The Credibility of Monetary Policy: International Evidence Based on Surveys of Expected Inflation

David Johnson*

Introduction

The issue of the credibility of monetary policy is crucial in many models. Simply put, if actual inflation and expected inflation are the same, then the presumption is that society reaches a better economic outcome. Multiperiod or even single-period labour and debt contracts are based on expected inflation. When expected and actual inflation are equal, then participants in contracts carry out the transaction as anticipated when the contract was signed. If a central bank changes its target inflation rate, and this change is rapidly perceived by participants in the economy, then there are more periods when actual and expected inflation are equal. If a central bank is able to achieve its target rate of inflation and this target rate of inflation is the expected rate of inflation, then there are more periods when actual inflation equals expected inflation, and society gets a better economic outcome.

Governor Thiessen, our host at this conference, in addressing the London Chamber of Commerce in 1996, remarked (Thiessen 1996, 64):

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> The [Bank of Canada's] undertaking is to make monetary policy predictable and to provide Canadians with greater certainty about future movements in the price level. For the economy to reap the full benefits of a low-inflation policy, we need to do our best to ensure that the expectations of Canadians in making their economic plans are consistent with our targets. At present, this means keeping to an inflation-control target of 1 to 3 per cent—not above 3 per cent, not below 1 per cent.

The evidence accumulated in the Phillips curve literature over the past 40 years is that episodes of disinflation, when the average rate of inflation is lowered, are associated with sustained increases in unemployment. More credibility, interpreted as a more rapid acknowledgment of the change in the monetary regime to a lower inflation rate, could reduce the severity of the recession in many of the models of the monetary transmission mechanism.

This paper uses survey data to try to assess the credibility and success of monetary policy in 18 countries between 1984 and 1995. The unique aspect of this project is the examination of data on individual forecasts of inflation by professional forecasters in each year in each country. Two approaches are taken in the analysis and description of these data. If a country has a formal inflation target, the inflation forecast in the survey is compared with the announced inflation target. This is a direct measure of credibility. There are relatively few countries and years in this category. Thus for all countries, a second approach is taken: the inflation forecast in the survey is compared with actual inflation in the analysis of forecast errors. Forecast errors are related both to the credibility of monetary policy (whether the central bank's target rate of inflation is believed by the rest of society) and to the ability of monetary policy to keep actual inflation near target inflation. Both are interesting measures of the success of monetary policy. Two comparisons are carried out: a comparison of forecast errors across different countries with and without inflation targets, and a comparison of forecast errors within the same country between inflation-targeting and non-inflation-targeting periods.

The results indicate that it was difficult to establish credible inflation targets. Canada and New Zealand had the most credible inflation targets. In Australia, Finland, Sweden, and the United Kingdom, the evidence suggests that inflation targets were not credible in that the distribution from which the differences between inflation forecasts and the midpoint of the target range is drawn has a positive mean statistically different from zero in the sample of years with targets. However most of the individual forecasts in all six countries fall within the announced target bands for inflation.

The comparison of forecast errors before and after targeting within the same country yields some interesting results. In the targeting countries, it is clear that the package of policies associated with inflation targets did substantially reduce the variance of forecast errors. In particular, the inflation-targeting reforms reduced the variance of the group-error contribution to forecast errors, the part of the forecast error that can be directly attributed to “unsuccessful” monetary policy. This provides some evidence that targets have been a success in these countries. But because non-targeting countries have also reduced the level of inflation, it is useful to try to ascertain if the reduction in forecast error variance is general across countries or specific to the targeting countries. When this comparison is carried out, it becomes clear that during the 1990s inflation forecasts became less variable in all countries, both targeting countries and countries without targets. Thus the extra contribution of targets is not easily defined. In both targeting and non-targeting countries, the disinflation of the 1990s is associated with unexpected disinflation. Targets did not provide a mechanism to avoid unexpected disinflation. But this does not mean targeting was a bad strategy. It is very clear in these data and in other discussions (see Freedman 1995 and Bowen 1995) that the decision by these six countries to adopt targets was endogenous—that is, associated with a previous lack of success of monetary policy. Inflation-targeting countries are clearly countries in which private forecasters have the worst inflation-forecasting record—the highest standard deviation of forecast errors relative to other countries. Thus targets may have prevented an even larger unexpected disinflation than would have occurred in the absence of targets. It is the nature of economic policy that repeated controlled experiments are difficult to carry out and that the contribution of targets to whatever success monetary policy might have had will be difficult to judge with complete certainty.

The paper proceeds as follows. Section 1 discusses the nature of the survey data used and describes the inflation targets. Section 2 lays out a statistical framework for the analysis of these data. Section 3 presents results. The conclusions and some ideas for extensions follow.

1 The Survey Data and Formal Inflation Targets

1.1 The survey data

In 1984, *Economic Forecasts: A Monthly Worldwide Survey* began publication as a monthly journal of economic forecasts. These provided the basis for the present study of the behaviour of inflation forecasts in 18 countries, listed in Table 1. These 18 countries are all those for which

Table 1

A Description of the Forecasts Studied: 1984-95

Country	Number of forecasts		Number and type of forecasters in sample		Average month of forecast in sample	Number of forecasts falling in each quarter				Price index forecast by most forecasters
	Total	In years with inflation targets	Total	Official		Q1	Q2	Q3	Q4	
Austria	24		2	—	4.1	12	12	0	0	CPI
Australia	49	12	8	—	8.6	0	20	1	28	CPI
Belgium	58		9	1	6.1	4	38	5	11	CPI
Canada	73	31	9	—	5.8	23	11	34	5	GDP deflator
Denmark	39		5	1	5.3	7	27	2	3	CPI/PCE
Finland	37	11	4	1	6.7	7	11	11	8	CPI
France	68		9	1	4.4	38	20	9	1	PCE/CPI
Germany	80		8	—	6.7	10	29	24	17	CPI
Ireland	19		2	1	9.4	0	3	7	9	CPI
Italy	57		5	—	4.6	21	27	9	0	CPI
Japan	86		12	—	6.7	15	24	32	15	CPI
Netherlands	32		6	1	5.9	6	13	11	2	CPI
New Zealand	36	18	4	2	7.1	4	20	3	9	CPI
Norway	42		7	4	7.3	7	10	11	14	CPI
Sweden	74	17	11	1	4.3	41	17	4	12	CPI
Switzerland	65		10	1	5.7	21	21	6	17	GDP deflator
United Kingdom	182	46	28	1	2.8	143	24	10	5	CPI
United States	291		25	[a]	2.9	269	22	0	0	GDP deflator

Notes: Shading indicates countries that adopted inflation targets within the sample. CPI stands for consumer price index, GDP for gross domestic product, PCE for consumption price deflator. — means none.

a. The type and the individual names of forecasters in the U.S. sample were not collected.

Source: See the data appendix.

Economic Forecasts provides a substantial list of individual forecasters.[1] Column 1 of the table gives the total number of individual forecasts for each country in the sample. Since there are 12 years in the sample, dividing by 12 gives the average number of forecasts in a year. (This is not shown in the table, but it can quickly be calculated that, for example, in Austria there are only 2 distinct forecasts in each year; in the United States there are roughly 25.) Six countries, each marked by shading in the table—Australia, Canada, Finland, New Zealand, Sweden, and the United Kingdom—had inflation targets for part of the sample. For these countries, column 2 gives the number of distinct forecasts after the announcement of inflation targets. In Australia, for example, there were 12 forecasts after the announcement of targets, in a total of 49 forecasts.

Reports on some countries were issued every month. These tended to be the larger countries—Germany, Japan, the United Kingdom, and the United States. For other countries, there were usually only two or three reports in a calendar year. The date of each forecast and the name of the forecaster were identified. Column 3 gives the approximate number of individual forecasters in each country (in Austria, only two different forecasters responded over the 12 years). Column 4 gives the number of forecasters I was able to identify as being official agencies, either a national ministry of finance or a central bank. Most forecasters appear not to be official agencies. Only in Norway are most forecasters in the survey clearly "official"; in New Zealand, two of four forecasters are official; in Ireland, one of two.[2]

Individual forecasters do enter and leave the survey. Table 1 shows that in most countries there are more individual forecasters than average forecasts per year. When a new country report is issued in a particular month, not all forecasts are new to that month; some are repeats from the previous report. Only forecasts that differ both by date of forecast and by forecaster within a calendar year are included in the data used in this paper. The sample is the individually unique forecasts in a calendar year for each country. That is, if a specific forecaster for Canada, say the Conference Board, makes four forecasts in a calendar year, only the first forecast made by the Conference Board is included. Considering only the first forecast of

1. Although *Economic Forecasts* does contain reports on other countries, these reports do not contain individual forecasts. They present merely a summary statement on the country's prospects.

2. I did not collect the names of the individual forecasters in the United States. This portion of the sample was a late addition to the data. However I believe all these forecasters are private. This is the ASA-NBER survey initiated by Victor Zarnowitz and subsequently carried out by Phillip Braun. The data I used was from March issues of *Economic Forecasts: A Monthly Worldwide Survey.*

the year by each forecaster greatly restricts the data set: in 12 years, there are about 3,000 forecasts in total, but only 1,300 are unique by both individual and year. It is also important to identify the month of the forecast to have a sense of the information set available to the forecaster when the forecast is made. Table 1 presents the average month of the forecast in each country. There is quite wide variation by country: in the United States and the United Kingdom, the average forecast occurs in March; in Ireland, it occurs in September. In most countries, the average forecast occurs in the second quarter of the year. Table 1 also gives the number of forecasts in each quarter of the year by country. It is important to understand the timing of the forecasts because of the nature of the survey question asked.

