What Has Inflation Targeting Changed in Canadian Monetary Policy?

Paul Hubert

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Abstract

In 1991, Canada has been one of the first to adopt inflation targeting. This paper investigates the empirical implications of this change of strategy. Comparing first the performance of different forecast model of inflation, I find that the best model of inflation forecast is now 2: the middle of the target range. Second, a main contribution of this paper is to determine the weight accorded to each objective by the Bank of Canada in the conduct of its monetary policy. The results of the estimated policy rules point to differences in the coefficients that are consistent with conventional wisdom for the seventies and eighties and show that the behaviour of the Bank of Canada has changed since inflation targeting. It responds in a stabilizing and strong way to expected inflation and more significantly than before to expected output. This paper suggests that by more firmly anchoring expectations of inflation, the monetary policy of the Bank of Canada has been able to focus more attentively on growth.

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* PhD Student at Sciences Po Paris - OFCE (France). Contact: paul.hubert@ofce.sciences-po.fr. This paper was written during a research assistantship under the direction of Jean Boivin at the Business School of Columbia University. I would like to thank Jean Boivin for his very helpful and insightful advices, comments and suggestions. I also thank Jérôme Creel for his help making this research assistantship possible.
1 Introduction

Inflation targeting is one of the most significant developments of the theory and practice of monetary policy of the last decade. While a growing amount of papers study the characteristics, the implications and the impact of inflation targeting, an increasing number of central banks among which Canada, United Kingdom or Sweden have adopted this framework with a certain success in terms of pursue of a low and stable inflation. Some papers have studied the macroeconomic outcomes of inflation targeting and the results are mitigated. On the one hand, Mishkin (1999) and Neumann and von Hagen (2001) and on the other hand, Ball and Sheridan (2003) have showed diverse empirical results about the value added by inflation targeting to economic performance. Thus, there is still a long way to find a consensus about the macroeconomic impact and all the more so as the most aggressive critics deal with the neglect of the growth objective at the expense of the solely inflation objective. Opponents also point up the opaqueness of a supposed transparency and increased communication that only evocate the stability of prices.

Canada being one of the first to adopt inflation targeting in 1991 and thus providing a longer experience with this regime, the goal of this paper is to identify empirically the implications of the changes due to inflation targeting on the actual conduct of the Canadian monetary policy and also on the behaviour of inflation. Indeed, one may imagine that the adoption of this framework has just been a pure advertising: an announcement without concrete changes. Inflation had already decreased substantially before the adoption of the new regime and the neighbour economy: the United States succeed to bring its inflation to a low and stable level without it. The objective is then to determine whether the central bank has really changed its behaviour with the adoption of this new monetary policy framework and what have been the implications of the changes.

This paper consists of a two-step strategy. First, a comparison calculated in real time of different models of inflation forecast to a model based solely on the middle point of the target range: 2, analyses the credibility of the target and the anchorage of expectations across time. The second step characterizes the behaviour of the monetary authorities (what means the link between its instrument -the central bank rate- and the monetary and economic conditions) in a way
adopted by Clarida, Gali and Gertler (2000) and estimates by GMM the reaction function of the Canadian central bank. The inclusion of a set of instruments and forward-looking terms for inflation and output in the specification appears to be consistent with the reality of central bank behaviour and then, perform well in describing the monetary policy actions.

The results of this paper are the followings: since inflation targeting has been implemented, in comparison with other models, the more accurate one of forecasting inflation is simply 2. This outcome show that the evolution of inflation is now easily readable, what suggests that the expectations are now better and stronger anchored.

In appreciation of the existing literature, a marginal contribution of this paper is to provide on the last three decades the estimated policy rules of the Bank of Canada and thus to determine the actual conduct of the monetary policy: the differences across time in the response to inflation and growth. The results show that there is a significant difference in the way monetary policy has been conducted pre- and post-inflation targeting. When the coefficients in the estimated policy rules during the seventies and eighties confirm the spread wisdom about the macroeconomic evolution of these two decades, they show that the central bank responds strongly to expected inflation, in a stabilizing way: the coefficient of response is thus above one since inflation targeting. Moreover, it appears from the estimates that it responds also now meaningfully to the real activity variable. These differences could be argued as an important shift in the monetary policy behavior due to inflation targeting.

While one of the main critics of inflation targeting is to neglect or even to abandon the objective of growth, an interesting suggestion of this paper is that by more firmly anchoring expectations of inflation, the monetary policy of Bank of Canada appears to have been able to focus more attentively on growth. This paper suggests inflation targeting has made Canadian monetary policy more stabilizing for inflation and more apt to take care of the real activity side. It is as if while the central bank ties its hands with its commitment to inflation, this precise engagement (by making it gain credibility and anchoring better expectations) unties its hands to response in a discretion way to growth.

The rest of the paper is organized as follows. Section 2 discusses the literature on the inflation targeting framework. Section 3 builds the comparison of real time forecasts of inflation.
Section 4 estimates and describes Canadian monetary rules and the behaviour of the Canadian central bank across time. Section 5 provides evidence of a structural change in the parameters since the adoption of inflation targeting. Section 6 concludes.

