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Abstract

In this paper, we develop a new way to test hypotheses about policy-makers' targets, and we implement that test for Canadian monetary policy. If, for example, the Bank of Canada is using interest rates to target an inflation rate of 2 per cent and there is an 8-quarter lag in the effect of the interest rate on inflation, then deviations of inflation from 2 per cent should be unforecastable and uncorrelated with any information in the Bank of Canada's information set lagged by 8 quarters. This would imply that empirical causality tests of monetary policy on inflation could be very misleading. Our test indicates that there was indeed a major change in the Bank of Canada's objectives about the time when formal inflation targets were announced.

JEL classification: E52, E61
Bank classification: Monetary policy

Résumé

Les auteurs proposent une nouvelle façon de tester les hypothèses formulées au sujet des cibles visées par les autorités monétaires et appliquent leur test au cas canadien. Si, par exemple, l'instrument d'intervention de la Banque du Canada est le taux d'intérêt, que celle-ci vise un taux d'inflation de 2 % et que le taux d'intérêt met huit trimestres à agir sur le taux d'inflation, les écarts de l'inflation observée par rapport à la cible devraient être imprévisibles et ne pas être corrélés avec l'information, retardée de huit trimestres, à la disposition des autorités monétaires. Cette façon de procéder implique que l'on ne pourrait se fier aux tests empiriques servant à vérifier l'effet de causalité de la politique monétaire sur l'inflation. Selon les résultats du test effectué par les auteurs, un changement important serait en effet survenu dans les objectifs de la Banque du Canada à peu près au moment où cette dernière a annoncé l'établissement de cibles explicites en matière d'inflation.

Classification JEL : E52, E61
Classification de la Banque : Politique monétaire

1. Introduction

The objectives of a policy authority are not generally fully known; even if they are clearly stated,[1] tactical considerations may lead to a divergence between stated and actual objectives.[2] The objective of a policy authority can be thought of as the targeting of particular macroeconomic variables (hereafter called target variables) towards some level. For example, a monetary authority may attempt to target output growth sufficient to close the output gap, or alternatively target a constant inflation rate.

The standard approach to testing hypotheses about the objectives of a monetary authority is to estimate a policy reaction function. There is a growing literature[3] where economists try to estimate these reaction functions, usually as variants on a Taylor rule, for various monetary authorities around the world. The dependent variable of the estimated equation is the bank's policy instrument, while the independent variables include possible target variables and indicators of those target variables.

A variant to the standard approach attempts to identify the policy-maker's underlying preferences.[4] However, it is not possible to identify agents' preferences independently of the constraints they feel they face. Therefore, the economist is jointly estimating the policy-maker's preferences together with the policy-maker's perceived structure of the economy.

In this paper, we develop a new test to determine the objective of a policy authority and implement our test using Canadian data. Our test turns the standard approach on its head. The standard approach looks for where the monetary authority's gun is pointing; our approach looks for the impact of the bullets. According to our analogy, if we have correctly identified the monetary authority's target, then deviations of the bullets from the target should be random errors that are unforecastable from the information available to the monetary authority when it pulled the trigger.

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1. The Bank of Canada has an explicit inflation target of between 1 and 3 per cent until the end of 2001.
2. Thornton (1999) documents evidence from Federal Open Market Committee (FOMC) transcripts that the Federal Reserve started targeting the federal funds rate in 1982, although their official stated target was Borrowed Reserves until 1989. He argues that this discrepancy was due to political considerations.
3. See Clarida et al. (1998) or Bernanke and Mihov (1996).
4. See Swank and Swank (1993), Bernanke and Mihov (1995), Favero and Rovelli (1999), Cecchetti et al. (1999), or Cecchetti and Ehrmann (1999).

Hall (1978) proposed a way to test Friedman's permanent income hypothesis: if individuals with rational expectations seek to smooth consumption over time, then changes in consumption between period t and $t+1$ should be uncorrelated with anything in the individual's information set at time t. Our test is similar in spirit to Hall's test. We show that if a policy-maker is using an instrument to target a variable and there is a j period lag in the effect of the instrument on the target variable, then deviations of the target variable from the target at time $t+j$ should be uncorrelated with anything in the policy-maker's information set at time t, including *inter alia* the instrument itself. In practice, the main difference between our test and Hall's is that we use a lagged information set, to reflect the lag with which the policy instrument affects the target variable, whereas Hall uses a contemporaneous information set, to reflect the assumption that consumption is chosen contemporaneously.

Our result casts doubt on the validity of existing empirical causality tests. Suppose, for example, that monetary policy is chosen to target output to follow a smooth path over time. If that policy is successful, money-output causality tests will be biased towards rejecting a relationship between the two variables. Correlations between output and measures of monetary policy will decrease in the successfulness with which monetary policy achieves its target of smoothing output. What others have interpreted as evidence against causality could be interpreted as evidence of successful targeting. The same applies to money-inflation causality tests if monetary policy is chosen to target inflation.

We are not the first to criticize econometric causality tests. Buiter (1984) demonstrates that with an optimizing policy-maker, using money to influence output, the data may reject Granger-causality of money on output even when money does cause output. In an illustration of this point, Cover (1988) builds a Keynesian macroeconomic model and shows that if monetary policy is conducted optimally,[5] then money would not Granger-cause output. A Keynesian economy, whereby construction money does cause output, would appear to the econometrician like a classical economy where money was neutral.

Our paper is a generalization of Cover's. Our smoothing test, as well as our implied critique of econometric causality tests, applies to all economies (not just Keynesian ones); to all target variables (not just output); to all instruments (not just the money supply); and to all policy-makers (not just monetary authorities). However, our primary objective is to test

5. That is, aggregate demand shocks are offset while aggregate supply shocks are accommodated.

hypotheses about what the policy-maker is doing, rather than to critique econometric causality tests.

We describe the model in Section 2, the method for empirical testing in Section 3, and the results in Section 4.

2. The Model

Suppose that a policy-maker is trying to target X using the policy instrument Z, where X is a scalar and Z is a vector. Suppose further that the policy instrument acts on X with a lag of j periods, such that in terms of the underlying reduced form,

$$X_{t+j} = F(Z_t, \ldots). \tag{1}$$

The target variable X_{t+j} may be decomposed into its rational expectation conditional on all information available to the policy-maker at time t plus some error term,

$$X_{t+j} = E(X_{t+j}|I_t) + e_{t+j}. \tag{2}$$

By definition of rational expectations, the random error term e_{t+j} is uncorrelated with everything in the policy-maker's information set, I_t. Assuming that the policy-maker knows the value of its instrument at time t, the instrument Z_t will be included in the information set I_t.[6]

Suppose that the object of the policy-maker were to target X such that it follows a time trend. That is, for some B,

$$X_t^* = Bt. \tag{3}$$

Given the lag between changes in the instrument and its effect on the target, plus the policy-maker's imperfect information, exact targeting is impossible to achieve. Instead, the best the policy-maker can do is to make the rational expectation of the target variable follow a time trend at and beyond the control lag (j). The policy-maker sets the instrument Z_t such that

$$E(X_{t+j}|I_t) = B(t+j). \tag{4}$$

6. Strictly, I_t should contain data, as it was published at time t, so that the information set changes over time due to both the addition of new data and revisions in existing data. We use final revised data; extending the analysis to real-time data is left for future work.