In each case the forecaster is asked to give two forecasts of inflation—one for the current calendar year and one for the next calendar year. Both forecasts are analysed below. Forecasters are assumed to forecast the percentage increase, year over year, in the average level of prices.[3] Early in a calendar year, a forecaster may give a "forecast" for inflation for the previous calendar year, because of lags in the release of data; such a forecast is not as silly as it sounds. The previous-year forecasts are not analysed. As indicated in the last column of Table 1, in 14 countries the rate of increase in the consumer price index (CPI) or some close variant is the inflation rate forecast; in Canada, Switzerland, and the United States, the implicit gross domestic product (GDP) deflator is forecast.[4] In France, most forecasts are for the deflator on personal consumption expenditures. This is also true for some years in Denmark.

1.2 Inflation targets in the sample

Six countries in the sample have inflation targets in at least some years covered by the surveys. The inflation targets are described in Table 2. Inflation-targeting countries, following Bernanke and Mishkin (1997), operate monetary policy to satisfy two criteria: (1) there are explicit numerical targets for some measure of inflation, and (2) there are no other intermediate targets for monetary policy. The latter criterion excludes Germany and Switzerland from the list of inflation-targeting countries; see the discussion in von Hagen (1995). All central banks continuously express

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3. This is certainly true in the survey of Canadian forecasters, and assumed to be true for the other countries.

4. There are fewer revisions in the CPI in most countries. There are substantial revisions in the GDP deflator. I ignore the distinction between the forecast of the first release of the GDP deflator or its revised value; see Keane and Runkle (1990) for an extensive discussion of the U.S. evidence on this issue.

Table 2

Inflation Targets in the Sample, by Country

Country (adjustments to CPI in inflation rate targeted)	Year of forecast	Target for current calendar year, per cent	Target for next calendar year, per cent	Band of target, % points	Number of forecasts
Australia (mortgage interest, energy prices, government-controlled prices)	1993	2.5	3	1	4
	1994	2.5	3	1	4
	1995	2.5	3	1	4
Canada (indirect taxes, food, and energy prices)	1991	3	3	2	6
	1992	3	2.5	2	6
	1993	2.5	2.25	2	6
	1994	2	2	2	6
	1995	2	2	2	7
Finland (none)	1994	na	2	na	4
	1995	2	2	na	4
New Zealand (commodity prices, government-controlled prices, and interest and credit charges)	1990	4	4	2	3
	1991	3.5	3	2	3
	1992	2.5	1	2	3
	1993	1	1	2	3
	1994	1	1	2	3
	1995	1	1	2	3
Sweden (nominally none but actually indirect taxes and subsidies)	1994	na	2	2	8
	1995	2	2	2	2
United Kingdom (mortgage interest)	1993	2.5	2.5	3	15
	1994	2.5	2.5	3	15
	1995	2.5	1.75	1.5	15

Notes: na indicates not applicable. The values for the targets are the midpoints of the announced bands applied, with some judgment, to the forecasts in those years. The exact correspondence between the calendar years of the forecasts and the announced targets and transition paths is partly a matter of judgment. Adjustments to the CPI target are those listed in Siklos 1997, Table 1.
Source: See the data appendix.

interest in low or lower inflation; only the six central banks in Table 2 set numerical inflation targets.[5]

As Bernanke and Mishkin (1997), Siklos (1997), and others point out (and it cannot be overemphasized), inflation targets are part of a package of changes to monetary policy. The package always included an increased attempt to communicate the goals of monetary policy. In Canada this takes the form of the Bank of Canada's semi-annual *Monetary Policy Report*; in Britain, the Bank of England's *Inflation Report*. Siklos (1997) and Fischer (1993) stress that the New Zealand targets for inflation included simultaneous and substantial fiscal and electoral reforms. No other targeting country went through such a substantive reform. For each country the analysis of the effects of targets is the analysis of the effects of the whole package.

It is also important to note that the rate of inflation targeted is not exactly the rate of inflation forecast. Almeida and Goodhart (1996) and Siklos (1997) distinguish clearly between the inflation rates that are targeted and the "headline" inflation rates that are the objects of these forecasts. Only in Finland is the announced targeted rate of inflation simply the rate of increase of the CPI without any adjustment factors. In all the other countries, the CPI is adjusted in some manner to measure the "underlying" rate of inflation, and it is the underlying rate of inflation that is the target. One important adjustment made in Australia, Canada, New Zealand, and Sweden is that inflation is measured after an adjustment for indirect taxes has been made. In Australia, Canada, and New Zealand, an adjustment to "headline" inflation is intended to remove unstable commodity-related prices from the index. Bernanke and Mishkin (1997) and Fischer (1993) interpret these adjustments as significant modifications to a regime of strict inflation targeting. The adjustments may allow inflation targeting to mimic nominal GDP targets and allow a partial accommodation of a supply shock. It should be noted that the Canadian surveys in this project forecast GDP deflators, and the Canadian target is for the underlying increase in the CPI after the adjustments. The increase in the GDP deflator may actually be a good proxy for the increase in the underlying CPI since indirect taxes play a smaller role

5. Spain also has inflation targets in the above sense. For part of the sample, *Economic Forecasts* does have a country report on Spain. That report does not include individual dated forecasts but is rather a report written by a single author from a variety of forecasts. Thus I do not include Spain in the sample.

in the GDP deflator.[6] However, rather than attempt to know all such details in each of the 18 countries, a year-specific commodity price shock to that country's price index or an indirect tax shock enters the year-specific term of each forecast error, or enters into the deviation of forecast inflation from the target if the shock was anticipated by forecasters.

In all targeting countries but Finland, the numerical inflation-control target range is specified as a band around a midpoint. The band is 2 percentage points in Canada, New Zealand, and Sweden; 1 percentage point in Australia; and up to 3 percentage points during at least the first of the targeting period in the United Kingdom. The interpretation of these bands is not completely clear. Siklos (1997) points out that it is unlikely that central banks are indifferent as to their location within the band—five years of inflation at 1.05 per cent is quite different from five years of inflation at 2.95 per cent although both lie within the target range. Table 2 reports my judgment as to the midpoint of the band relevant to the forecast made in that calendar year for either that calendar year or the next calendar year. These choices reflect both my own judgment and a reading of the literature. For example, in Canada the transition path was specified in 1991 to include a 1.5 to 3.5 per cent target range by mid-1994. I arbitrarily chose 2.5 per cent for both current-year forecasts and next-year forecasts made in 1993. In Britain the time period for the target was specified to relate not to the calendar year but rather to the life of the Parliament. A distinction was made between time "near" the end of the Parliament's life and the time of the announcement. The target range was specified in the announcement as 1 to 3 per cent, with the lower half of the range to be reached by the end of the Parliament in 1997. Some authors (Almeida and Goodhart 1996, Bernanke and Mishkin 1997) interpret the target as the low end of the range; others (for example, Bowen 1995) interpret the target in the high end. The midpoints of the target ranges, when combined with the forecast data, are used to evaluate the credibility and success of monetary policy in different countries.

6. There is a Conference Board survey of forecasters in Canada that collected both CPI and GDP deflator inflation forecasts over the period considered here. These data are explored in Johnson (1997) and were used in Laidler and Robson (1993). These forecasts are not as precisely dated as those in *Economic Forecasts*. To maintain comparability of the data source across countries, I use the smaller sample of Canadian forecasts in *Economic Forecasts*. It has also been pointed out to me that in the 1984-95 sample in Canada, inflation measured by the GDP deflator has been lower than that measured by the CPI.

2 Forecasts and the Study of Credibility: A Statistical Framework

2.1 Introduction

In using the survey data to assess credibility I take two approaches. The first compares forecasts and the midpoints of the bands of the inflation targets. This is a direct measure of credibility. Because inflation targets are a new phenomenon, there are relatively few years in this sample. In addition some inflation-targeting countries have very few forecasters in the survey. And there are the difficulties already discussed with the literal interpretation of midpoints as point estimates.

For all these reasons I take a second approach as well in which I construct forecast errors by individuals for all countries, forecasters, and years, targeting and non-targeting. This greatly increases the number of observations. The comparison of forecasts with actual inflation does yield information on the success and perhaps on the credibility of monetary policy.

2.2 Forecasts and a target for inflation

In each inflation-targeting country, denoted by superscript C, in year t, there is a forecast of inflation by forecaster I. This forecast is denoted $F_t^{i,C}$. As noted in Section 1, the forecast in the current calendar year could be for either the current calendar year or the next calendar year. The notation below does not distinguish between these two cases. Separate results are presented for current-year and next-year forecasts as necessary. It is clear that, given the question asked and the timing of the forecasts, the next-calendar-year forecasts are of more interest. For each period forecast, the authorities in inflation-targeting country C have announced a target rate of inflation, T_t^C. The model used to analyse the credibility of the target's announcement in a targeting country is:

$$F_t^{i,C} = C^C + g_t^C + T_t^C + e_t^{i,C}, \tag{1}$$

where C^C is an overall index of credibility in country C for this targeting period. The targeting period runs for n^C years in country C; the index t runs from $1 \ldots n^C$; and g_t^C is a mean-zero random variable with variance $\mathrm{Var}(g^C)$ in each country. There is one value of g_t^C in each year of the targeting period; $e_t^{i,C}$ also has mean zero. For a given forecast year, the difference between the announced target rate of inflation and the group's belief about the expected rate of inflation in year t is the sum of C^C, the "usual" disbelief from the target for the whole targeting period, and particular value g_t^C from the g^C distribution in year t. If C^C is zero, then for the targeting period as a whole, the targets were credible. In a given year when the target may not be credible, a year-specific draw of g_t^C may be non-zero. If there are no year-specific draws of g_t^C, its variance and all values are zero and the targets are equally credible (or equally not credible) throughout the sample of targeting years. Both measures of credibility are of interest: the estimate of the value of C^C and the variance of g^C. If the estimate of C^C is negative, then the target is "conservative"—that is, the forecasters believe the midpoint of the target range will be easily achieved. If the estimate of C^C is positive, the target is not credible for the period. The variance of g^C is also an important measure of credibility. A country needs a low variance of g^C to have a successful targeting strategy even if the value of C^C is zero. It is not good enough to be credible on average if in any given year it is unlikely that the target is believed. The values of g_t^C in a given year are also of interest, but discussion of these estimates is left to future work. A year-specific value of g_t^C is the extent to which the forecasters as a group do not believe, beyond their usual level of disbelief, in the announced target in that particular year *t*.