2 Related Literature

In last decades, a large number of central banks have adopted as framework for monetary policy explicit “inflation targeting” or at least, informally considered it. This regime, as described by Svensson (1997, 1998) is characterized by (i) an announced numerical inflation target by the central bank (mostly in coordination with the government) in the form of a target range, a point target, or a point target with a tolerance interval and a timetable for reaching that target, (ii) the framework for policy decisions uses “inflation-forecasts targeting” in the extent that the central bank forecasts inflation at medium- and long-term horizons and these serve as an intermediate target and (iii) a high degree of transparency and accountability. The two important features are that low and stable inflation is the overriding goal of monetary policy and that communication with public about the plans and objectives of policymakers and their accountability to reach them must be increased.

Inflation targeting has taken various forms since it appears in 1990 in New-Zealand. A number of industrialized countries, including Canada, and the United Kingdom, New-Zealand, Australia, Sweden have highly publicized changes to inflation targeting and institutionalized a commitment to give much meaning to this strategy. Some monetary approaches, like in Germany (before EMU) or Switzerland, contain important elements of inflation targeting and the Maastricht treaty mandates price stability as the primary objective of the European Central Bank, incorporating some of the elements of inflation targeting in its procedures.

Bernanke and Woodford (1997) and Bernanke and Mishkin (1997) were the firsts to name the advantages and inconveniences of this strategy for conducting monetary policy. The major advantage is to increase transparency and coherence of monetary policy and in a flexible way, discretionary policy actions can be proceed. There is breathing space for additional secondary objective, albeit achieving the inflation target is the primary objective. Moreover, the “velocity
instability” problem\(^2\) can be ruled out by setting target for the goal variable rather than for an intermediate indicator (such as money growth).

The main disadvantages come from the empirical fact that inflation responds to changes in monetary policy with a non-negligible lag, from one to two years. This implies two problems: first, the information the central bank needs to target inflation can be much more important than that needed to target an intermediate variable. Second, it could be difficult for the central bank to know and let know to public whether the forecasts are out of line of reality, which has potentially adverse consequences for the central bank’s accountability and credibility.

One of the possible ways to overcome this problem has been studied by Bernanke and Woodford (1997) and consists in targeting forecasts of medium-term inflation\(^3\). However, the authors find that targeting forecasts is not fully satisfying solutions because of two reasons: paradoxically, the success of targeting forecast conduce to private sector to stop to gather information and then the inflation forecast becomes uninformative. Furthermore, attempts to target forecasts of inflation lead to indeterminacy of the rational expectations equilibrium. The main general conclusion is that central banks should turn to a more subtle approach where forecasts are used as one of the several sources of information and not tie monetary policy too much to any variable sensitive to expectations of public.

Finally, inflation targeting is more defined as a framework or a strategy than a rule.

A growing literature has now developed to find out how to make inflation targeting better. Among many papers, one may quote King (1999) who suggested that the long-run performance of an inflation-targeting central bank might be based on a price path constructed from the accumulation of inflation targets. Also, support for including a price path among the central bank’s objectives is found in the econometric study for Canada by Black, Macklem, and Rose (1997). Support for a degree of price-path targeting has also been demonstrated in a variety of small policy models by Dittmar, Gavin, and Kydland (1999), Clarida, Gali, and Gertler (2000), Vestin (2000), and Nessen and Vestin (2000).

Concerning the monetary rules and problems of multiples solutions, Benhabib, Schmitt-Grohè, and Uribe (1999) show that there are at least two equilibria (including one with low output and

\(^2\) When there are unexpected changes in the relation between the intermediate target and the final objective.

\(^3\) For this, three types of approaches have been proposed: central bank targets (i) the forecast of private sector, (ii) the forecast of inflation implicit in various asset prices and (iii) its own internal forecasts of inflation.
deflation) in monetary models where the central bank uses a Taylor rule to conduct policy. Clarida, Gali, and Gertler (2000) and Carlstrom and Fuerst (2001) show that backward-looking Taylor rules may result in real indeterminacies (the real interest rate may take on many different values) that may lead to economic instability, because even if a central bank has an inflation target, the policy regime may include bubbles and sunspot equilibriums if the central bank is not sufficiently aggressive in reacting to inflation. Dittmar and Gavin (2003) report numerical results showing that putting just a small weight on a price-path target eliminates this source of real indeterminacy in the flexible-price models.

About the incomplete policy representations, Mankiw (2003) argues that neither New Keynesian nor New Classical models adequately capture realistic inflation-output dynamics and claims that the empirical facts are better explained in a model with incomplete information. Thus, Ball, Mankiw, and Reis (2003) use such a model to show that a flexibly implemented price-path target is the optimal policy in the presence of shocks to productivity and aggregate demand.

The main critics of inflation targeting concern the emphasis made on the inflation goal at the expense of the output goal. Opponents deplore the lack of communication about output or unemployment and the weight, compared to that on inflation, that central bank place on this objective. They argue that if at all there is one, the interest in real activity is hidden and does not contribute to transparency, one of the main advantages advocated by the pioneers of inflation targeting framework.

