_t$$

Where π is the quarter-over-quarter difference in the natural log of core inflation multiplied by 100. c , y , and i represent a constant, the output gap, and a “persistence” term respectively. The persistence term is simply the lagged growth rate of the four quarter moving average of core CPI growth. A positive relationship between this variable and current inflation growth suggests that current inflation rates are correlated with past inflation rates. The output gap is the percent difference between actual and potential GDP estimated by the Bank of Canada. The traditional Keynesian Phillips curve assumes a positive relationship between the output gap and inflation growth. Since our independent variable is the not-seasonally-adjusted core CPI index, historical estimates of seasonal factors (z) were included to control for normal seasonal price movements.

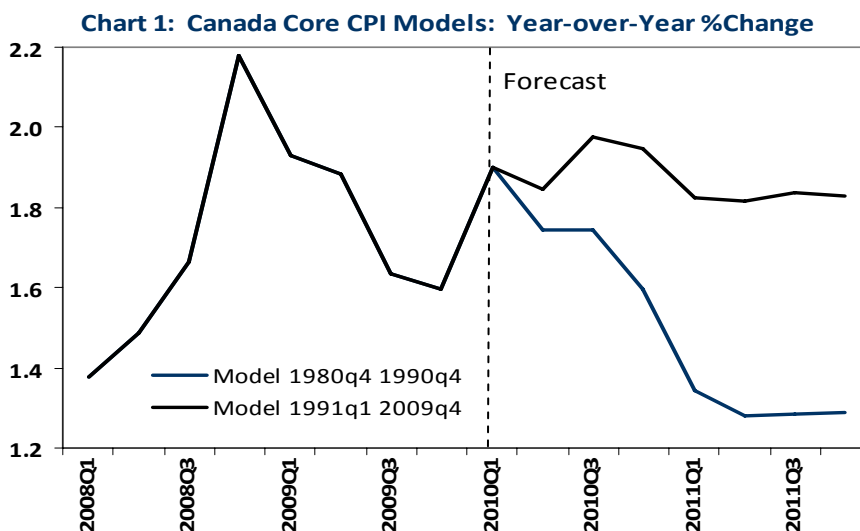
Ideally we would include an explicit forward looking measure of inflation expectations, however here we are restricted by the lack of a good historical series of inflation expectations in Canada. Over the period of price targeting, we would expect that inflation expectations remained stable in Canada and, thus, can be represented by a constant. Prior to inflation-targeting, it is likely that inflation expectations were largely correlated with past inflation and, as a result, would be captured in the persistence term.

Estimates of equation 1 over the two time-periods specified are reported in Table 1 of the Appendix. They suggest that the adoption by the Bank of Canada of an explicit target for inflation in February 1991 had a notable impact on both the persistence of inflation and its response to output shocks. Prior to 1991, inflation appears to have been largely a function of persistence (lagged inflation growth) and the output gap. The positive and statistically significant sign on the output gap over the 1980 to 1991 period suggests that core CPI growth was positively correlated with the output gap, as expected, over that time-frame. The relatively large coefficient on the persistence term (0.87) suggests that high periods of inflation tended to lead to further high periods of inflation and vice-versa.

²This model is similar to the benchmark model estimated by Demers (2003). “The Canadian Phillips Curve and Regime Shifting.” Bank of Canada Working Paper 2003-32.

However, estimating our model using only the post-inflation-target era data, core CPI growth is determined almost entirely by a constant term which, at .435, represents about a 1.8% (0.435% quarterly increase compounded over 4 quarters) annual inflation rate. The impact of the output gap and the persistence term on inflation were small and statistically insignificant over this period. This is consistent with the hypothesis that inflation expectations have been relatively well anchored at close to the Bank of Canada's 2% inflation target over the past two decades. The result of well-anchored inflation expectations appears to be that actual core CPI growth has become much less sensitive to changes in the output gap and much less persistent at levels below or above the target rate.

Chart 1 below illustrates the change in the Phillips curve model of inflation growth following the adoption of inflation-targeting in Canada. The chart shows projections for the annual increase in core CPI in Canada through 2011 based on our simple model estimated over the two separate time periods mentioned above. Using the relationship estimated over the 1980s results in a much lower profile for inflation projected through 2011 than is the case using the relationship estimated from the period 1991 to 2009. This difference largely reflects the greater importance of the output gap over the earlier period and the increasing importance of expectations over the latter period. As a result, projecting forward using our Phillips curve estimated over the 1991 to 2009 period results in a fairly steady rate of inflation that remains slightly below the Bank's 2% target rate despite the slack, or widening of the output gap, through the recent recession.