Assuming that the probability distribution of X_{t+j} around its expectation is symmetric and that the loss function of the policy authority is quadratic, this policy rule will minimize the variance of X_{t+j} around its trend and hence minimize the expected loss. Substituting equation (4) into the decomposition identity given by equation (2) yields

$$X_{t+j} = B(t+j) + e_{t+j}. \quad (5)$$

This equation is empirically testable: if equation (5) holds, deviations of X about its trend should be uncorrelated with any variable in the policy-maker's information set at time t, including current and lagged values of the instrument, $\{Z_t, Z_{t-1}, \dots\}$.

To illustrate the intuition behind our approach, suppose the structure of the economy can be represented by

$$X_{t+j} = BZ_t + GU_t + e_{t+j}, \quad (6)$$

where $B > 0$, $G > 0$, X_t is inflation, Z_t the policy instrument, U_t some other variable that affects inflation and is observed by the monetary authority, and e_t an unforecastable, mean zero, error term.

If the bank targets a constant inflation rate of C, it will choose its instrument according to the policy reaction function

$$Z_t = \frac{C - GU_t}{B}. \quad (7)$$

Substituting the reaction function into equation (6), we get

$$X_{t+j} = C + e_{t+j}, \quad (8)$$

and inflation deviations from the target are perfectly unforecastable.

Using our approach for testing the hypothesis that the bank is targeting a constant rate of inflation, neither the policy instrument, Z_t, the exogenous indicator, U_t, nor both variables together will appear to be significant in explaining variations in inflation from C. We interpret this as evidence of an inflation target of C. The high (or even perfect) multicollinearity between the independent variables (U_t and Z_t) makes it difficult to identify the coefficients B and G in structural equation (6), thereby invalidating empirical causality tests.

Our test for what the bank is targeting is invulnerable to these problems, since we directly test equation (8) using an F-test, which is largely invariant to multicollinearity. Whether the econometrician uses all of the information available to the monetary authority or only a subset of that information, if the bank targets a constant inflation rate, inflation should be unforecastable and the F-statistic of the forecasting equation should be insignificant. More generally, equation (5) can be replaced by any time path for the target variable desired by the policy-maker, X_t*, and the corresponding errors tested for forecastability.

In testing equation (5), we are testing a joint hypothesis of (i) rational expectations on the part of the policy-maker, (ii) the policy-maker's desired time path for the target variable, (iii) correct knowledge of the policy-maker of the structure of the economy, and (iv) the lag length with which the instrument influences the target variable.

The desired time path for the target variable must be feasible. If the policy-maker tried to use monetary policy to make real output grow permanently faster than potential output growth, we should not expect equation (5) to hold. But then a policy-maker with rational expectations would not try to achieve an unattainable target.

Our method of testing for targeting is general. There are many different combinations of policy-makers, policy instruments, and target variables for which the test could be applied. Over the past 10 years, several monetary authorities have announced explicit inflation targets. Our approach can be used to test whether their announcements coincided with a change in the actual policy objective.

3. Empirical Testing

Hypotheses about what the Bank of Canada was seeking to target over the past 30 years will now be tested. We consider regressions on quarterly data incorporating a small number of key macroeconomic variables that economic theory suggests should be important in explaining future movements in the target variables. For inflation, we regress deviations of the growth rate of the core consumer price index (*GCPIX*)[7] from its target on lags in the growth rate of the real gross domestic product (*GRGDP*), short-term interest rates (*CP*),[8] the

7. The core consumer price index is defined as headline CPI less food, energy, and the effect of indirect taxes. The growth rate of core CPI is the measure of inflation that the Bank uses as a near-term operational target.
8. The interest rate on 90-day commercial paper is used as a measure of monetary policy. This is an interest rate on which monetary policy has an immediate and predictable impact. The mechanism by which monetary policy is implemented has changed over the past 30 years, making the Bank Rate and overnight rate less suitable as measures of monetary policy.

growth rate of narrow money (*GM1*), and itself. Other variables considered were the percentage change in the nominal exchange rate with the United States (ΔE) and alternative measures of the interest rate, including measures of the term structure. The results reported in Section 4 are robust to these choices.

For output growth, we regress deviations of *GRGDP* from its target on lags in *CP* (and alternative measures of interest rates), the percentage change in the real exchange rate with the United States (ΔRE), and itself.

For all periods except the final quarter, we have a longer panel of data than the monetary authority had to determine the policy that would have been optimal given any policy target. To minimize any bias that may result, we test for targeting in the context of (two-sided) rolling regressions, adding and dropping one observation each regression. This testing accommodates an evolving economic structure over time, as well as an evolving target. We estimate one-sided rolling regressions as warranted, to determine whether the addition of new data or the loss of old data drives changes in the test statistic over the sample. This practice enables us to comment on changes in the Bank of Canada's target at particular points during our sample.

Suppose we wish to test whether the monetary authority sets its policy instrument to target core inflation of 2 per cent. We would estimate the following equation:

$$GCPIX_t - 2 = \sum_{i=j}^{j+k} \gamma_i GRGDP_{t-i} + \sum_{i=j}^{j+k} \delta_i CP_{t-i} + \sum_{i=j}^{j+k} \zeta_i GM1_{t-i} + \sum_{i=j}^{j+k} \xi_i GCPIX_{t-i} + \varepsilon_t \tag{9}$$

where j is the number of lags at which the policy instrument has an impact on $GCPIX$, and k is the number of lags on all of the explanatory variables that will be included in the regression.[9] To test that the monetary authority was targeting an inflation rate of 2 per cent involves the following null hypothesis:

9. In reality, variables become available with differing lags. For example, measures of interest rates are available almost immediately, while measures of output are available only with a lag of about two months. The effect of this is likely to be small on the estimates obtained in this exercise.

$$H_0 : \gamma_l = \delta_l = \zeta_l = \xi_l = 0 \text{ for all } l \text{ s.t. } j \le l \le j+k. \tag{10}$$

That is, under the null hypothesis, equation (9) takes a form similar to equation (5),

$$GCPIX_t = 2 + \varepsilon_t. \tag{11}$$

This test can be completed for each rolling regression, with a plot of the test statistics indicating movements by the monetary authority towards or away from this objective.

One remaining issue is how to choose j, the length of time required for the working of the monetary transmission mechanism. There is no one lag length at which monetary policy impacts the economy, but a complete distribution. The Bank would wish to operate with the smallest feasible lag length for the control of the economy (j), since the longer it waits, the more information it has available when it sets its instrument. But there is a danger that operating on too short a lag length may cause "instrument instability." Consider a simple example, where monetary policy affects inflation at two lag lengths only, but where it is twice as powerful at the longer lag length. If the Bank operated only on the shorter lag length, the required oscillations in the interest rate would double every period. A full examination of what determines the shortest feasible lag length (that is, not subject to instrument instability) is beyond the scope of this paper. Our results will be sensitive to the choice of j: if j is too large, our test will be biased towards not rejecting the null hypothesis. If j is too small, our test will be biased towards rejecting the null hypothesis. We consider values of j equal to 6 and 8 quarters, consistent with the predominant view within the Bank of Canada, and describe the extent to which our results are sensitive to the choice of lag length.

Finally, we estimate our rolling regressions on panels consisting of 36 consecutive quarters of data. Because of the limited degrees of freedom available, we include 4 lags on each of the variables in that model ($k = 4$). The time period that we consider coincides with the longest available data panel: from the second quarter of 1968 to the third quarter of 1998.