Finally the values of $e_t^{i,C}$ represent the variation across forecasters around the group average forecast. The expectation of this variable is zero. Its variance, $\mathrm{Var}(e^{i,C})$ may also be an interesting measure of credibility. Again this paper does not focus on this variance. Individual variation could be interpreted in several ways. If individuals believe that the central bank usually hits its target, then individual variation reflects variation in beliefs about the actual target itself. If individuals believe that there is variation in the ability of a central bank to hit its target in different circumstances, individuals may look at the same or different information sets and arrive at different estimates of the ability to hit a common target. In either case the variance of $e^{i,C}$ is interesting information about forecasters' beliefs. If monetary policy is very credible or very successful, then forecasts may be closely grouped around the target or at least the believed target.

In each country, the entire inflation-targeting period is used as a sample to estimate the following parameters: the value of C^C, the variance of g^C, and the variance of $e^{i,C}$. These parameters are estimated using a single-factor analysis-of-variance (ANOVA) model. While not often used in economics, this model is a commonly used framework in other social sciences. In this framework, equation (1) is rewritten as

$$F_t^{i,C} - T_t^C = C^C + g_t^C + e_t^{i,C}. \qquad (2)$$

When the values of g_t^C and $e_t^{i,C}$ are thought of as being drawn from a random distribution of possible values, this model is also known as a random-effects ANOVA model. The difference between an individual forecast and a target in a given year is the sum of three variables. There is or is not a general disbelief in the targets for the whole targeting period, the value of C^C. There is disbelief particular to a year, g_t^C. And there is the individual-specific variation, $e_t^{i,C}$. In this study, the statistical framework assumes that the error terms $e_t^{i,C}$ and g_t^C are independent normal variables. The framework assumes that the draws of g_t^C across the years are independent variables.[7] In this case the variance of the forecast minus the target variable is $\mathrm{Var}(g^C) + \mathrm{Var}(e^{iC})$. This breakdown gives this analysis its other name, the components-of-variance model.

Searle, Casella, and McCulloch (1992) give the relevant formulas to carry out maximum-likelihood estimates of $\mathrm{Var}(g^C)$ and $\mathrm{Var}(e^{i,C})$ and approximate confidence intervals on these estimates.[8] The null hypothesis that $\mathrm{Var}(g^C)$ is zero versus the alternative that it is greater than zero is tested using the F-test in the ANOVA model. This hypothesis is of considerable interest; if the null hypothesis cannot be rejected then there are no year-associated credibility effects. When the variance of g^C is not zero, then the maximum-likelihood estimates of the components of variance are combined with the annual average deviation of forecast from target to estimate C^C; see Searle et al. (1992). The intuition is that different years receive different weights according to sample size and according to the components of variance. This makes the estimate of C^C slightly more complicated than a simple average across all observations. The null hypothesis that the value of C^C is zero is then tested. In the limit, if the estimated value of C^C is zero, and the null hypothesis that $\mathrm{Var}(g^C)$ is zero cannot be rejected, then the target is fully credible if the individual error term is interpreted as variation in beliefs about the ability of the central bank to hit the target. If the individual error term is interpreted as differences in beliefs about the actual target, then at least the group of forecasters on average believes the target although individual forecasters may not believe the target. Results for these tests of hypotheses are presented below in Subsection 3.2. These hypotheses can be tested only for the few countries in the sample with formal inflation targets. The number of years with targets is quite limited. Therefore I extend the statistical framework (discussed below) to analyse the properties of the forecast errors as they relate to the credibility and success of monetary policy.

7. This is an assumption that may be relaxed in future work. It may be possible to consider learning processes in this framework.

8. The SAS procedure VARCOMP was used to generate a maximum-likelihood estimate of the components of variance.

2.3 Forecasts and actual inflation

The extension of the model starts with the observation that actual inflation in country C in year t, denoted π_t^C, deviates from target inflation by $B^C + b_t^C$ according to

$$\pi_t^C = B^C + b_t^C + T_t^C. \tag{3}$$

In countries that do not formally target inflation, T_t^C is not public information. Forecasters and other interested parties clearly spend time and energy trying to infer the authority's target. The term B^C in equation (3) is the average inability of a central bank in country C to hit its target rate of inflation over the sample of all years t. If central banks do choose and achieve the targeted rate of inflation in the sample of t years, then B^C is zero. Although it seems reasonable to assert that B^C is zero over a long sample, there may be year-specific reasons that a central bank may not be able to hit its target in that particular year. These are represented by a non-zero value of b_t^C drawn from a distribution b^C with mean zero and non-zero variance, $\mathrm{Var}(b^C)$. The variance of b^C is proposed as a reasonable measure of "successful" monetary policy: a successful monetary authority is able to hit its desired rate of inflation most of the time. To summarize: if B^C is zero, then this is the assumption that the authorities have both a view concerning the target rate of inflation and sufficient control over the national inflation rate to achieve their target in the long run; in the short run, the central bank faces shocks, b_t^C, that prevent the exact achievement of their target in a particular year. This seems to be a useful picture of monetary policy.

Combining equations (1) and (3) leads to

$$F_t^{i,C} - \pi_t^C = C^C - B^C + g_t^C - b_t^C + e_t^{i,C}, \tag{4}$$

where the left-hand side of equation (4) is the forecast error made by forecaster I in year t in country C. If we combine terms on the right-hand side, we get

$$F_t^{i,C} - \pi_t^C = E^C + u_t^C + e_t^{i,C}, \tag{5}$$

where $E^C = C^C - B^C$ is (approximately) the average forecast error in country C over a sample of years. The term $u_t^C = g_t^C - b_t^C$ is the year-specific deviation from the usual level of forecast error for this country in this sample. The comparison of equations (4) and (5) makes it clear that forecasts can be correct for a variety of reasons. Forecast errors will be small if the forecasters have the target correctly identified (a small value of g_t^C and a low value of C^C) and if the authorities successfully hit the target in that year (a small value of b_t^c and a low value of B^c). A small forecast error is normally interpreted as a success in monetary policy (recall the comments by Governor Thiessen in the introduction). But there are many other combinations in equations (4) and (5) that can also generate small forecast errors. Forecast errors are small if everyone believes the inflation target is higher than it actually is and the central bank does not succeed in hitting the target. Thus the properties of the forecast errors are not precisely the properties of successful monetary policy.

If the reader is willing to assume that the value of B^C is zero, then the estimate of E^C in equation (5) is the estimate of C^C, and forecast error data can be used to generate one of our measures of credibility. Readers can decide if they are willing to make that assumption as the results are presented. It is clear that neither the variance of g^C nor the variance of b^C is likely to be zero. But we can think of the variance of u^C as the aspects of monetary policy for which central banks are responsible. A central bank is responsible for clear communication of its target, a low variance of g^C. A central bank, once it has chosen its target, could be considered responsible for hitting its target as closely as possible—a low variance of b^C. One way in which the variance of u^C can be low is if both its components have low variance.[9] The variance of u^C can also be used as a measure of the success of monetary policy.

The parameters of equation (5) that are estimated are analogous to the parameters of equation (2) that are estimated. E^C can be estimated and is of central interest; this is the central point in the distribution from which all forecast errors are drawn for the sample of years in question. We are also very interested in the variance of u^C, the year-specific component of the forecast errors. The null hypothesis that this variance is zero is of great interest. If it is, then forecast errors are drawn from a distribution with the same mean in all years in the sample. In a sense, when monetary policy is more successful, all the variation is in the interpretation of the same data by the individual forecasters. This is the variance of e^C. If the overall sum of the two variance components is small, then the central bank has done its job, and inflation is relatively predictable. These parameters of the forecast error distributions are estimated for periods before and after targets in the targeting countries and for all countries before and after 1991.

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9. The variance of u^C is $\mathrm{Var}(g^C) + \mathrm{Var}(b^C) - 2\,\mathrm{Cov}(g^C, b^C)$, where "Cov" denotes covariance. Small forecast errors can occur if, in years in which the target is not believed, the central bank is also not able to achieve the forecast. This issue merits more investigation in future work.

3 Results

3.1 Forecast errors: The basic characteristics

Table 3 and Figure 1 are a first look at the forecast errors. Errors are defined as forecast inflation minus actual inflation measured as percentages. A positive value indicates an unexpected disinflation. Actual inflation for both the CPI and the GDP deflator is measured with revised data (this paper provides a short data appendix with the details), thus forecast errors are constructed using the revised data. Data revisions could also play a small role.[10] Even within a country, the forecasters do not all claim to be forecasting the same measure of inflation. The variation is usually small—the consumption price deflator instead of the consumer price index is the most common variant. As already noted, the consumption price deflator is the dominant variable in French forecasts. This does mean that part of what is measured as forecast error is the difference between the actual inflation measure used and the forecast variable.