Sources: Statistics Canada, RBC Economics Research

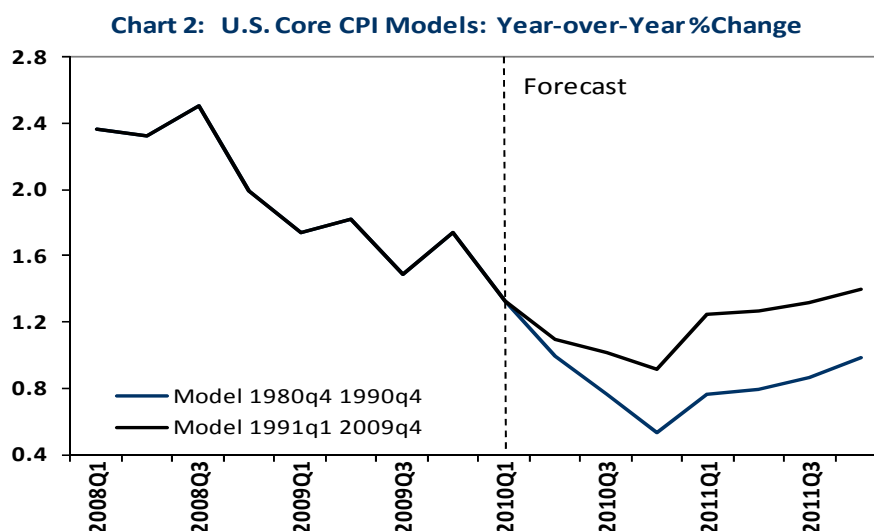
The U.S. Model

We estimated a similar model for U.S. core CPI growth based again on a simple linear Phillips curve model of price growth. However, for the U.S. we are able to utilize the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters inflation expectations measure to control more directly for the impact of expectations. As in the case of Canada, a persistence term to capture the impact of past inflation on future inflation is included as well as estimates of the output gap derived from the Congressional Budget Office's (CBO's) estimate of U.S. potential GDP.

Estimation results for the U.S. models are also reported in table 1 of the Appendix. Results suggest that, as in Canada, the role of the output gap has diminished in the U.S. relative to the role of inflation expectations since the early 1990s. This result is consistent with the success that the Federal Reserve has had in keeping inflation expectations anchored over that time-period. In fact, based on the survey of professional forecasters, expectations for 10-year average annual growth in CPI (our chosen expectations measure) have largely remained constant at 2.5% for the last 15 years or so after trending down from much higher levels in the mid-1980s.

However, unlike in Canada, our model does suggest that the output gap continues to have significant influence on the rate of inflation in the U.S. This is consistent with recent U.S. price data and suggests that the current large U.S. output gap could explain at least some of the current lower inflation growth in the U.S. compared to Canada.

The below chart shows projections for the annual increase in core CPI through 2011 generated using the models estimated over the two chosen time periods separately. The chart shows that the output gap has a much larger impact on the projection when the model is estimated over the period 1980q1 to 1990q4. The output gap still weighs on annual core CPI growth through the forecast period when using projections generated from the model estimated over the 1991q1 to 2009q4 time-period, however its impact is more moderate compared to the earlier period.



Sources: U.S. Bureau of Labor Statistics, RBC Economics Research

Conclusion

This paper used simple Phillips curve representations of the rate of inflation for both Canada and the U.S. to examine how the relative roles of the output gap and inflation expectations in determining the rate of inflation may have changed over time. Our analysis suggests that the output gap has ceased to be a significant driver of inflation growth in Canada since explicit inflation targeting became the official policy of the Bank of Canada. This could partly explain the relatively muted response of core CPI growth as the output gap widened late in 2008 and early in 2009 and the faster-than-expected return to the Bank of Canada's 2% target. However, it also implies that, provided expectations remain well anchored, core inflation could remain close to the Bank's target rate as the output gap begins to close. As a result, the Bank of Canada will likely be keeping a close eye on indicators of Canadian inflation expectations³ going forward to ensure that they remain anchored around the 2% target. This would allow the Bank to withdraw monetary stimulus at a moderate rate, allowing the output gap to close more quickly without putting significant upward pressure on inflation. Results for the U.S. suggest that the output gap remains a significant factor in determining the rate of inflation, however its role has diminished since the 1980s with expectations increasing in relative importance.

³On its webpage (<http://www.bank-banque-canada.ca/en/rates/indinf.html>) the Bank of Canada provides a list of important measures of inflation expectations. These include the inflation expectations measure in the Conference Board of Canada's Business Confidence Index, monthly forecasts for inflation published by Consensus Economics, the Senior Loan Officer (SLO) survey's inflation expectations measure as well as expectations implicit in the spread between nominal and real-return bond spreads.

Appendix

Table 1: Model Estimates

	Canada Models		U.S. Models	
	1980:4-1990:4	1991:4-2009:4	1980:4-1990:4	1991:1 2009:4
constant	0.090 (0.10)	0.435 (0.09)	- -	- -
persistence (i)	0.873 (0.07)	0.050 (0.20)	0.408 (0.18)	0.495 (0.12)
output gap (y)	0.064 (0.02)	0.002 (0.01)	0.056 (0.02)	0.017 (0.01)
expected inflation (e)	- -	- -	0.163 (0.05)	0.109 (0.03)
seasonal factor (z)	1.030 (0.30)	1.035 (0.18)	1.372 (0.30)	1.131 (0.12)

*Standard errors reported in brackets below coefficient estimates

Data definitions:

Constant: A constant term is included in the models for Canadian core CPI growth. In the absence of a separate expectations term the constant proxies for such in an environment of stable expectations.

Core CPI (π): Consumer price index excluding the eight most volatile components and the effect of indirect taxes. Prior to 1984q2, core CPI refers to the consumer price index excluding the eight most volatile components only (the series removing the impact of indirect taxes was not available until 1984q1.)

Persistence(i): defined as the difference in the natural log of a four quarter moving average of the core CPI index in Canada.

Output Gap(y): The percent difference between actual and potential GDP estimated by the Bank of Canada

Expected inflation rate (e): The annual inflation rate expected over the next 10 years according to the Survey of Professional Forecasters published by the Federal Reserve Bank of Philadelphia.

Seasonal Factors (z): The difference in the natural log of historical core CPI seasonal factors estimated by the Bureau of Labor Statistics in the U.S. and Statistics Canada in Canada, multiplied by 100. (Statistics Canada only publishes estimates of core CPI seasonal factors back to 1984. Prior to this, seasonal factors are determined using the x12 seasonal adjustment program published by the Bureau of Economic Analysis in the U.S.)

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