4. Results

4.1 Inflation targeting

Consider two examples of policy targets where core inflation is being targeted by the Bank of Canada. Inflation targeting is consistent with the stated policy objectives of the Bank over the past 10 years. In January 1988, the Bank's Governor John Crow (1988) made it clear in the Hanson Lecture that the longer-run objective of monetary policy should be price stability. In February 1991, this was formalized when the federal government and the Bank of Canada jointly announced explicit inflation targets for reducing the rate of inflation towards 2 per cent, with a target range of ± 1 per cent. Figure 1 contains the official inflation targets and realized inflation; vertical bars indicate the timing of the Hanson Lecture and the announcement of targets.

4.1.1 Targeting core inflation equal to 2 per cent

Consider a target of core inflation equal to 2 per cent. This is consistent with the Bank of Canada's stated target since the end of 1995. Figure 2A contains test statistics for the hypothesis of inflation targeting. These are F-tests[10] of the hypothesis that none of the variables included in the regression explain deviations of *GCPIX* from the target.

The horizontal dotted lines represent the critical values at the 5 per cent and 1 per cent levels, respectively, and the dates on the horizontal axis are the first quarterly observation included in the rolling regression; the final observation is 36 quarters, or 9 years, later.

The addition of new quarters starting around the time that explicit inflation targets were announced by the Bank coincides with less significant test statistics, and when all recent data are included, an inflation target of 2 per cent cannot be rejected at the 1 per cent level, even though some of the observations included in the regression predate explicit inflation targets.

Figure 2B contains the same test statistics, but with a transmission mechanism length of 6 quarters (j = 6) assumed. An inflation target of 2 per cent is always rejected, although the magnitude of the test statistics declines as more quarters from the explicit inflation targeting period are included in the rolling regressions.[11] This is not surprising, since the test is biased towards rejecting the null hypothesis if j is too small.

10. Because some of the independent variables included in the regressions are random, the test statistics are not strictly F-distributed under the null hypothesis. We believe that the F-distribution is closer to the true critical values, given our small sample size, than the asymptotic critical values from the χ^2 distribution. At the very least, the critical values can be viewed as a reference point to allow comparisons of test statistics across series and targets. We examine the finite sample properties of our F-test in the appendix.
11. All other results described are qualitatively similar with $j = 6$ or $j = 8$.

To illustrate that our test is sufficiently powerful to discriminate between alternative targeting assumptions, Figure 2C contains the test statistics for a null hypothesis of an inflation target of 4 per cent, for $j = 8$. While this null hypothesis cannot be rejected for a number of samples starting in the early 1980s, it is rejected when most quarters in the estimation are from the explicit inflation targeting period. Further, simple Monte Carlo simulations of the model revealed that the power of the test is good for simple alternative hypotheses.[12, 13]

4.1.2 Targeting core inflation equal to its recent past

Consider a target of core inflation equal to its recent past, defined as a 20-quarter moving average.[14] Figure 3A contains the test statistics.

Around the middle of the sample period, the test statistics change substantially, and there is strong evidence that the monetary authority was not targeting core inflation to its recent past as measured here. This change (starting in the first quarter of 1982 in Figure 3A) may be due to the loss of old data from the rolling regression, or it may be due to the addition of new data. To determine which of these is responsible, the estimation is repeated twice, in one-sided rolling regressions (see Figure 3B). First, the sample size used for estimation starts with the full sample and becomes progressively smaller, as the earliest observation is dropped with each regression, until only 36 observations remain (labelled “Dropping data”). Second, the sample begins with the first 36 observations and becomes progressively larger as one observation is added with each regression, until the full sample is included (labelled “Adding data”).

Figure 3B contains the test statistics, where the horizontal axis represents the date of the final observation included in the regression less 36 quarters for adding data, and the earliest observation included in the regression for dropping data. The test statistics from the two-sided rolling regression are included for reference.

The large change in the test statistics in Figure 3A coincides with that obtained by dropping one observation each quarter, and is therefore driven not by data from the early 1990s, when inflation targets were announced, but by data from the early 1980s. This is

12. See the appendix for details.
13. Similarly, an inflation target of 1 per cent can be rejected for all periods.
14. The choice of 20 quarters is arbitrary. The aim is for a sufficient length that temporary deviations in inflation do not have a large influence on the target.

consistent with an accommodative monetary policy until the early 1980s, followed by an anti-inflationary policy thereafter.

In contrast, the test statistic from adding one additional observation each regression climbs steadily, starting shortly before the announcement of explicit inflation targets by the Bank, demonstrating that around the time targets were announced, the inflation target of the Bank departed from its recent past.[15]

4.2 Targeting real GDP

4.2.1 Targeting potential output

Consider a target of *RGDP* equal to potential output, in logs. The measure of potential output for this purpose is constructed using the extended multivariate filter (EMVF) of Butler (1996), in real time.[16] The techniques used by the Bank to measure potential output have changed over time. Here, we control for the changing information set, not the methodology used.

Figure 4A contains the test statistics. They reveal that, until 1982, there is mixed evidence of forecastable deviations of output from potential. The inclusion of data around the time of explicit inflation targets coincides with statistically significant deviations of forecastable output from potential.

To further examine the cause of these test statistics, one-sided rolling regressions were estimated (Figure 4B). The addition of new observations starting at the time of explicit inflation targets (labelled 1982 in the graph) drive the change in the test statistics described above.

When quarters corresponding to explicit inflation targeting are included (starting in 1982 on the graph), deviations of output from potential are forecastable with data available 8 quarters in advance. This is consistent with a change in policy objective around the time of the announcement of an explicit inflation target.

15. Because the horizontal axis represents the end of the sample less 36 quarters, test statistics after the first quarter of 1982 include information from the inflation targeting period.
16. We thank Stephen Murchison for providing this series. The EMVF was run recursively, with the last data point at each recursion used to construct the series. Since only contemporaneous or lagged data are used at each recursion, it is effectively a one-sided filter, and can be considered to be a real-time measure of potential output. Revised data are used, rather than the original data available to the monetary authority to formulate monetary policy.

4.2.2 *Targeting recent growth rates*

Consider that the monetary authorities have chosen as their objective that the economy continue to grow at recent historical levels. We use a 20-quarter moving average[17] to represent that objective. Figure 5A contains the test statistics.

This targeting hypothesis is generally consistent with the data in the early part of the sample, but is rejected at the 5 per cent level for some quarters in the second half of the sample. Test statistics from one-sided rolling regressions (Figure 5B) reveal that the presence of jagged peaks is largely driven by the dropping of old observations. However, starting around the time of the Hanson Lecture (Crow 1988), when the goal of price stability was announced by the Governor of the Bank, the addition of new observations results in a steadily increasing test statistic. This is consistent with a change in policy focus away from targeting output to targeting inflation. However, in contrast with the earlier tested hypotheses, the power of this test is poor for simple alternative hypotheses.[18]

5. Conclusions

We have developed and implemented a test for the target of a policy authority. Our methodology focuses on the idea that the forecastable component of a variable is a measure of the policy target of a rational policy authority. Therefore, the distance between the forecastable component of a variable and its hypothesized target can be used to construct a test of the particular target. We have shown that commonly used empirical causality tests can be of dubious value in detecting empirical relationships involving policy instruments.

In February 1991, the federal government and the Bank of Canada jointly announced explicit targets for inflation. We have shown that the period leading up to the date of the announcement coincided with an actual change in monetary policy. We can reject the hypothesis that the Bank was targeting low inflation before 1988, but we cannot reject the hypothesis that it was targeting stable output. After 1991 the reverse is true. By our test, the policy announcement reflected a change in actual policy. The Bank has done exactly what it said it would do.