In a large study about inflation targeting, Faust and Henderson (2004) look over the different critics to be made to this framework. Now the mean of inflation is low and stable in almost all industrialized countries, the main problem of the conduct of monetary policy is about the variance of inflation and they argue than inflation targeting does not constitute “best practice” in resolving this question. Furthermore, they argue that inflation targeting (by the way the pre-eminence of the inflation goal is stated) obscures rather than facilitates the communication of “best-practice” policy: inflation targeting bending heavily on stabilizing inflation, several usual features give inflation a role that is literally inconsistent with optimization. Then, the primary shortcoming of the inflation targeting is that it does not explain clearly the roles and balance of multiple goals.

For instance, the prerogatives of the Fed naming specifically inflation and growth, opponents do not want to let disappear the reference to growth to the Federal Reserve’s requirements.
In that way, Faust and Svensson (2001) present an example in which inflation fluctuates narrowly around the optimum value, but due to lack of transparency about the nature of other goals the economy is significantly more volatile than under full transparency. Moreover, inflation targeting imposes many requirements, for example, fixed horizons, target ranges, lexicographic preferences regarding price stability. To authors, these requirements might be viewed as constraining policy, but they are inconsistent with optimization and generate dissonance between how the banks talk and how they act.

Then, they made some suggestions. First, central banks should communicate in a balanced way about the objectives driving short-run policy. To the extent that other goals are more difficult to quantify than the inflation stability goal, the need for clear reporting is increased. The main idea is that the focus on inflation has allowed a better understanding; putting real stability on the table can promote similar innovation on the real side. Second, central banks should strive to communicate clearly the likely line of policy. If forecasts are part of this process, the relationship between the forecasts and the future course of policy should be explained. Only if there is a known relationship from the forecast to policy is that forecast of clear use (Svensson and Woodford (2003)). Then, a more detailed explanation of the link between the forecast and future policy would be useful, because under standard practice, the forecasts are of unclear value in understanding the course of policy.

Friedman (2004) analyses that inflation targeting contribute to banish from the objectives of monetary policy any concerns for real activity by communicating solely on inflation issues. He argues herewith that inflation targeting is actually obscuring central bank’s goals and that it, refusing to talk explicitly about others goals, tries “not just to manage the public’s expectations but to manipulate them”.

At last, while Mishkin (1999) and Neumann and von Hagen (2001) has shown the macroeconomic value added of it, Ball and Sheridan (2003) show by empirical comparison between inflation targeting and non-targeting countries that the economic performance (measured by inflation and output) did not improve with inflation targeting framework. To explain this result, one possibility is that targeting and non-targeting countries pursue almost similar policies, for instance, the Fed has demonstrated that one can run policy with at least reasonable success without placing constraints on policy or communication. In that way, Svensson (2003) argues that the will not to adopt inflation targeting comes from the will of the FOMC not to lose the freedom to secretly change its goals.
concentrating a lot more on the inflation goal since the beginning of 1980s and furthermore, all the countries of the sample have known approximately the same evolution of inflation during the last two decades. For instance, as Mankiw (2001) suggests, US has been a “covert inflation targeter”. That is why the comparison does not distinguish significant difference and that the value added of the inflation targeting does not find strong evidence in the recent data.

So because, the comparison between countries which have and have not adopted this framework does not make satisfying sense, a comparison of some changes in the evolution of one monetary policy of one country could maybe give us better answers.

*The case of Canada*

Regarding to Canada, in February 1991, the federal government and the Bank of Canada jointly announced the setting up of inflation targeting. The targets specified a decelerating path of the year-over-year rate of CPI inflation, with a target of 3 per cent to be reached by the end of 1992, declining to a target of 2 per cent by the end of 1995. The goal of these series was to reduce the core inflation, measured by the consumer price index excluding food and energy and effects of indirect taxes. The 1 to 3 per cent target range for inflation has been extended thereafter. The time horizon of the policy is usually considered to be 18 months. Figure A illustrates Canada’s inflation experience since the inflation targeting.

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**Figure A**

*Consumer Price Index in Canada*  
(monthly, year-over-year)
As shown in Figure A, in 1991 at the time of the announcement of pursuing an inflation target, the rate of inflation was over 6 per cent. This was due to the introduction of a value-added tax (the Goods and Services Tax) which temporarily increased the CPI inflation. During the first year, inflation declined, going below the target and coming back into the range as the range itself declined in line with the path outlined. Finally, inflation has always remained within the range. Moreover, to establish its credibility, central bank made inflation starts on the down side of the range rather than around the upper limit.

To complete the requirements of inflation targeting, the Bank of Canada has furthermore decided to publish a detailed account of inflation developments and the conduct of monetary policy in its semi-annual *Monetary Policy Report*, in order to improve the transparency and accountability and thus, the Bank’s credibility. Concerning credibility, studies from Perrier (1997) and Johnson (1997, 1998) conclude that the Bank of Canada has developed increasing credibility over the inflation targeting period. Moreover, Ravenna (2002) shows that the credibility gains of the Bank of Canada from inflation targeting are a key factor for stabilizing inflation and that the central bank interest rate would have had to be considerably more volatile to attain the inflation target goal when not enjoying full credibility.