Figure 1 shows the nature of the data set—in each nation in each calendar year a number of forecasters make a forecast for the current year (the upper panel) or the next year (one year ahead, in the lower panel). The figure is structured so that, for each country, the forecast errors for the same calendar year are aligned vertically. It is clear that it is much easier to forecast within the current year. This is confirmed by the fact that the standard deviations of the current-calendar-year forecast errors (see the first half of Table 3) are, for most countries, much smaller than those for the next calendar year. This makes perfect sense: most of the information about actual inflation in the current calendar year is available when the current-year forecast is made.

Table 3 and Figure 1 reveal important information about the nature of the forecast errors. This sample of years and countries deals with unexpected disinflation. Of the 18 countries studied, 14 have average next-year forecast errors that are positive. Using a conventional t-test, the null hypothesis that the forecast errors from 1984 to 1996 are drawn from a distribution with mean zero is rejected for all countries but Denmark, Finland, France, Italy, the Netherlands, Sweden, Switzerland, and the United Kingdom. That leaves 8 of 18 countries with unexpected disinflations over

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10. I had insufficient resources to go back and track the initial announcements of the GDP deflator versus the final values. Revisions in the CPI are rare. Keane and Runkle (1990) deal carefully with the issue of data revisions in the U.S. GDP deflator because their primary interest lies in a precise measure of the rationality of expectations and the relationship of the forecast errors to the information set at the time of the forecast. Data revisions in the GDP deflator are larger. I have looked at data in revisions in the Canadian GDP deflator and found them small (Johnson 1997).

Table 3

The Properties of the Forecast Errors, 1984–95

Country	Rank	Current-calendar-year forecast errors				Next-calendar-year forecast errors			
		Average	Standard deviation	Minimum	Maximum	Average	Standard deviation	Minimum	Maximum
Austria	18	0.20	0.39	−0.30	0.96	0.46	0.36	−0.53	2.11
Australia	4	0.40	0.32	−0.34	1.32	0.70	1.83	−1.98	4.11
Belgium	12	0.15	0.26	−0.39	0.84	0.57	0.98	−1.75	2.71
Canada	8	0.25	0.88	−1.79	3.35	0.82	1.09	−1.59	3.35
Denmark	15	−0.10	0.53	−2.41	0.63	−0.18	0.91	−2.46	1.15
Finland	5	0.21	0.51	−1.02	1.42	0.46	1.76	−3.03	3.91
France	10	0.03	0.38	−0.83	0.86	0.19	1.06	−2.23	3.59
Germany	13	0.08	0.27	−0.50	0.75	0.35	0.97	−2.97	2.75
Ireland	17	−0.02	0.33	−0.81	0.50	0.40	0.69	−1.25	1.60
Italy	11	0.05	0.90	−5.66	1.54	0.08	1.02	−2.64	2.14
Japan	9	0.00	0.57	−2.11	1.38	0.50	1.07	−1.81	3.02
Netherlands	16	0.19	0.46	−0.69	0.92	0.25	0.77	−0.92	1.80
New Zealand	3	−0.01	1.61	−3.01	4.33	−0.70	1.98	−6.01	3.09
Norway	6	0.31	0.98	−1.02	5.94	0.59	1.68	−1.48	9.66
Sweden	1	0.44	0.88	−2.25	3.82	0.02	2.18	−5.95	5.32
Switzerland	7	−0.16	0.82	−1.42	1.78	−0.10	1.43	−3.42	2.80
United Kingdom	2	−0.20	1.14	−4.75	2.84	−0.05	2.13	6.75	4.94
United States	14	0.00	0.48	−1.37	1.41	0.70	0.96	−3.19	4.04

Notes: The sample includes forecasts made from 1984 to 1995, inclusive. Forecast errors are calculated as forecast inflation rates minus actual inflation rates. Rank: ranking from (1) highest to (18) lowest by the standard deviation of the next-year forecast error. Countries marked by shading adopted inflation targets at some point in the period between 1990 and 1995.

Source: See the data appendix.

Figure 1

Forecast Errors by Country

Austria, Australia, and Belgium

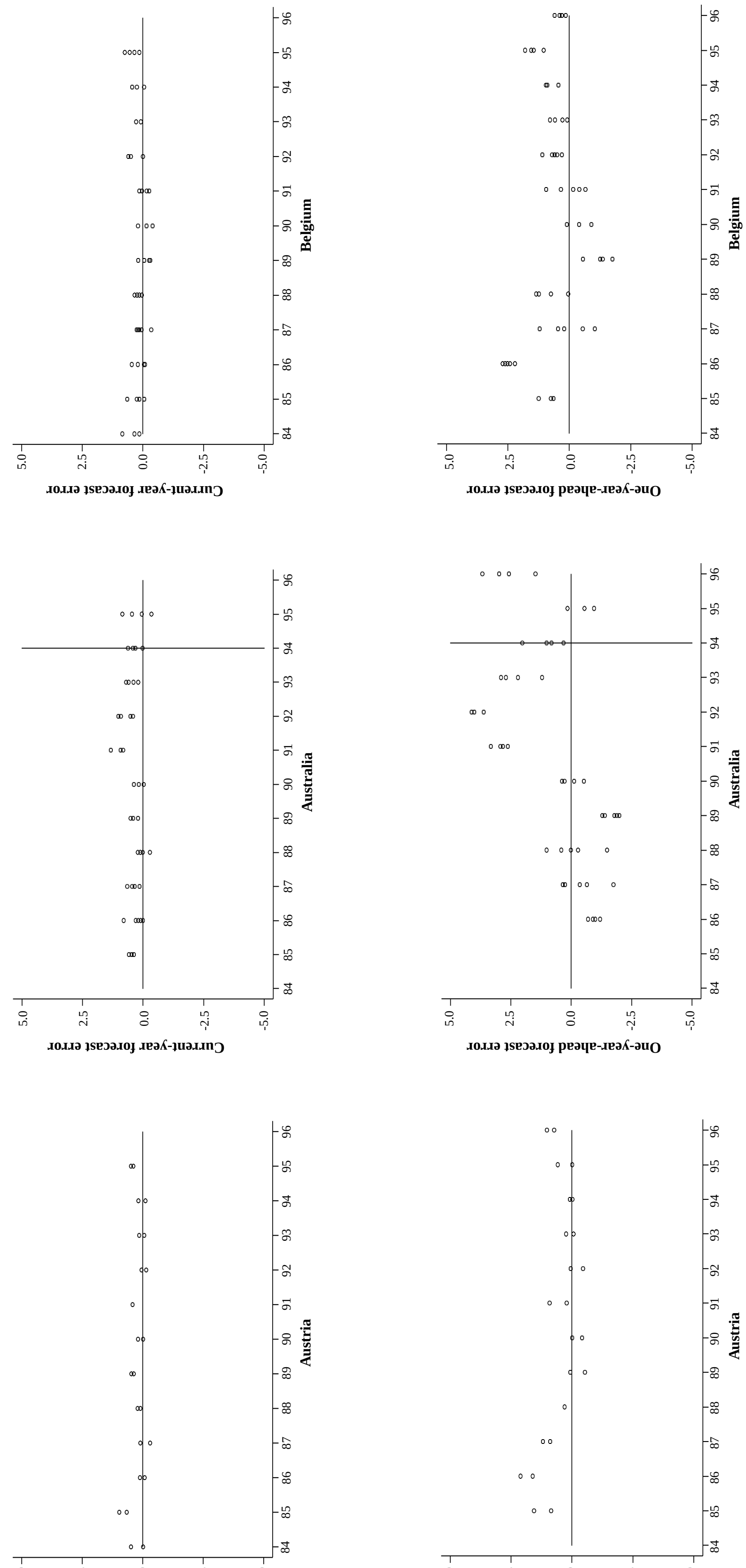


Figure 1 (cont'd)