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17. As with the inflation case considered earlier, this choice is arbitrary. A large number of lags are necessary; otherwise, smoothing may be found merely as a consequence of the high degree of persistence in real output.
18. See the appendix for details.

Some caveats are in order. We have jointly tested rational expectations on the part of the policy-maker and the lag length with which the instrument influences the target variable, along with the policy-maker's target. If either of the first two assumptions are incorrect, our test will be biased. Also, monetary authorities may well have multiple objectives in practice. Nonetheless, the empirical evidence presented here identifies a shift in at least the relative weights accorded to different objectives around the time inflation targets were announced.

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Figure 1: Inflation and official targets

Note: Vertical lines indicate the timing of the Hanson Lecture (January 1988), and the official announcement of inflation targets (January 1991).

Figure 2A: Targeting core inflation of 2%

j=8 quarters

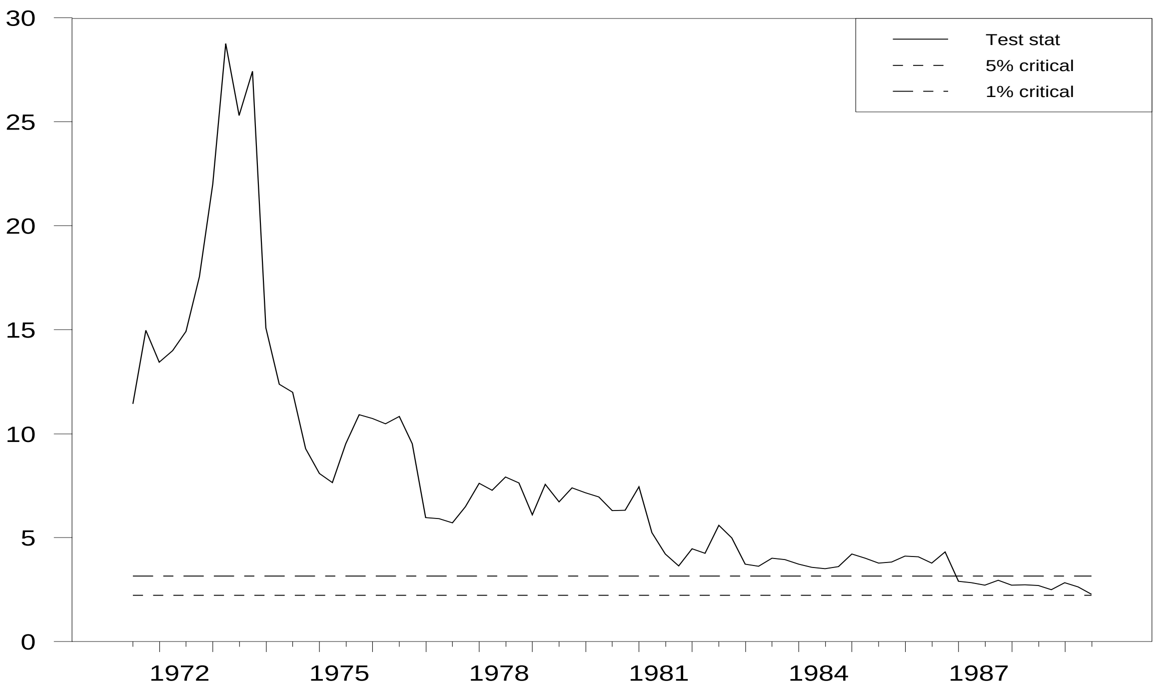


Figure 2B: Targeting core inflation of 2%

j=6 quarters

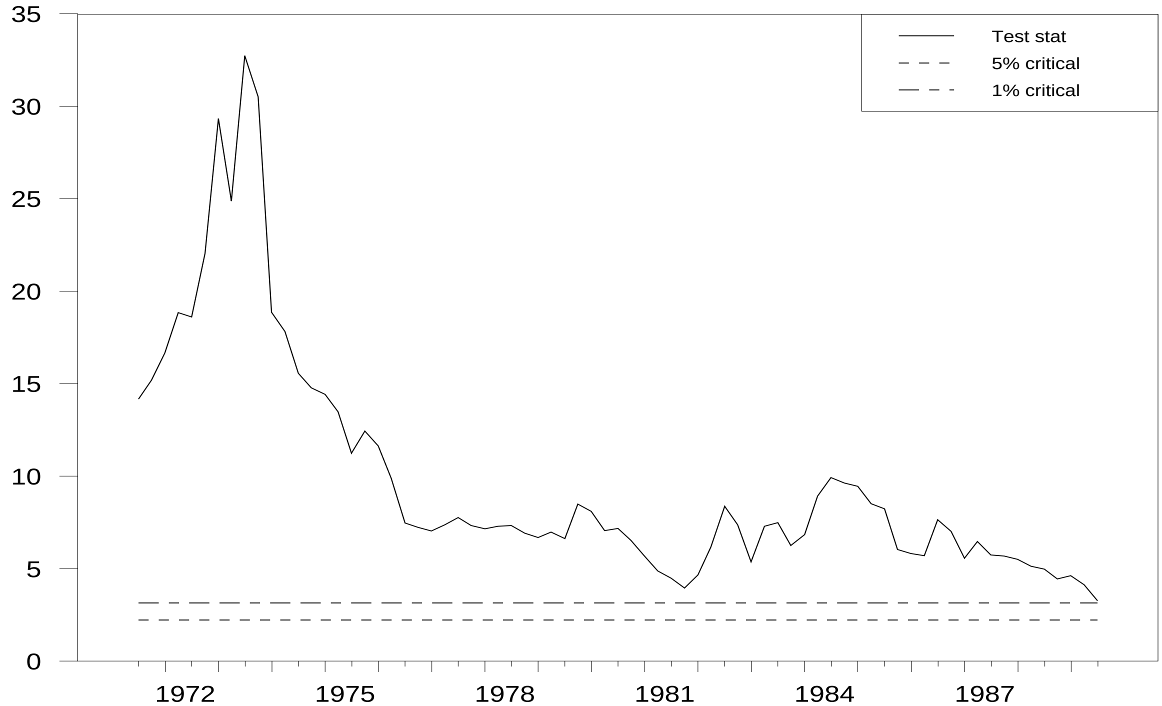


Figure 2C: Targeting core inflation of 4%

j=8 quarters

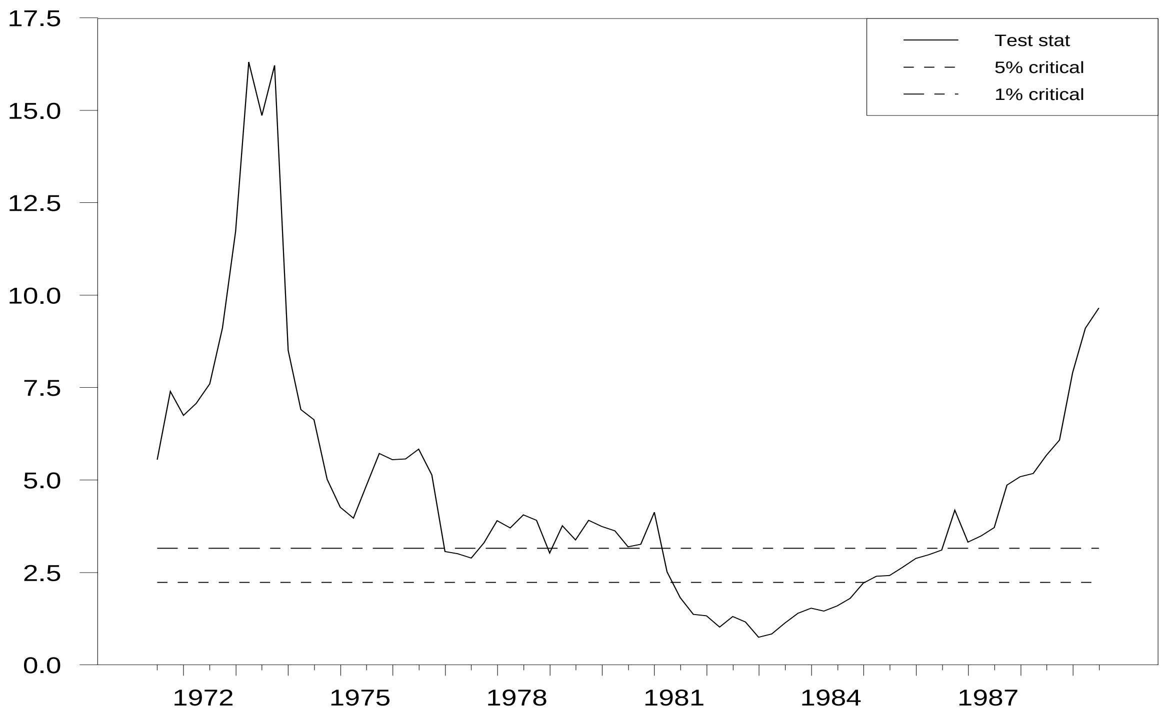


Figure 3A: Targeting core inflation equal to its recent past

j=8 quarters

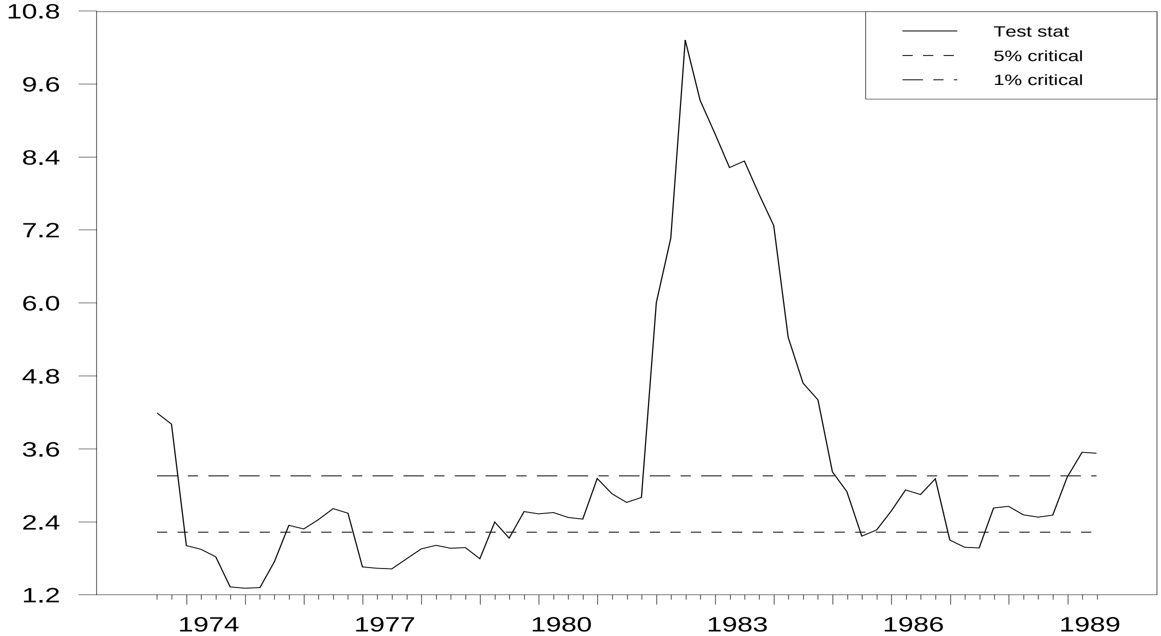
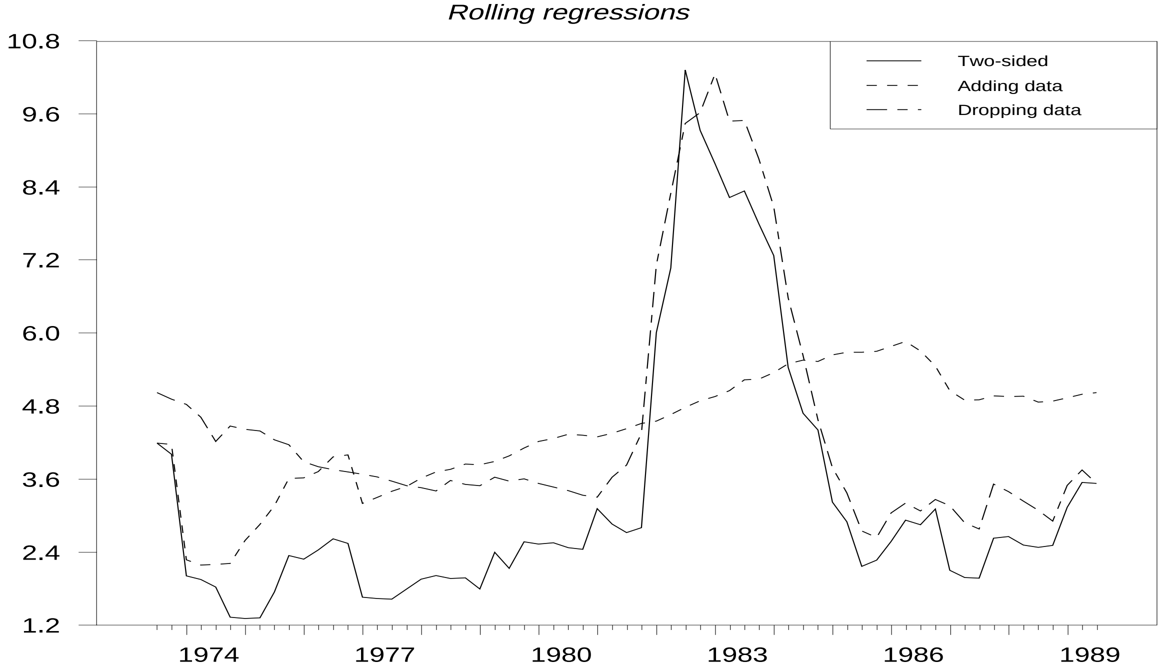


Figure 3B: Targeting core inflation equal to its recent past

Rolling regressions



Note: Adding data refers to starting with an initial sample of 36 observations (1973Q3–1982Q2) and including one more in each rolling regression. Dropping data refers to starting with the complete sample (1973Q3–1998Q2) and dropping the earliest observation each regression. For adding data, the horizontal axis refers to the latest observation included in the sample less 36 quarters. For dropping data, the horizontal axis refers to the date of the earliest observation included in the regression.