### 3 Comparing Forecasts

The first step of this investigation consists of comparing the effectiveness of some different simple models of forecast of inflation with a model solely based on the inflation target of the Bank of Canada\(^6\). The main idea is to determine whether the target is a fine predictor of future inflation. More precisely, the goal of this approach is to reveal whether or not the introduction of inflation targeting has made the forecasts of inflation more precise and then has allowed the forecasts and going further the anchorage of expectations to gather around the target (under the realistic assumption of credibility of the central bank of Canada and knowledge by private agents of the inflation target).

\(^6\) For this exercise, I consider the middle point of the range defined by the Bank of Canada: 2 per cent, which corresponds with the target of other inflation targeting regime like Sweden and is the desired level of inflation of some other central banks, like the ECB.
The different forecast models used are the following:

- an adaptive model: \( \pi_{t+h} = \pi_t \)

- a mean model: \( \pi_{t+h} = \frac{1}{n} \sum_{i=1}^{n} \pi_i \)

- a AR(1) model: \( \pi_{t+h} = c + \beta \cdot \pi_{t-1} \)

- a AR(p) model: \( \pi_{t+h} = c + \sum_{i=1}^{p} \beta_i \cdot \pi_{t-i} \)

- the inflation target model: \( \pi_{t+h} = \bar{\pi} = 2 \)

All forecasts were computed using the real time methodology, which means that at every date \( t \), forecasts of inflation are reconstituted only with information available at this date \( t \). In the mean model, the forecasts are based on a constant: the mean of past values of inflation on the estimation period. In the AR(p) model, the \( k \)-number of lags determined by the Schwarz Information Criteria is re-calculated for each date to satisfy to real time. These forecasts are computed for different horizons \( h=1, 2, 3, 6, 12 \) and 18. For the five models, they are finally compared for every date of the sample to the effective values of inflation\(^7\). Thus, the forecast error is calculated by the Root Mean Squared Deviation (RMSD) between the forecast and the effective value. Three periods of test are defined: the global period (1970:1 to 2006:1), the pre-inflation targeting one (1970:1 to 1991:1), the post-inflation targeting one (1996:2 to 2006:1, letting five years of estimation after the beginning of inflation targeting).

One might defend that inflation, like many other macroeconomic time series, has become much less volatile, so the root mean squared error of relatively simple forecasts had declined since the mid-1980s. Then, inflation becoming easier to forecast due to a lower volatility, the RMSD of inflation forecasts has fallen. However, the important point here is not the RSMD of the forecast itself but the RMSD of the inflation target model compared to the one of the other models.

Moreover, in order to demonstrate the relevance of these models, the performance of standard multivariate forecasting models, such as the backwards-looking Phillips curve, has been weaker since the mid-1980s than before. This point has been vigorously argued by Atkeson and Ohanian.

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\(^7\) The series are taken from the Datastream database. The inflation rate is the year-over-year change of the consumer price index. The original data set runs from 1960:1 to 2006:1.
(2001), who find that backwards-looking Phillips curve forecasts are inferior to a naïve forecast of average twelve-month inflation.

Table 1 presents the results. For pre-inflation targeting period, the forecast error of adaptive, AR(1) and AR(p) models are quite similar for each horizons and are the lowest: they are the best models of forecast of future inflation. However, for post-inflation targeting period, the tendency inverts. For the very short term, the threesome adaptive, AR(1) and AR(p) is still the better predictive, whereas for the 6, 12 and 18 months horizons, the inflation target model has the lowest forecast error of all models. Moreover, the model with the constant fixed at 2 performs even better than the mean of past values of inflation revaluated at every date. The constant fixed at 2 is better than a constant evaluated on the mean of the past values. Therefore, the best forecast model of inflation is simply 2 since inflation targeting has been promulgated.

At last, a comparison between the post-inflation targeting RMSD and a fourth test period (from 1996:2 to 2006:1, with a estimation period beginning in 1960:1) shows that the forecast error is highest considering estimation on the complete period than only on the post-inflation targeting period. This result indicates that a forecast during the post inflation targeting period is more accurate by dint of a estimation sample based on the post period than a estimation sample widen on the complete sample. This confirms the presence of a structural change in inflation process at the split sample date (see section 5).

Then, one may affirm that by forecasts more accurate and under the realistic assumption that the Bank of Canada is credible and that private agents know the target of this one, the evolution of inflation is more readable and so the inflation expectations are more firmly anchored. Monetary policy is pre-eminently production of signals able to structure expectations in the direction of stability and credibility. These first results show that inflation targeting fulfil these requirements and then, could be an efficient framework for a good inflation control.