Forecast Errors by Country

Canada, Denmark, and Finland

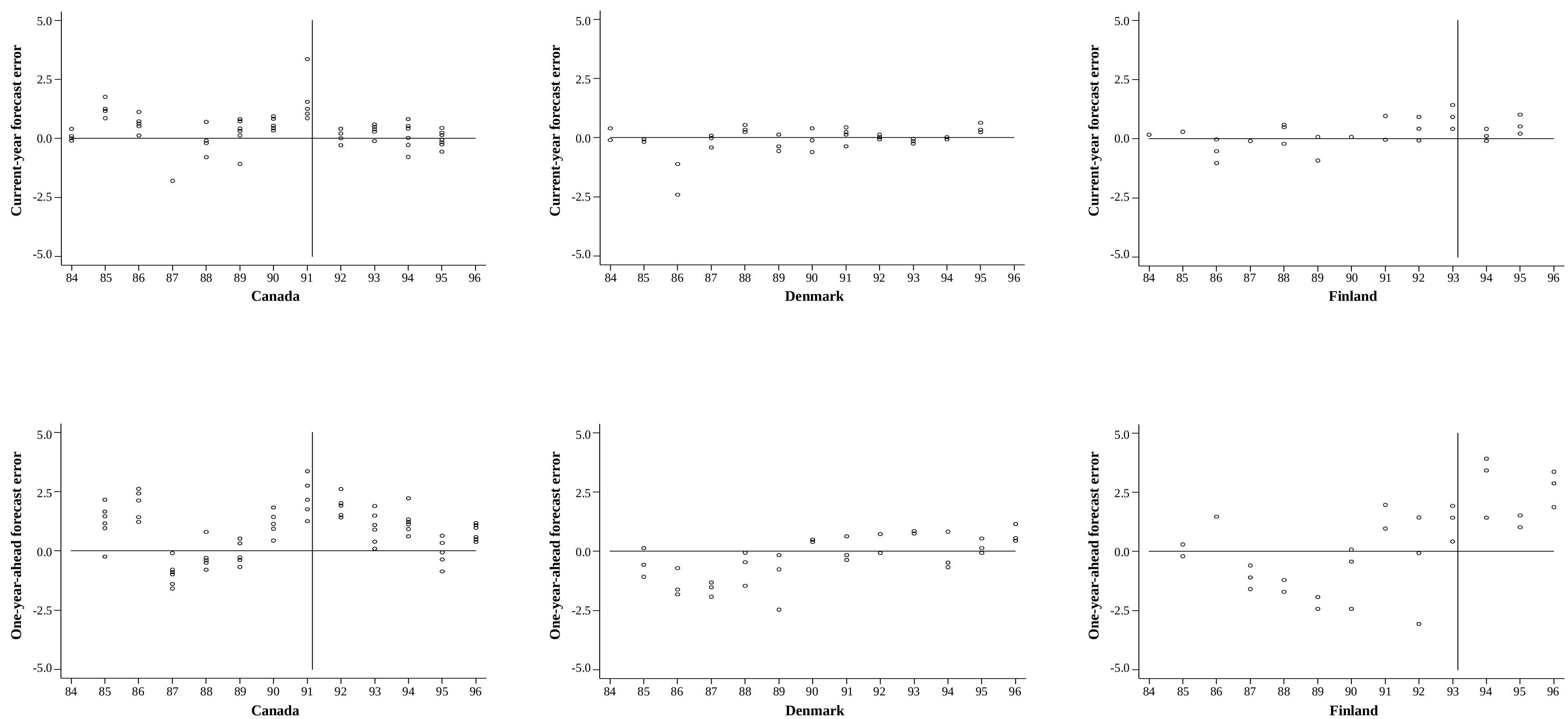


Figure 1 (cont'd)

Forecast Errors by Country

France, Germany, and Ireland

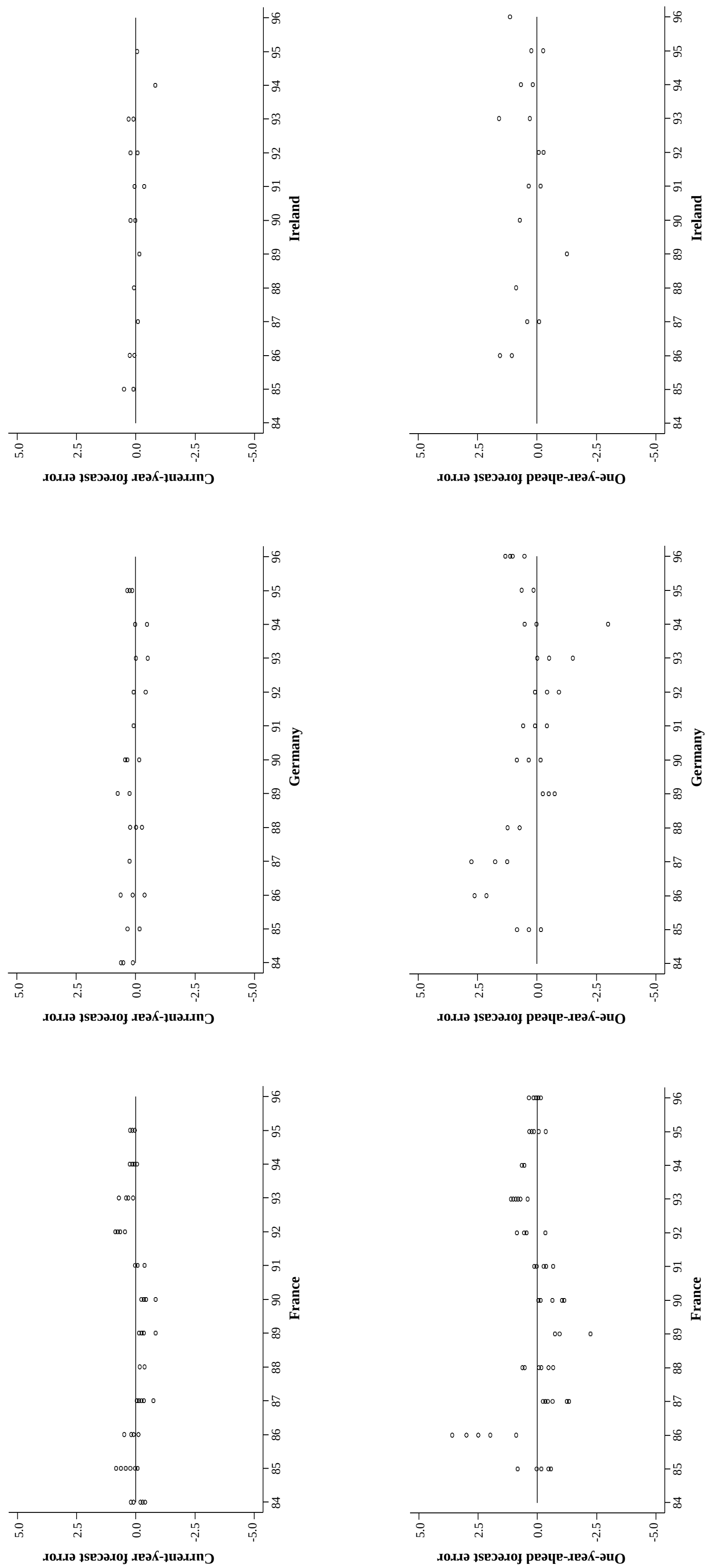


Figure 1 (cont'd)

Forecast Errors by Country

Italy, Japan, and Netherlands

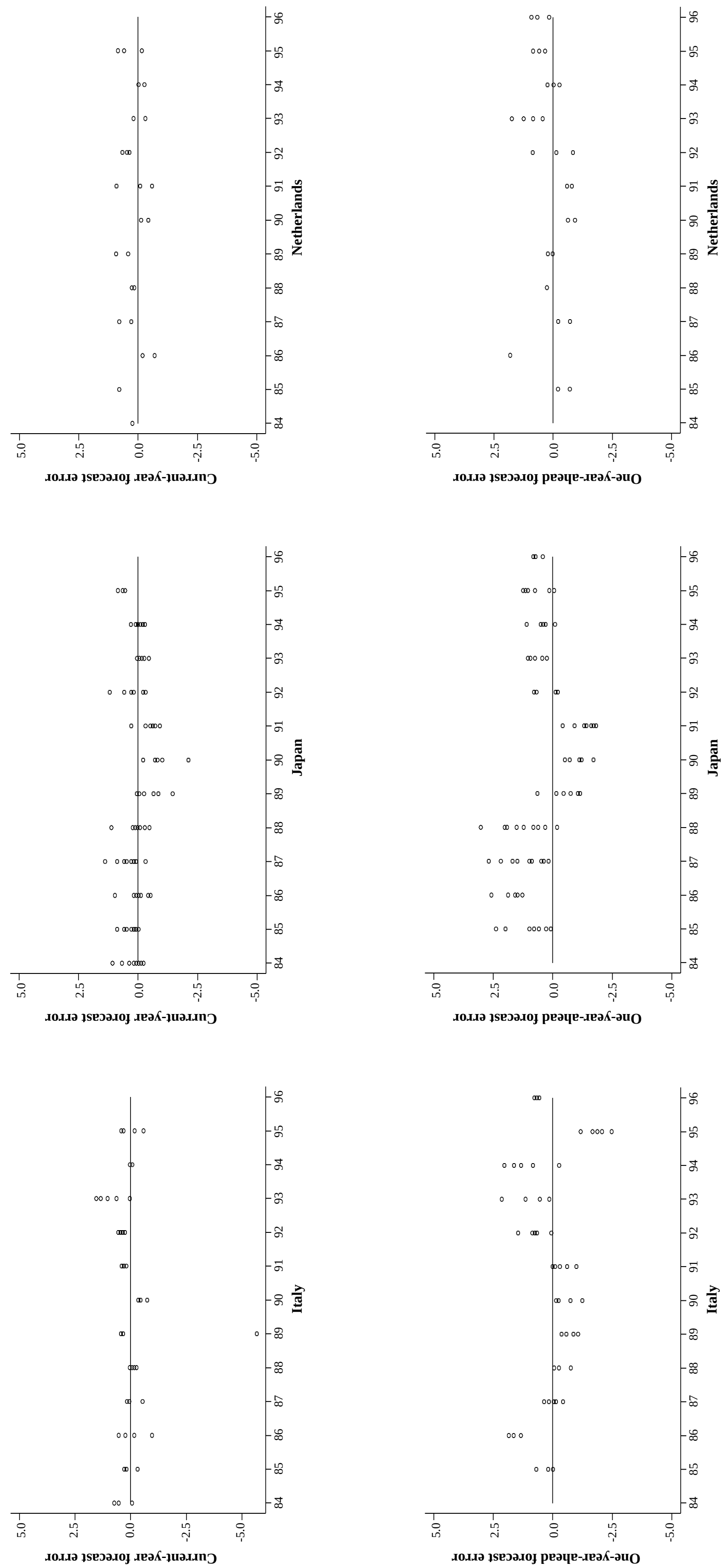


Figure 1 (cont'd)