Figure 4A: Targeting potential output

j=8 quarters

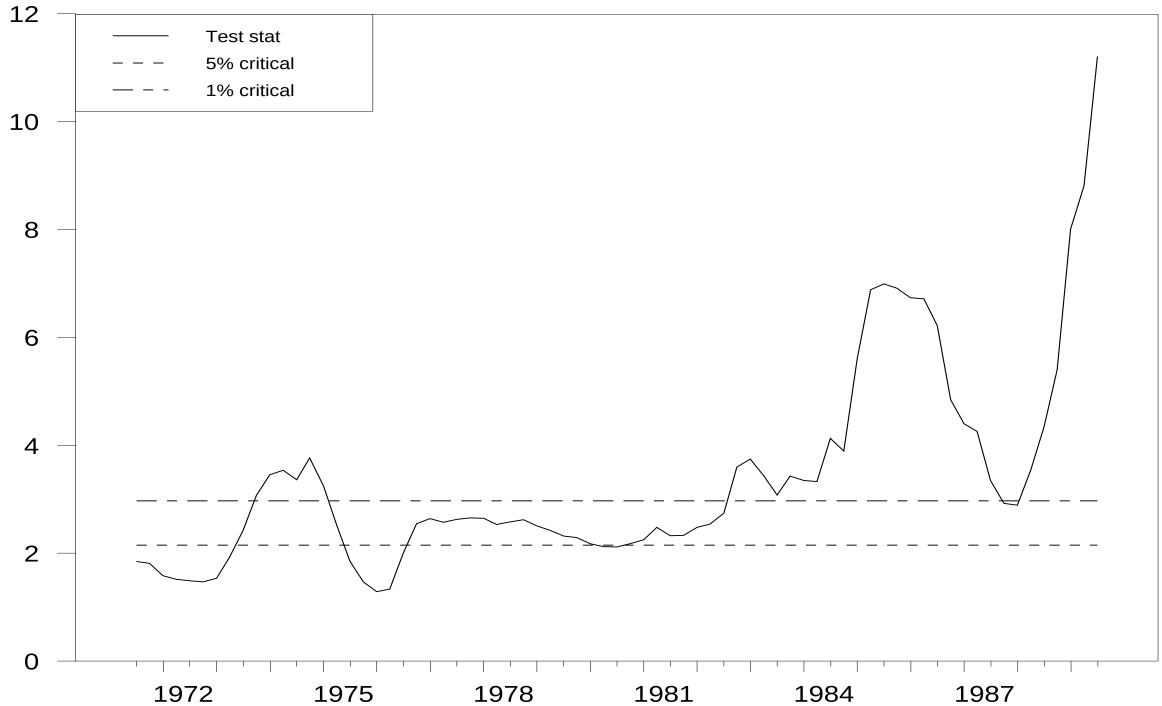


Figure 4B: Targeting potential output

Rolling regressions

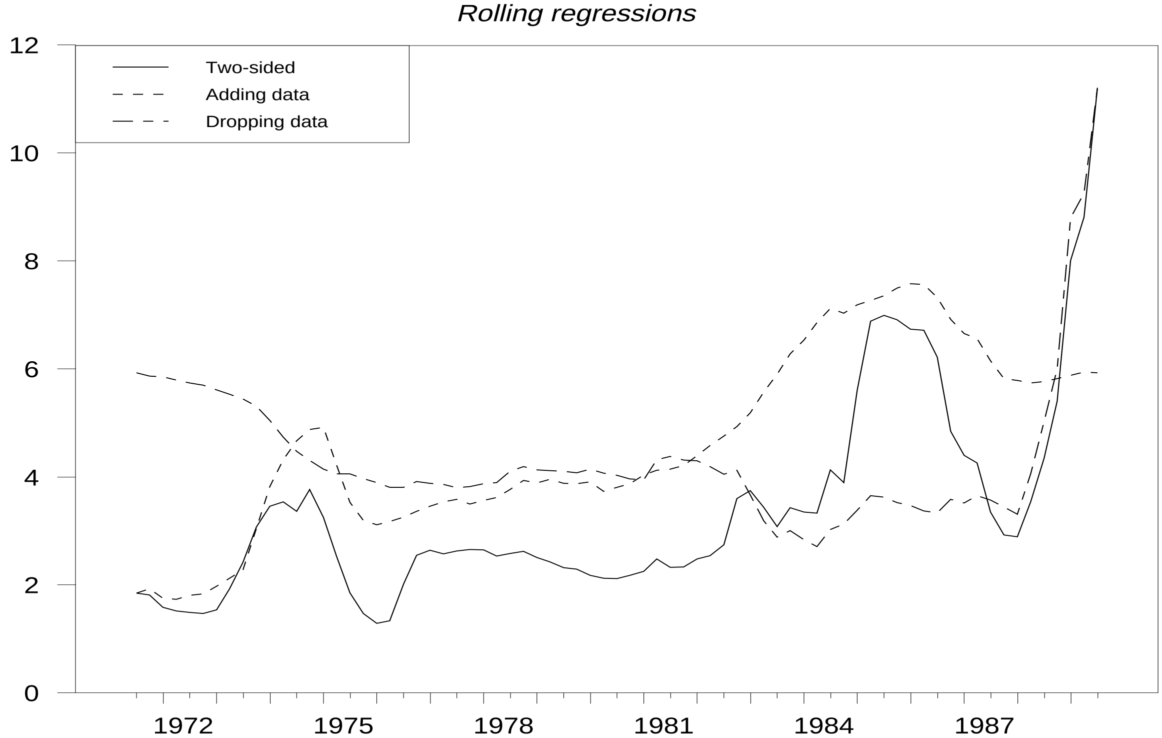


Figure 5A: Targeting recent growth rates

j=8 quarters

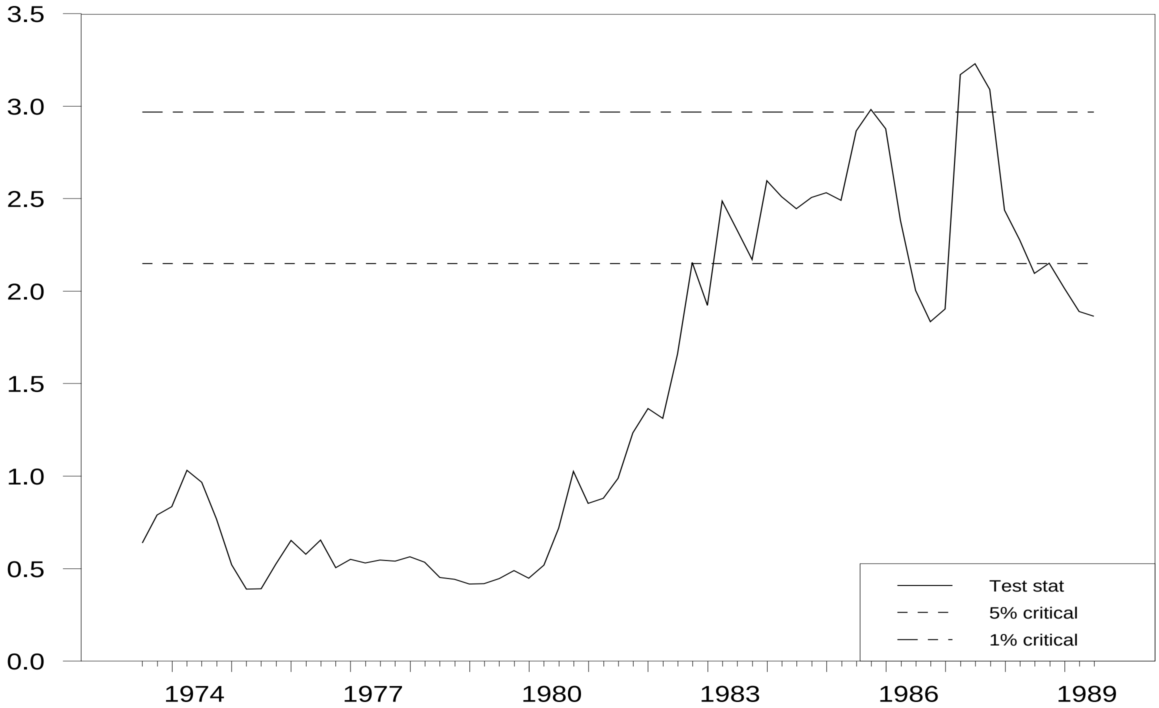
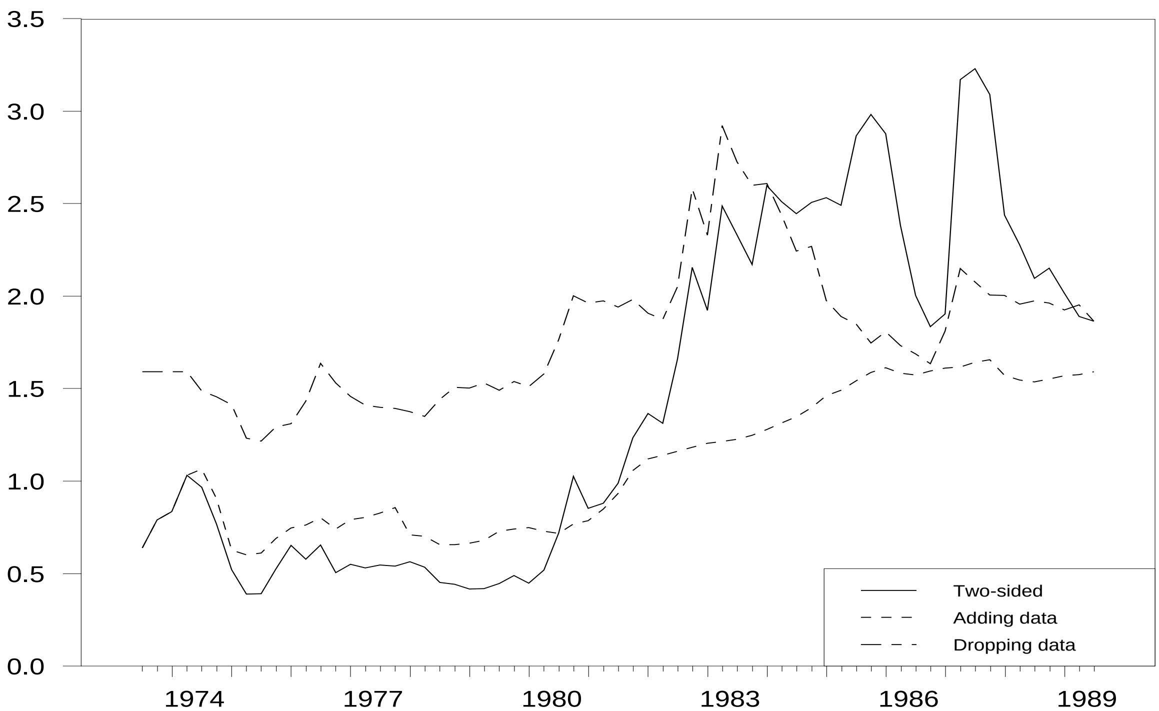


Figure 5B: Targeting recent growth rates

rolling regressions



Appendix
Monte Carlo Simulations

Because of the small degree of freedom allowed in the tests conducted here, a simple Monte Carlo experiment was conducted to investigate the finite sample properties. Using resampled residuals, the test for each target at a specific horizon was conducted with 10,000 replications. The null hypothesis takes the following form:

$$H_0 : \beta_i = 0 \text{ for all } i . \tag{A1}$$

Three alternative hypotheses were considered:

$$H_1 : \beta_i = B \text{ for all } i, -C < B < C \text{ for some } C , \tag{A2}$$

$$H_2 : \beta_i = (-1)^i B, -C < B < C \text{ for all } i, \text{ and} \tag{A3}$$

$$H_3 : \beta_i = SB, -C < B < C \text{ for all } i, \tag{A4}$$

$$\text{where } S = -1 \text{ if the estimate of } \beta_i \text{ is negative } (S = 1 \text{ otherwise}). \tag{A5}$$

Under the first alternative hypothesis, all coefficients are equal. Because the majority of independent variables share the same sign and are highly collinear, this equality is likely to provide an upper bound on the power of the test. In the second alternative hypothesis considered, all coefficients have the same magnitude but their signs alternate. This alternation is likely to understate the power of the tests. In the third alternative hypothesis, all coefficients have the same magnitude but the sign is the same as that estimated