Moreover, whatever the models or the horizon, the RMSD is the lowest for the post-inflation targeting period. If it is not a surprise that inflation, like many other macroeconomic time series, has become much less volatile since the mid-1980s, one might suppose that inflation targeting has contributed to accelerate the stabilization of inflation (see Section 4).
The results of Table 1 could be roughly compared with two working papers of the Bank of Canada: Engert and Hendry (1998) who use and improve the M1-based vector-error-correction model (VECM) developed by Hendry (1995) to forecast inflation, and Gosselin and Tkacz (2001) who develop factor model including a set of hundreds of macroeconomic and financial variables also to forecast inflation. If the results can not be compared rigorously and scientifically because of some different frequencies, horizons or estimation period, the main view is that the RMSD of inflation target model is still the lowest.

These findings confirm and extend the results of Amano, Coletti and Macklem (1999) who demonstrate that the dispersion of inflation forecasts across forecasters\(^8\) is decreasing for the years 1985 to 1997. This convergence of inflation expectations across forecasters is suggestive of uncertainty reducing. More precisely, they show that for the inflation targeting years, private sector forecasts are closer to the mid point of the Bank’s target range and conclude that the smaller the deviation is on average, the better expectations are anchored on the target.

An other paper tends to confirm these findings: Yetman and Rowe (2002) implement a test to find out whether or not a policy authority is targeting inflation. They reject the hypothesis that Bank of Canada was targeting low inflation before 1991 and affirm that the inflation targeting announcement reflected well a change in the conducted policy. The changes in inflation process and about expectations anchorage can be placed to the credit of the inflation targeting framework. Finally, Levin, Natalucci and Piger (2004) show in the same way, that private sector inflation forecasts are uncorrelated with lagged inflation in Australia, Canada, New Zealand, Sweden and the United Kingdom and then conclude that inflation targeting is quite successful in delinking expectations from realized inflation.

## 4 Canadian Monetary Rules

The aim of this section is to report estimates of the policy reaction function of the Bank of Canada to try to describe the past policy actions of the Canadian monetary policy over the last decades. Indeed, some lessons can be extracted from changes in the coefficient of response to

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\(^8\) Listed by Consensus Forecasts Canada.
inflation and output gap before and after the inflation targeting: first, results confirm the existence of a strong relationship between the central bank rate and the forecasts of future inflation and a more varying one with the output gap. Second, they identify changes in the conduct of monetary policy across the last decades and more specifically for the pre- and post-inflation targeting periods.

The baseline specification of the policy rule take as instrument of monetary policy the central bank rate, what appears to be a generally admitted and reasonable choice (Bernanke and Mihov (1998)). The baseline policy rule takes this form:

\[ r_t = (1 - \rho)(\beta \cdot E_t \pi_{t+k} + \gamma \cdot E_t Y_{t+q}) + \rho(L)r_{t-1} \]  

where \( r_t \) is the central bank rate, \( E_t \pi_{t+k} \) and \( E_t Y_{t+q} \) are the expected value of inflation and some proxy of the real activity, respectively at horizons \( k \) and \( q \). The strength of the response to each of these variables depends on the weights \( \beta \) and \( \gamma \). The parameter \( \rho \) specifies the degree of interest rate smoothing, with \( \rho(L) = \rho_1 + \rho_2 L + \ldots + \rho_n L^{n-1} \), and where \( \rho \equiv \rho(1) \). More precisely, each period the central bank adjusts its rate to reduce of a part \( (1 - \rho) \) the distance between its target level and some linear combination of its past values.

This policy rule has some interest on both theoretical and empirical grounds: approximate (and sometimes exact) forms of this rule are optimal for a central bank that has quadratic loss function in deviations of inflation and output from their respective targets in a simple macroeconomic model with nominal price inertia (Svensson (1997)). On the empirical side, Taylor and since, a large number of authors have shown that this kind of policy rules provide reasonably good descriptions of the conduct of monetary policy. This rule corresponds to the popular rule proposed by Taylor (1993), augmented by forward looking specification for inflation and output variables and lags of the central bank rate.

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9 This intertemporal smoothing behaviour can be explained from different ways: the monetary authorities wish not to destabilize the financial markets by too curt changes. A second argument is that the optimal monetary policy is unknown and so a degree of cautiousness can not be harmful. Finally, Woodford and Rotenberg (1997) and Woodford (1999) show that a certain degree of inertia of monetary policy reinforce the credibility.
Considering the methodology of Clarida, Gali and Gertler (2000) and too strong restrictions (first, the rule treats all changes in interest rates along time as reflecting the central bank’s systematic response to economic conditions and second, it assumes that the central bank has perfect control over interest rates), equation (1) is rewritten:

\[ r_t = (1 - \rho)(\beta \cdot \pi_{t+k} + \gamma \cdot Y_{t,eq}) + \rho(L)r_{t-1} + \varepsilon_t \]  

(2)

where \( \varepsilon_t \equiv -(1 - \rho)\left[ \beta(\pi_{t+k} - E\pi_{t+k}) + \gamma(Y_{t,eq} - EY_{t,eq}) \right] \)

Let \( z_t \) designate a vector of instruments known when \( r_t \) is set. Equation (2) implies the set of orthogonality conditions:

\[ E\left\{ [r_t - (1 - \rho)(\beta \cdot \pi_{t+k} + \gamma \cdot Y_{t,eq}) - \rho(L)r_{t-1}] \cdot z_t \right\} = 0 \]  

(3)

Equation (3) provides the basis for the estimation of the parameter vector \((\beta, \gamma, \rho)\) using the Generalized Method of Moments (Hansen 1982) and more specifically the Two-Stage Least Squares Method, with an optimal weighting matrix that explains possible serial correlation in \( \varepsilon_t \).