Forecast Errors by Country

New Zealand, Norway, and Sweden

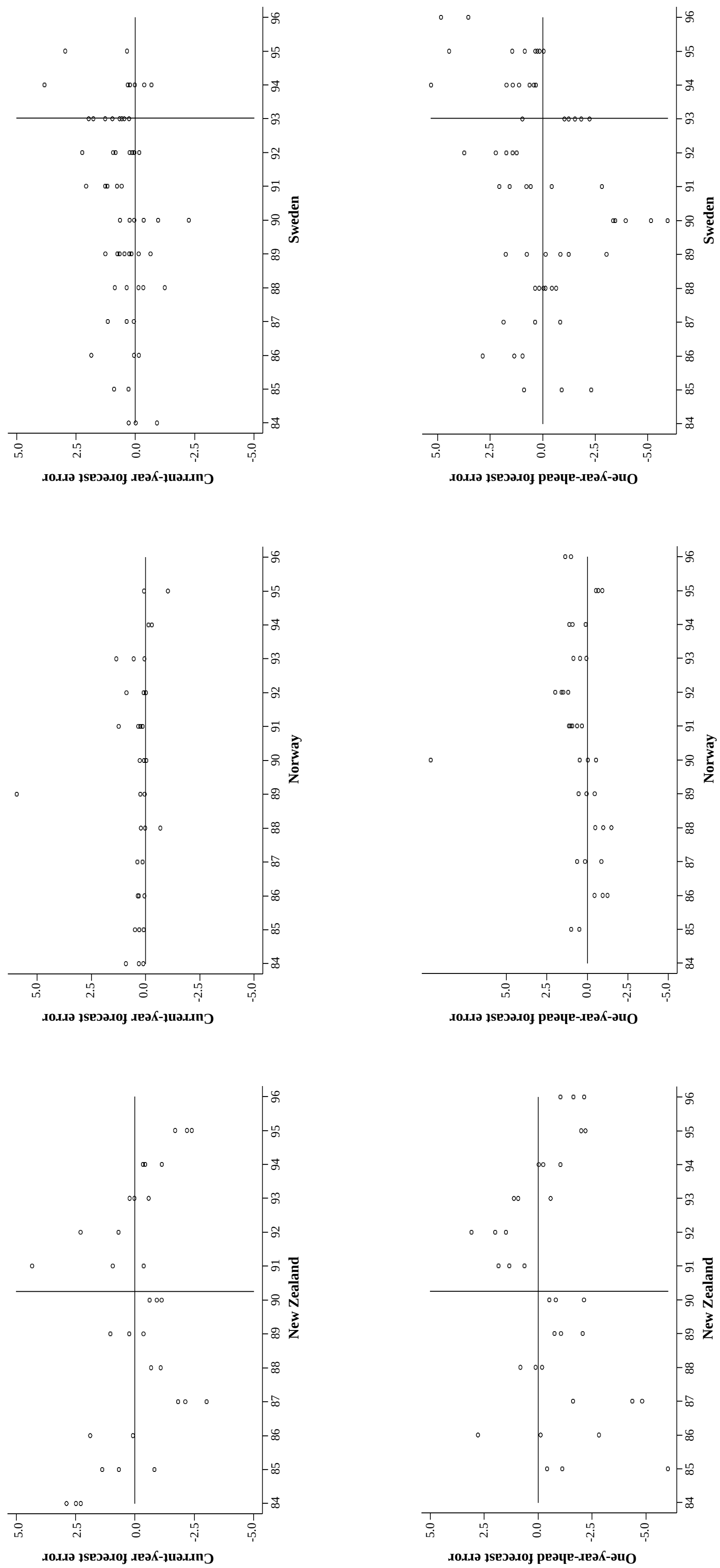
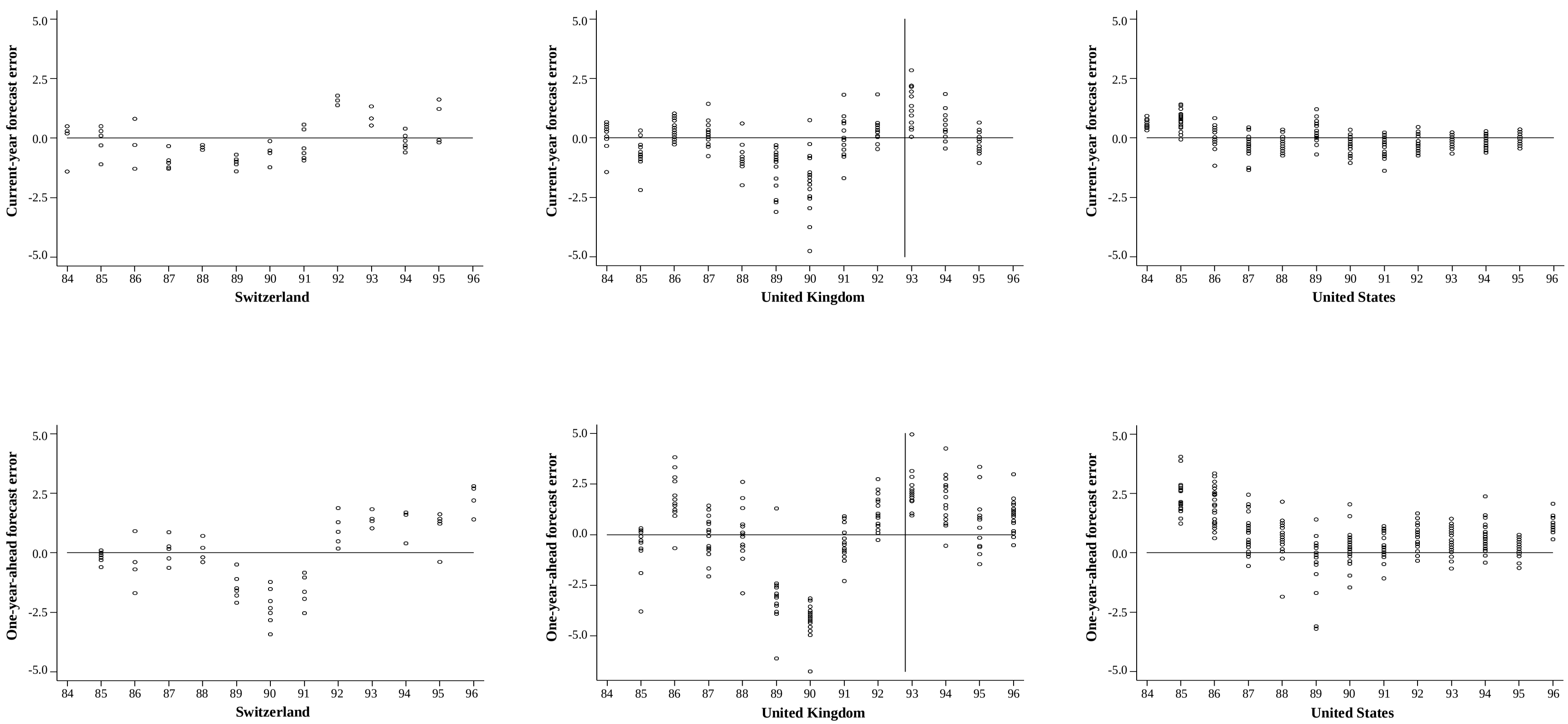


Figure 1 (cont'd)

Forecast Errors by Country

Switzerland, United Kingdom, and United States



Source: See the data appendix.

the 13 years. It is more important, as Figure 1 makes clear, that we cannot treat all observations in all years as equivalent information. It shows that in nearly all countries there are years when the average forecast error is different from zero—that is, there are non-zero values of u_t^C. This is particularly prominent in the analysis of the next-year forecast errors. In every country there is at least one year in which all the next-year forecast errors lie to one side or the other of the zero line. There are significant year-specific errors across years that must be taken into account in the analysis. This shows how we need the random-effects ANOVA framework to really understand these data.

Table 3 ranks the countries by standard deviation of next-year forecast error over the full sample including the periods of targeting. Targeting countries are marked by shading. It is striking that the targeting countries occupy six of the eight highest slots. (Norway is ranked sixth, but its high standard deviation is dominated by one extreme next-year forecast error—9.66 per cent in Table 3. This outlying observation is actually present in the data, but it may be an entry error in *Economic Forecasts*.) The decision to target was almost certainly endogenous: countries with poor records in the management of monetary policy turned to targets. It is also not surprising that the targets were not instantly credible.

3.2 A direct comparison of forecasts and inflation targets

Table 4 presents the estimates of the model of the differences between forecasts and the midpoints of the target bands over the targeting period—the estimates of the parameters of equation (2). In each country, targets and forecasts are compared for both current-year and next-year, as available. First the table presents the average difference, over all years and forecasts, between the forecast and midpoint of the relevant target range. The standard deviation of that difference is in parentheses. Some good news for the credibility of targets is that zero lies within one standard deviation of the average difference between forecast and midpoint. More good news for the credibility of targets is that in all countries except Australia most forecasts lie within the target bands. We should recall that the width of the bands in the United Kingdom was 3 percentage points. If the United Kingdom were to have bands of 2 percentage points, then 13 of its 41 next-year forecasts would be outside the bands, thus presenting a weaker case for credibility. However the estimates of C^C and the variability of g^C do not suggest that targets were instantly credible.