for the data. This hypothesis is a point estimate of the “true” power curve, albeit under the restrictive assumption that each β_i varies from zero at the same rate. This set of alternative hypotheses is not complete, but indicates the power of the test methodology employed here.

Figures A1–A3 plot the power of the test at a typical forecast horizon for the tests considered in Sections 4.1.1, 4.2.1, and 4.2.2. The value of C was chosen to reflect the average absolute value of the estimated coefficients in each of the tests considered: for targeting core inflation of 2 per cent (Section 4.1.1) or output to grow at recent rates (Section 4.2.2), the value was approximately 0.2; for output to equal potential (Section 4.2.1), it was approximately 0.02.

For targeting core inflation of 2 per cent (Figure A1), the power curve is roughly symmetric and rises quickly as the magnitude of B rises for all alternatives. Even the worst-case scenario (with alternating signs), $|C| = 0.1$, is sufficient for a 50 per cent probability of rejecting the null hypothesis. Similar results are found for the alternative inflation targets considered. The test for a target of potential output has extremely good power for all three hypotheses (Figure A2). The test for targeting recent growth rates (Figure A3) has very poor power, with substantial deviations in B from zero required for a high probability of rejecting the null hypothesis when it is untrue.

These Monte Carlo results are consistent with the results reported earlier. For all targets except recent growth rates, the null hypothesis is rejected for a substantial proportion of the rolling regressions. In contrast, a target of recent growth rates can be rejected for only a few horizons.