A test of overidentifying restrictions – the Hansen J-test – to assess the validity of the specification as well as the set of instruments used is run as the dimension of vector \( z_t \) exceeds the number of parameter being estimated.

As generally admitted, in this rule, the sign of the response of the real interest rate to changes in expected inflation and output gap depends respectively on whether \( \beta \) is greater or less than one and on the sign of \( \gamma \). Thus, interest rate rules characterized by \( \beta > 1 \) will tend to be stabilizing, whereas those with \( \beta < 1 \) accommodative to shocks to the economy. The sign of \( \gamma \) (stabilizing if \( \gamma > 0 \), destabilizing if \( \gamma < 0 \)) follows the same logic. Benchmarks \( (\beta = 1, \gamma = 0) \) are then settled to evaluate differences in the estimated policy rules across time.
Furthermore, this estimation method presents other advantages: the forward-looking specification based on a set of informative instruments allows the central banks to form judicious expectations about the future of the economy, a feature that appears to be highly realistic with the effective behaviour of central banks and as Bernanke and Boivin (2003) show that the use of data-rich environment can improve the estimation of the Fed’s policy reaction function. Second, one of the most important characterization of the inflation targeting framework being the announcement and targeting of inflation forecasts, and the monetary authorities trying to respond to future inflation in order to smooth policies, a forward-looking rule renders well the reality of this central bank behaviour.

Before proceeding, some econometric issues are raised: the empirical analysis suppose the assumption that both inflation and the interest rate are stationary. This assumption seems to be reasonable for Canada. In addition to its empirical plausibility, stationarity of both inflation and the interest rate is also a property of many papers that use policy rules. Second, estimating the rule over a short sample and with little variability in inflation can return highly misleading results, the sample period must contain sufficient variation and be sufficiently long to determine well the coefficients. The samples satisfy these conditions.

Results
The data are quarterly time series\textsuperscript{10} from 1969:2 to 2005:1 and divide into three main subperiods. The first (69:2-79:4) is the -generally admitted- period of the raising inflation and accommodative monetary policies. The second (80:1-90:4) matches the disinflation period whereas the third (91:1-05:1) corresponds to the inflation targeting. The comparison is not made on pre- and post-inflation targeting periods, due to the fact that the pre-period can generate misinterpretation: the two first subperiods roughly correspond to the unstable and stable eras of recent macroeconomic history. The baseline inflation measure is the year-over-year rate of change of the Consumer Price Index Excluding, Food and Energy\textsuperscript{11}. The baseline ‘real activity’ measures are the unemployment rate, the detrended output (the deviation of GDP from a fitted

\textsuperscript{10} All series are taken from the Datastream database.

\textsuperscript{11} Because of the introduction of the Goods and Services Tax or GST (which is a multi-level value-added tax) in Canada, on January 1, 1991 by then-Prime Minister Brian Mulroney, I use the same measure (CPIXFE) but excluding also effects of indirect taxes for the inflation targeting period beginning at the same date, to keep the same benchmark across the samples.
quadratic function of time\textsuperscript{12}) or the year-over-year rate of change of the real GDP\textsuperscript{13}, according to the best statistical results. The instruments set includes lags of the central bank rate, inflation, ‘real activity’ measure, and same number of lags of energy price inflation, M2 growth, and the spread between the long term bond rate and the three-month Treasury Bill rate.

The methodology is the following: to determine the best specification, several tests of different monetary rules are executed over the sample of inflation targeting (91:1-05:1): different lags in the instruments set, different horizons ($k$ and $q$) and different forms of the baseline monetary rule ($\gamma = 0$ and $\rho = 0$), with different variables for $\gamma$, are tested. The specification with one lag in instruments, $k=1$ and $q=1$, and one lag of interest rates is kept\textsuperscript{14} and the estimation extended to the other samples. Table 2\textsuperscript{15} presents GMM estimates of the interest rate rule parameters $\beta$, $\gamma$ and $\rho$ for each sample period.

Given the results of all rules, it seems to appear that the conventional variables for the real activity: the detrended output and the rate of unemployment are not suitable for this kind of estimation on Canadian data. Thus, the $p$-values of the Hansen J-test show that the specifications containing these variables are wrong and the $t$-stats characterizing the significant of the coefficients are low. Moreover, these rules show results which are totally inconsistent with conventional results identified by a large consensus for the monetary policy rules: the response to inflation is supposed not to be negative. That would make any theoretical sense.