The table then presents the estimates of C^C, along with a t-statistic on the null hypothesis that the mean of the distribution of the forecast minus the midpoint of the target band over the whole targeting period is zero. This hypothesis is clearly rejected for next-year forecasts for Australia, Finland,

Table 4

The Difference Between Inflation Targets and Forecasts

Country / Year	Number of forecasts	Average difference *(standard deviation)*	C^c *(t-statistic)*	Per cent within target bands	Prob. Value H_0: $Var(g^C) = 0$	$Var(g^C)$ *(confidence interval)*	$Var(e^{i,C})$ *(confidence interval)*
Australia							
Current	12	0.60	0.60	66	0.000	1.41	0.12
		(1.29)	*(0.86)*			*(1.17)*	*(0.059)*
Next	12	1.53	1.53	25	0.005	0.72	0.54
		(1.17)	*(2.83)*			*(0.70)*	*(0.25)*
Canada							
Current	31	−0.60	−0.60	93	0.000	0.80	0.29
		(1.05)	*(1.46)*			*(0.53)*	*(0.28)*
Next	31	−0.19	−0.19	100	0.093	0.033	0.26
		(0.55)	*(1.57)*			*(0.048)*	*(0.07)*
Finland							
Current	4	−0.32	−0.32	na	na[a]	[b]	na
		(0.39)	*(1.64)*				
Next	8	0.75	0.75	na	0.106	0.062	0.31
		(0.65)	*(2.82)*			*(0.147)*	*(0.18)*
New Zealand							
Current	18	0.38	0.38	94	0.734	[b]	—
		(1.02)	*(1.58)*				
Next	18	0.39	0.39	100	0.337	0.008	0.41
		(0.66)	*(2.52)*			*(0.10)*	*(0.16)*

(continued)

Table 4 (cont'd)

The Difference Between Inflation Targets and Forecasts

Country Year	Number of forecasts	Average difference *(standard deviation)*	C^c *(t-statistic)*	Per cent within target bands	Prob. Value H_0: $\text{Var}(g^c) = 0$	$\text{Var}(g^c)$ *(confidence interval)*	$\text{Var}(e^{i,c})$ *(confidence interval)*
Sweden							
Current	2	2.20 *(1.83)*	na[a]	50	na[a]	na	na
Next	10	1.67 *(1.40)*	1.67 *(3.89)*	80	0.475	[b]	—
United Kingdom							
Current	46	0.47 *(0.63)*	0.47 *(4.59)*	97[c]	0.160	0.007 *(0.026)*	0.385 *(0.08)*
Next	46	1.51 *(1.14)*	1.51 *(9.43)*	91	0.659	[b]	—

Notes: na means not applicable; — recognizes that, once the estimate of the $\text{Var}(g^c)$ is zero, the estimate of $\text{Var}(e_t^{i,c})$ is simply the square of the standard deviation in the third column.

a. Insufficient observations to estimate.

b. The maximum-likelihood estimate of $\text{Var}(g^c)$ is zero. The estimate of the mean of the distribution of $F_t^{i,c} - T_t^c$ is the average difference divided by the standard deviation adjusted for the size of the sample.

c. Using the 3 percentage point band for all years.

Source: See the data appendix.

New Zealand, Sweden, and the United Kingdom. Only in Canada do next-year targets pass this test of credibility. For the five countries without credibility, forecasts exceed the midpoints of the target band by about 1 per cent over the targeting periods. None of these countries succeeded in establishing a credible future inflation path related to their targets.

Notice that the point estimate of the average difference and the value of C^C are frequently identical. This occurs when the samples are balanced—that is, when they have an equal number of forecasters in each year. Nonetheless, if the hypothesis that the variance of g^C equals zero is rejected, then the estimate of the standard deviation of C^C needs to take into account the common error structure across years in tests of hypotheses on the value of C^C.

If the hypothesis that the variance of g^C equals zero is not rejected, then confidence intervals and test statistics are calculated ignoring the commonality in the year-specific error within a year. All observations contribute equally to our information about credibility. Thus for the next-year estimates in Sweden and the United Kingdom and the current-year estimates in New Zealand and Finland, the t-statistic on C^C is the t-statistic on the null hypothesis that the mean value of the differences between forecast and target is equal to zero. In these cases the maximum-likelihood estimators of the variance of g^C are driven to zero. This is indicated by the notation “b” on Table 4. There are also several cases for which there are too few observations to estimate the parameters.

Analysis of the current-year differences between forecasts and targets indicates that for all countries but the United Kingdom, targets for current-year forecasts were credible. None of these differences were drawn from a distribution with a mean significantly different from zero. The Canadian point estimates of C^C in both the current-year and the next-year case raise an interesting issue: it seems possible for the central bank to choose targets that are so easily achieved that the forecasters believe from the outset that they will be overachieved and that inflation will fall faster than the target path. Further investigation of the evolution of credibility within a sample period is left to future work.

3.3 Forecast errors before and after inflation targets

What does the behaviour of forecast errors tell us about credibility? Table 5 compares the properties of forecast errors—forecasts of inflation minus actual inflation—for the six targeting countries in the periods before and after the implementation of targets. The results indicate that for all targeting countries except New Zealand, disinflation was unexpected in the targeting period. Targets did not prevent unexpected disinflation. These results do not tell us, however, if the magnitude of unexpected disinflation would have been even larger in the absence of targeting and the associated reforms.[11] The most vital message in Table 5 is that it is extremely important to allow for year-specific effects in the analysis of forecast errors. The null hypothesis that the variance of u^C is zero is strongly rejected in most cases. In the cases of Finland and Sweden, the hypothesis cannot be tested, because data are available for only one year.

In Canada and the United Kingdom, the point estimate of E^C is 1 per cent in the next-year forecast error analysis. In Finland and Sweden, it exceeds 2 per cent in a much more limited sample. In Australia, the point estimate is about 1 per cent but the estimate is not statistically different from zero. At least over these short time periods, there is little evidence of the success of targeting. Only in New Zealand does the statistical result indicate that unexpected disinflation is avoided over the whole targeting period. However New Zealand has the longest experience with targets, and examination of Figure 1 reveals that the first portion of the New Zealand target period looks much like the experience of the other countries—disinflation is unexpected. Later reflation is also unexpected.

There is an important dimension in which targeting has been fairly successful. Compare, before and after targets, the estimates of the variance of u^C. This variance relates to the year-specific factors that can be thought of as under the control of the central bank—the variance in the group's belief in the target from year to year, and the variance in the ability to hit the target from year to year. The decline in this portion of the variance of forecast errors is striking in Australia and in the United Kingdom for next-year forecast errors. The estimates of this variance also drop sharply in Finland and Sweden but those samples are small. In New Zealand, the variance of u^C does rise. It is important that the decline in the variance of u^C usually occurs without an increase in the variance of e^C. There is evidence that the overall variance of forecast errors does drop in comparing the targeting with non-targeting periods. The next issue, considered only briefly, is whether the same drop in the variance of forecast errors is common to both targeting and non-targeting countries.[12]

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11. In attempting to answer this question for Canada in another paper (Johnson 1997) I did not find that the announcement of targets in Canada in 1991 reduced expected inflation after controlling for the information known by forecasters.

12. It would be interesting to ask what other factors beyond a simple sample split might be associated with the fall in the components of variance. This is left to future work.

Table 5

The Effect of Inflation Targets on Forecast Errors

Country Year		E^C	(t-statistic)	Prob. value H_0: $Var(u^C) = 0$	$Var(u^C)$	(confidence interval)	$Var(e^{i,C})$	(confidence interval)
Australia								
Current	No targets	0.43	*(4.43)*	0.000	0.067	*(0.038)*	0.043	*(0.011)*
	Targets	0.36	*(3.77)*	0.686	[a]		—	
Next	No targets	0.76	*(1.15)*	0.000	3.47	*(1.73)*	0.33	*(0.08)*
	Targets	1.05	*(1.37)*	0.005	1.62	*(1.43)*	0.54	*(0.25)*
Canada								
Current	No targets	0.14	*(0.44)*	0.000	0.77	*(0.42)*	0.14	*(0.035)*
	Targets	0.41	*(1.71)*	0.000	0.25	*(0.18)*	0.29	*(0.08)*
Next	No targets	0.74	*(1.73)*	0.000	1.21	*(0.68)*	0.37	*(0.09)*
	Targets	0.93	*(3.44)*	0.000	1.33	*(0.23)*	0.26	(0.073)
Finland								
Current	No targets	0.069	*(0.54)*	0.005	0.09	*(0.06)*	0.14	*(0.044)*
	Targets	0.69	*(3.53)*	[b]	—		—	
Next	No targets	−0.42	*(0.84)*	0.000	0.91	*(1.04)*	1.08	*(0.34)*
	Targets	2.25	*(7.05)*	0.087	0.22	*(0.30)*	0.31	*(0.18)*

(continued)

Table 5 (cont'd)

The Effect of Inflation Targets on Forecast Errors

Country / Year		E^c (t-statistic)		Prob. value H_0: $Var(u^c) = 0$	Var (u^c) (confidence interval)		Var ($e^{i,c}$) (confidence interval)	
New Zealand								
Current	No targets	0.11	*(0.18)*	0.000	2.05	*(1.29)*	0.56	*(0.22)*
	Targets	−0.14	*(0.28)*	0.012	1.19	*(0.94)*	1.21	*(0.49)*
Next	No targets	−1.39	*(2.53)*	0.189	0.58	*(1.14)*	3.60	*(1.46)*
	Targets	−0.023	*(0.37)*	0.000	2.13	*(1.31)*	0.41	*(0.66)*
Sweden								
Current	No targets	0.38	*(3.98)*	0.047	0.083	*(0.075)*	0.62	*(0.11)*
	Targets	1.65	*(1.27)*	b	—		—	
Next	No targets	−0.04	*(0.07)*	0.000	2.70	*(1.306)*	1.43	*(0.276)*
	Targets	2.32	*(2.08)*	0.021	1.91	*(2.55)*	2.07	*(1.03)*
United Kingdom								
Current	No targets	−0.41	*(1.51)*	0.000	0.63	*(0.31)*	0.60	*(0.075)*
	Targets	0.51	*(1.60)*	0.000	0.29	*(0.25)*	0.38	*(0.083)*
Next	No targets	−0.38	*(0.58)*	0.000	3.86	*(1.85)*	1.15	*(0.14)*
	Targets	1.01	*(3.41)*	0.013	0.184	*(0.22)*	1.27	*(0.274)*

Note: — recognizes that, once the estimate of the $Var(g^c)$ is zero, the estimate of $Var(e_t^{i,c})$ is simply the square of the standard deviation in the third column.

a. Maximum-likelihood estimate equals zero.

b. Only one year of data available; hypothesis untestable.