Figure A1: Targeting core inflation of 2%

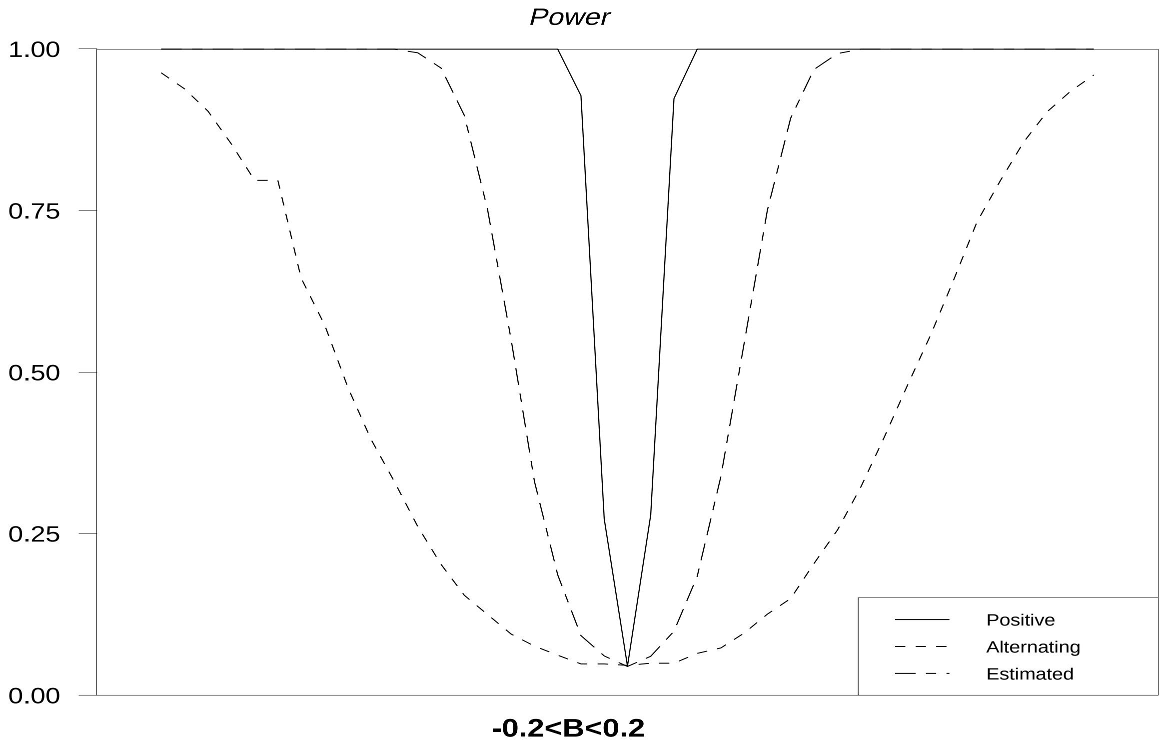


Figure A2: Targeting potential output

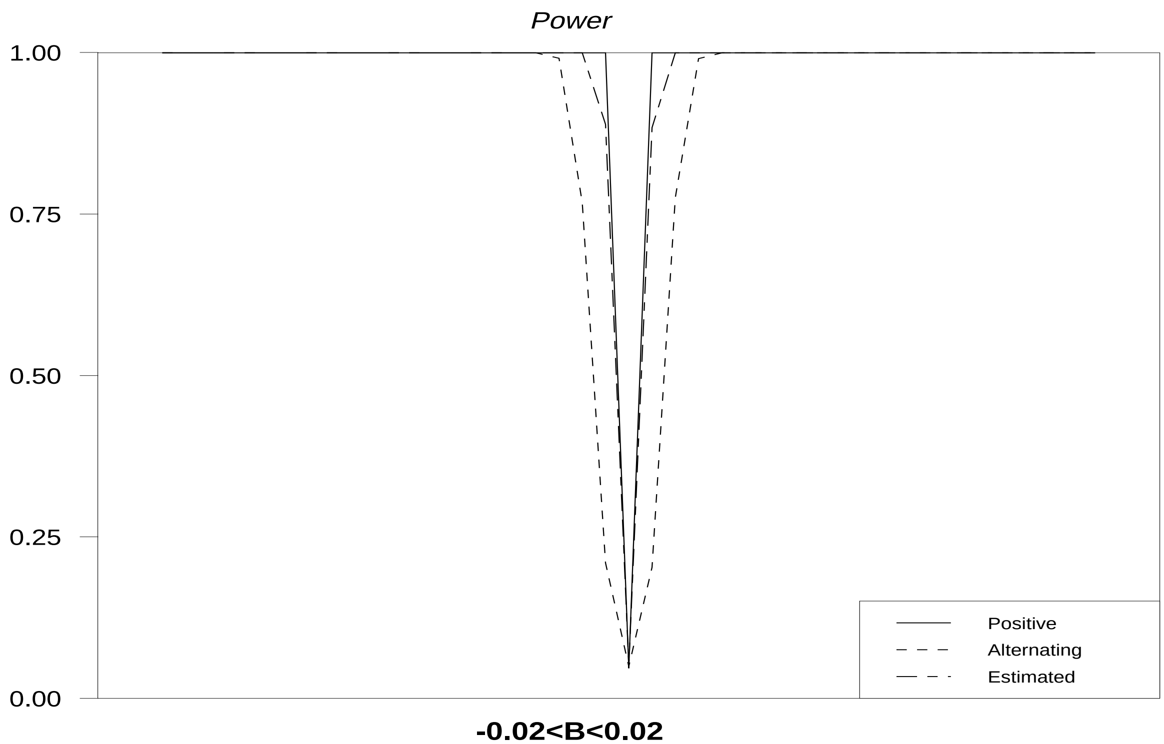
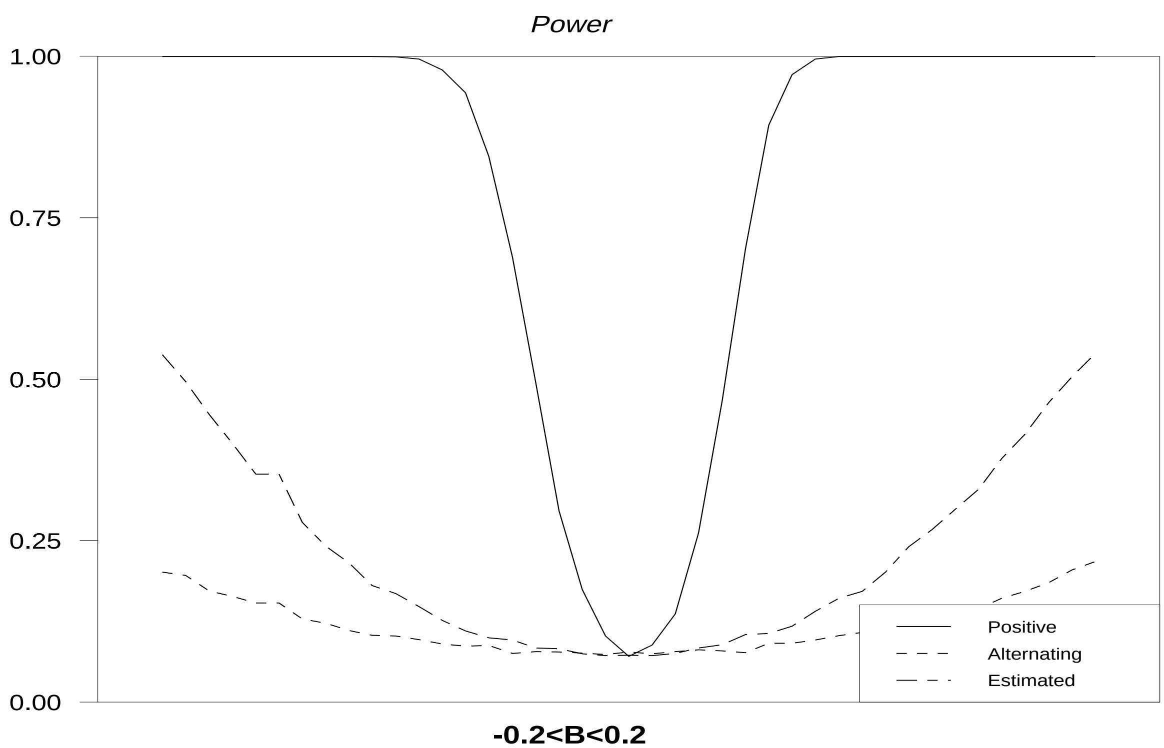


Figure A3: Targeting recent growth rates



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