\textsuperscript{12} The sign of the resulting series is switched in order to preserve the sign interpretation for parameter $\gamma$.
\textsuperscript{13} See below for further discussion.
\textsuperscript{14} The results of others specifications are of the same order and retrace same evolutions. Only too far horizons return different and non-relevant results. The specification is also tested with exchange rate in level and in change from its steady state, but the results are not more interesting.
\textsuperscript{15} Concerning the statistical results, one can note that the more the specification brings into play some other elements, the lower the statistical results are. One of the possible explanations of the low statistical results might be the nature of the inflation and central bank rate process. On the complete sample period of estimation, the standard deviation of inflation is 3.15 in Canada compare to 2.70 for the same measure of inflation in US. Identically, the standard deviation of the central bank rate is 3.60 in Canada for 3.20 in US. This comparison shows a larger variance for both main variables and it might explain why this kind of rules give better statistical results in US than in Canada. Moreover, coefficients of pre-1991 policy reaction function are difficult to estimate, due to the fact that the Bank of Canada had in the past dispersed its attention to a number of indicators, among which monetary aggregates, inflation, and exchange rate with the US currency or nominal spending growth.
Considering the combination of the *p-values* of Hansen J-test and the conventional wisdom on monetary rules, the only satisfying rule is then the one which use the measure of the growth rate of real GDP. Table A reports the baseline estimates.

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<th>Table A</th>
<th>Baseline Estimates</th>
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<tr>
<td>$\beta : \text{cpi}+1$</td>
<td>0,9503 (0,5479)</td>
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<td>$\gamma : \text{gdp}+1$</td>
<td>1,7467 (1,8158)</td>
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<td>$\rho : r^{-1}$</td>
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<tr>
<td>\textit{p-value}</td>
<td>0,1353</td>
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Standard errors are reported in parentheses. The p-value is associated to the Hansen J-test. For more details, see Table 2.

The use of this variable to measure the economic activity provokes a debate. This measure, indeed, does not satisfy theoretical basis, roughly because the monetary policy responds by nature to the gap between the effective growth and its trend, in a way to stabilize growth around its natural rate of growth. However, Orphanides and Williams (2002) show that the considerable uncertainties in real time and in hindsight about the natural rate are so vast that the use of detrended methods (whose the reliability to determine a proxy is prone to interrogation by Orphanides and van Norden (2002)) leads to misperceptions and then to errors in estimation of monetary rules. They argue that this phenomenon is in part the cause of the weak response to inflation in the stagflationary experience of the seventies.

They suggest that a simple approach for facing this problem is to use the growth rate of economic activity. This measure does not require knowledge of the natural rate of growth for setting policy and is consequently immune to the likely misperceptions in these concepts. An informal evidence of this contribution is the great diversity of measures from institutions or research centers of the natural rate of growth for each country. The purpose of the growth rate of the real GDP proves true to be relevant.

Some interesting results stand out. First, the coefficient of response to expected inflation is during inflation targeting largely above 1, so stabilizing. Second, one can note that while the response to growth was low during the eighties (what appears realistic), it was strong before (with low statistical evidence) and is now very strong in the inflation targeting period, with a solid
statistical confirmation. There is a striking difference in both coefficients between the pre- and post-inflation targeting periods. Finally, the estimate of the smoothing parameter is high in all cases, suggesting considerable interest rate inertia.

**Robustness Analysis**

The robustness of these results is now confirmed by different means. First, from all the specifications tested with similar structure but with different lags in instruments and in interest rate, the coefficients of $\beta$ and $\gamma$ give results of the same order of magnitude. The same idea emerges with a response higher than 1 since the beginning of inflation targeting and also a strong response to real activity.

Furthermore, to illustrate how well the specification represent the behaviour of the central bank rate, Figures 1, 2, and 3 present the effective rate of the Bank of Canada relative to the estimated one by this rule for each sample period. The results are very impressive and in each subperiod, the estimated rate captures extremely well the evolution of the effective rate.

Finally, Table 3 collects some estimates made with Ordinary Least Squares method on similar specifications and confirms the evolution of coefficients estimated with the GMM method on pre- and post-inflation targeting period.

**Discussion of the Empirical Results**

These estimates indicate substantial differences in the policy reaction function across periods. Most importantly, the coefficient of response to expected inflation is significantly above one for the inflation targeting period. The adoption of inflation targeting was then not pure advertising and on the contrary, the Bank of Canada has adopted an active stance toward controlling inflation: monetary policy becoming stabilizing for inflation. In certain ways, this result is not surprising, but corroborates that the central bank has with inflation targeting stabilizing impact on inflation.

Moreover, the results tend to confirm the common wisdom about the monetary policy evolution during the last decades. Specifically, the estimates of the seventies period matches the time of oil shocks and the attempt from the authorities to revive the economy by ‘stop and go’ measures. In response to inflationary pressures, the monetary authorities did not raise real rates and focus on real activity. Strongly marked by the Keynesian ‘stop and go’ policy strategy of the glorious
thirties, they kept continuing to try to stimulate economy by demand-side measures. The estimates of the second sample period show a different evolution, which here again could be consistent with the monetary history: indeed, to fight against inflation, the decade has known a tightening of the monetary conditions and the authorities sorely concentrated on it. The coefficient of response to expected inflation is just a little bit higher than the one of the previous period and is a little bit more significant, while the one of real activity slumps, what characterized realistically the behaviour of economic policy in the eighties.