Source: See the data appendix.

Table 6

Next-Year Forecast Errors Before and After 1991

Country	Number of forecasts	E^c (*t-statistic*)		Prob. value H_0: $Var(u^c) = 0$	$Var(u^c)$ (*confidence interval*)		$Var(e^{i,c})$ (*confidence interval*)	
Austria								
Before 1991	16	0.54	*(2.12)*	0.002	0.461	*(0.26)*	0.130	*(0.20)*
After 1991	8	0.32	*(2.08)*	0.094	0.078	*(0.08)*	0.068	*(0.04)*
Australia								
Before 1991	33	0.55	*(0.76)*	0.000	3.62	*(1.47)*	0.306	*(0.08)*
After 1991	16	1.35	*(2.14)*	0.002	1.45	*(1.12)*	0.550	*(0.22)*
Belgium								
Before 1991	16	0.44	*(1.21)*	0.000	1.01	*(0.53)*	0.280	*(0.07)*
After 1991	8	0.73	*(3.25)*	0.000	0.191	*(0.14)*	0.071	*(0.02)*
Canada								
Before 1991	48	1.87	*(2.22)*	0.000	1.18	*(0.62)*	0.359	*(0.08)*
After 1991	25	0.72	*(3.94)*	0.002	0.181	*(0.16)*	0.274	*(0.08)*
Denmark								
Before 1991	27	−0.66	*(2.32)*	0.000	0.464	*(0.28)*	0.370	*(0.12)*
After 1991	12	0.39	*(2.18)*	0.060	0.060	*(0.10)*	0.225	*(0.11)*
Finland								
Before 1991	22	−0.65	*(1.79)*	0.038	0.674	*(0.68)*	1.199	*(0.47)*
After 1991	15	2.02	*(6.24)*	0.058	0.258	*(0.31)*	0.629	*(0.26)*

(continued)

Table 6 (cont'd)

Next-Year Forecast Errors Before and After 1991

Country	Number of forecasts	E^C *(t-statistic)*	Prob. value H_0: $Var(u^C) = 0$	$Var(u^C)$ *(confidence interval)*	$Var(e^{i,C})$ *(confidence interval)*
France					
Before 1991	47	0.089 *(0.09)*	0.000	1.05 *(0.55)*	0.334 *(0.075)*
After 1991	21	0.39 *(2.38)*	0.000	0.103 *(0.079)*	0.045 *(0.015)*
Germany					
Before 1991	52	0.62 *(2.10)*	0.000	0.690 *(0.35)*	0.113 *(0.024)*
After 1991	28	0.20 *(0.78)*	0.251	0.251 *(0.18)*	0.109 *(0.031)*
Ireland					
Before 1991	12	0.26 *(0.91)*	0.000	0.521 *(0.31)*	0.081 *(0.05)*
After 1991	7	0.55 *(2.30)*	0.444	[a]	—
Italy					
Before 1991	37	0.06 *(0.24)*	0.000	0.506 *(0.26)*	0.145 *(0.03)*
After 1991	20	0.19 *(0.33)*	0.000	1.33 *(1.00)*	0.434 *(0.15)*
Japan					
Before 1991	64	0.33 *(0.82)*	0.000	1.09 *(0.54)*	0.460 *(0.08)*
After 1991	22	0.61 *(7.15)*	0.520	[a]	—
Netherlands					
Before 1991	17	−0.02 *(0.09)*	0.004	0.500 *(0.30)*	0.200 *(0.09)*
After 1991	15	0.56 *(2.70)*	0.009	0.136 *(0.12)*	0.144 *(0.06)*

(continued)

Table 6 (cont'd)

Next-Year Forecast Errors Before and After 1991

Country	Number of forecasts	E^C (t-statistic)		Prob. value H_0: $Var(u^C) = 0$	Var (u^C) (confidence interval)		Var ($e^{i,C}$) (confidence interval)	
New Zealand								
Before 1991	24	−0.61	*(0.91)*	0.011	2.27	*(0.16)*	2.82	*(1.00)*
After 1991	12	−0.89	*(1.80)*	0.003	0.872	*(0.70)*	0.365	*(0.18)*
Norway								
Before 1991	31	0.56	*(1.50)*	0.206	0.256	*(0.63)*	3.28	*(0.94)*
After 1991	11	0.39	*(1.14)*	0.003	0.430	*(0.34)*	0.146	*(0.07)*
Sweden								
Before 1991	47	−0.16	*(0.26)*	0.000	2.91	*(1.56)*	1.35	*(0.30)*
After 1991	27	1.23	*(1.34)*	0.000	3.02	*(2.51)*	1.81	*(0.53)*
Switzerland								
Before 1991	47	−0.64	*(5.08)*	0.000	0.842	*(0.45)*	0.404	*(0.09)*
After 1991	18	1.49	*(5.66)*	0.056	0.120	*(0.14)*	0.379	*(0.14)*
United Kingdom								
Before 1991	121	−0.70	*(1.06)*	0.002	3.42	*(1.71)*	1.18	*(0.15)*
After 1991	61	1.31	*(3.88)*	0.000	0.378	*(1.32)*	1.18	*(0.22)*
United States								
Before 1991	197	0.78	*(2.60)*	0.000	0.170	*(0.36)*	0.54	*(0.05)*
After 1991	94	0.60	*(3.48)*	0.000	0.112	*(0.08)*	0.219	*(0.03)*

Notes: — recognizes that, once the estimate of the $Var(g^C)$ is zero, the estimate of $Var(e_t^{i,C})$ is calculated from the standard deviation implied by the t-statistic on E^C in the third column. Countries marked by shading adopted inflation targets at some point in the period between 1990 and 1995.

a. The maximum-likelihood estimate of Var (u^C) is zero. The estimate of the mean of the distribution of forecast minus actual inflation is the average difference divided by the standard error adjusted for the size of the sample.

Source: See the data appendix.

3.4 A comparison of forecast errors before and after 1991: All countries

Table 6 is a loose attempt to obtain some insight on whether the targeting countries did significantly better than the non-targeting countries at reducing inflation forecast errors. The sample was arbitrarily split for all countries at the same point. I consider the four years of forecasts 1992 through 1995 as the post-1991 sample and the forecasts up to and including 1991 as the pre-1991 sample. 1992 was intended to be an average date of the beginning of targeting. To conserve space, Table 6 shows only next-year forecast errors.

Table 6 confirms the importance of the year-specific shocks, the draws of u_t^C. The null hypothesis that the variance of u^C equals zero is rejected in nearly all countries in both subsamples. It is also striking that there are several non-targeting countries with statistically significant disinflations in the 1992-95 subsample: Belgium, Denmark, France, Ireland, Japan, the Netherlands, Switzerland, and the United States. The point estimates of E^C vary somewhat across these countries, but the positive values all indicate it unlikely that forecast errors are drawn from a distribution with a zero mean during these disinflations. Inspection of Table 6 makes it hard to argue that the targeting countries (marked by shading) had disinflation experiences that differed greatly from those in the non-targeting countries. Further investigation of this issue is clearly necessary.

Our second measure of the success of monetary policy leads to a similar conclusion. While we discovered that the variance of u^C dropped substantially after the targeting countries imposed targets, Table 6 suggests that this was a worldwide phenomenon. Nearly all the countries in Table 6 show a sharp drop in the variance of u^C after 1991. This is a cautionary note against making too swift a conclusion that targeting inflation was the key to achieving a successful monetary policy.

Conclusions

This paper is a first attempt to consider how information in individual forecasts of inflation can be used to gauge the success of monetary policy and, more specifically, the success of recent experiments in targeting inflation. The paper offers a framework in which to consider this information, a framework in which both year-associated and forecaster-associated variability plays a role. The data show clearly that both types of sources of forecast uncertainty are important. Success in monetary policy can be associated with the reduction of year-associated shocks. Thus the framework offers a criterion on which to evaluate the success of monetary policy. It allows a clearer understanding of the nature of forecast errors, the creation of an overall index of credibility, and a way to measure the success of monetary policy over different periods. The direct evidence suggests two conclusions of interest to policymakers.

First, the paper confirms that, for most countries—both inflation-targeting and non-inflation-targeting countries—the disinflations of the 1990s were unanticipated. Further work must be done to determine what factors did lead to more success in generating a credible disinflation.

Second, there is also substantial evidence that the targets were not instantly credible. Perhaps this is not surprising. It is clear from both the direct evidence in this paper and the discussions that preceded the targeting decision that the adoption of targets reflected the failure of other approaches to monetary policy. Thus targets were adopted in exactly those situations in which credibility was going to be most difficult to establish. There is more work to be done in sorting out how credibility evolved and is evolving, and what factors can be identified in playing a role in the determination of credibility. The evidence in this paper does not point to inflation targeting as the instant solution; it does present some evidence that inflation targets made a useful contribution.

Data Appendix

All forecasts of inflation were drawn from *Economic Forecasts: A Monthly Worldwide Survey* from 1984 to and including 1995. Actual inflation rates for all countries but the United States and Canada are calculated as year-over-year percentage changes in the consumer price index, line 64 in the International Monetary Fund's *International Financial Statistics.* Any difference between the CPI and the deflator on personal consumption expenditures is ignored. The Canadian implicit gross domestic product deflator is CANSIM variable D20556. The implicit GDP deflator in the United States was drawn from the *Economic Report of the President* to Congress, February 1997, and updated from the *Survey of Current Business* of the U.S. Department of Commerce. The implicit GDP deflator in Switzerland was calculated by dividing nominal GDP (line 99b.c) by real GDP (line 99b.r) in the *International Financial Statistics.* The 1996 value used only the first three quarters of 1996.

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