The response to inflation can appear low, this period being considered as a period of strong disinflation and tight monetary policy, but the evolution of inflation show the contrary and confirm the disinflation. Croushore (1996), De Long (1997) and Orphanides (1997) show for US from different ways that the monetary policy in the seventies was not very accurate, due to systematic bias in inflation forecasts, misjudgements in the natural rate of unemployment or growth and the preliminary estimates of output gap. Moreover, the progress in the inflation process understanding and the idea that expectations matter in generating inflation emerged in the end of seventies. These elements may explain why the monetary policy has succeeded to fight against inflation without strong response to it in the eighties: a more accurate monetary policy practice with a better comprehension of the inflation mechanisms may have been responsible for the strong disinflation.

Comparing to the two previous periods, the inflation targeting period combines strong and stabilizing response to inflation and also a significant response to economic activity. The presence of the two objectives together is very interesting, while this framework is supposed to concentrate solely on inflation and that is why a lot of critics arise against it. The statistical results are clear and the evolution of the coefficient illustrates a striking difference between the eighties and inflation targeting period. Even if this period can be viewed as very stable for inflation and auspicious for a strong growth, first Canada has know a rough recession during five quarters in 1992-93 of the same order of magnitude than in 1988, second, the mean of growth in the eighties and inflation targeting periods are quite similar and finally, the estimation period covers fourteen years, so more than one business cycle. And yet, the coefficient has changed. That tends to attest that there could have been a change in the conduct of monetary policy, and although the objective is clearly to target inflation to a low and stable level, the monetary
authorities take into consideration the real activity evolution, as the meaningful estimates let suppose.

5 Structural Breakpoint

In order to validate that the evolution in the monetary policy is a real shift, a Chow test for structural stability is computed. The sample chosen for the test goes from 1985 to 2005 and covers a period of low and stable inflation, when inflation stabilization was explicitly the goal of monetary policy, thus the period of high volatility of inflation is excluded. The p-value of the Chow test performed at the date inflation targeting has been adopted clearly indicates a structural break in the coefficients of the policy reaction function. The results are reported in Table 4 and confirm the result of section 3 where the forecasts of inflation are more accurate when based on the inflation targeting sample and not on the complete sample. The structural breakpoint being detected at strong significant level and moreover in a period of low and stable inflation shows how important the shift in the monetary policy has been when inflation targeting was adopted. This confirms too that the change in real activity coefficient seems to be a consequence of inflation targeting.

6 Conclusion

Inflation targeting has been adopted by Canada since 1991 with good results: indeed, inflation evolves in the target range defined. However, the movement of low inflation being common to all industrialized countries, the question is whether the inflation targeting framework is responsible for a part of this decline and to what extent inflation targeting has changed monetary policy. This paper attempts to determine the causes of the good results noted on the Canadian inflation and the implications of this framework for the conduct of the monetary policy.

I first find that among the models tested, the best model of inflation forecast is since inflation targeting just 2, the central point of the target range. Under realistic assumptions of credibility of the Bank of Canada and that private agents know the target, the idea that the expectations of inflation are better anchored since the beginning of inflation targeting and then that the target, being credible, gathers the expectations around it, is consistent with these results.
Second, the response to expected inflation is since this framework has been adopted, above one what means stabilizing in the extent that the central banks raises real and nominal interest rates in response to inflation. One can also note that the response to ‘real activity’ has become more important and more significant than before with inflation targeting. Taken together, these results suggest that the breathing space (target range) being large enough to deviate from the target without paring its credibility, the central bank could be now able due to expectations better anchored to focus jointly on inflation and growth.

One may imagine that while the central bank ties its hands with its commitment to inflation, this precise engagement make it gain credibility and anchor more firmly inflation expectations at the target. That appears to allow it to untie its hands to response with discretion to real activity evolution. By focusing officially on inflation (but without failure to preserve credibility, as the estimates of the response to expected inflation show), this framework enable to rally its advocates and opponents, by concentrating unofficially but nevertheless significantly to growth. Kuttner (2004) write “what matters is what inflation-targeting central banks actually do – not what they say”, this can be derived for the Bank of Canada and is maybe the key of the achievement of inflation targeting: by saying its commitment to inflation, it authorize to do what it can for growth. Thus, the notion of “constrained discretion” used to depict inflation targeting gains a certain weight.

It would be relevant in subsequent research to evaluate the sensitivity of these results to a structural analysis. Thus, one possible extension of this paper could be to measure whether the change in the response to growth since inflation targeting has a significant effect on the Canadian economy with an eye to determine the inflation targeting effects.
References


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Standard errors are reported in parentheses. The set of instruments includes one lag of M2 growth, the short-long spread and commodity price inflation. det is the detrended output, gdp is the year-over-year rate of change of real GDP and u is the unemployment rate. The p-value is associated to the Hansen J-test.
Table 3

Coefficients for Monetary Rule - Estimated by OLS

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Standard errors are reported in parentheses. The third column reports the real coefficients.

Table 4

Structural Break Point at 91:1

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