Board of Governors of the Federal Reserve System

International Finance Discussion Papers

Number 525

September 1995

TARGETING INFLATION IN THE 1990s:
RECENT CHALLENGES

Richard T. Freeman and Jonathan L. Willis

Abstract

This paper provides an evaluation of the effectiveness of inflation targeting in four industrial countries -- New Zealand, Canada, the United Kingdom, and Sweden -- focussing on the recent period of economic recovery. Evidence drawn from financial market data suggests that credibility of their inflation targeting regimes on balance has deteriorated during the past year and a half, as reflected mainly in sizeable increases in medium- and long-term interest rates. Even after accounting for spillovers from increases in real rates globally (which appear to have been important) and cyclical effects, recent increases in long-term interest rates appear to be incompatible with the possibility that market expectations for inflation have remained on track with official objectives. The deterioration of credibility during this period, however, is considerably less than is implied by changes in nominal interest rates alone and varies considerably across targeting countries. Other evidence suggests that, although inflation targets have not had any detectable effect in altering the time-series characteristics of nominal interest rates (and, by implication, of inflation-expectations formation), there is mixed evidence that inflation targets may have helped stabilize inflation expectations and possibly lowered the inflation-risk premium in some countries.

Targeting Inflation in the 1990s: Recent Challenges

Richard T. Freeman and Jonathan L. Willis[1]

1. Introduction

Although a number of factors can influence inflation in the short run, it is generally accepted that, in the medium to longer run, monetary policy has a predominant influence and should bear the primary burden of inflation control.[2] Various nominal monetary "anchors" have been proposed that aim at improving the effectiveness of monetary policy in meeting this goal -- including money growth targets, fixed exchange rates, and exchange rate bands. Lately, in view of various shortcomings of the these approaches, a number of countries have adopted high-profile, medium- and long-term explicit inflation targets to anchor monetary policy. The implementation of inflation targeting often has been accompanied by other supporting institutional arrangements -- including specific frameworks for fiscal consolidation, measures granting greater central bank independence, formal identification of low inflation or

[2] Other prominent factors that may influence inflation include fiscal policy, labor market developments, productivity and technological change, and exchange rate movements. Lately, increased attention in policy circles in industrial countries has been given to structural reform -- especially in labor markets and in government budget policy -- as a necessary condition for sustained non-inflationary growth.

"price control" as the central bank's exclusive goal, and measures that provide increased visibility and accountability for monetary policy.[3]

Ultimately, whether or not inflation targeting is effective will depend on its impact on inflation expectations. Under usual conditions, expected inflation is thought to be a slowly moving variable that is influenced by both forward-looking and backward-looking factors -- in the latter case primarily by actual past inflation performance.[4] Accordingly, successful control of inflation over an extended period eventually should lower inflation expectations and long-term nominal interest rates. A sustained low-inflation environment should lead, in turn, to improved resource allocation and increased economic efficiency. Moreover, to the extent that a higher level of inflation is associated with greater variability of inflation -- and with a higher (and possibly more variable) inflation-risk premium -- an environment of low, stable inflation might reduce long-term *real* interest rates as well, leading to increased capital formation and growth.[5]

Inflation targets potentially can influence both the forward-looking and backward-looking components that feed into inflation expectations. To the extent that inflation targets exert discipline on authorities and provide insulation from outside pressures (especially

---

[3] Various issues related to the implementation of inflation-targeting programs are discussed in Ammer and Freeman (1995).

[4] The specific factors that contribute to inflation expectations have been difficult to identify conclusively, but there is evidence that in some instances the latest inflation performance may be less relevant to expectations formation than the longer-term inflation record.

[5] For a discussion of some of these points, see Ball (1992), Barro (1995), and Briault (1995).

political pressures), inflation control is likely to improve and eventually be reflected in lower nominal interest rates (and perhaps lower real rates, too) as economic agents take the better inflation performance into account and project its continuation.[6] In addition, it is possible that a highly credible targeting regime may influence directly the forward-looking component of inflation expectations -- or at least cause the process of inflation-expectations formation to become less backward-looking. Hypothetically in an ideal case, following announcement of a fully credible regime for inflation control, private-sector inflation expectations would converge quickly to the target with only temporary, minimal monetary restraint -- thereby finessing some potentially significant transition costs from lost output and unemployment. Once firmly established, such a regime also might give a central bank more flexibility to respond to macroeconomic shocks with less associated impact on long-term interest rates.

Some opponents of inflation targeting have questioned whether or not targeting regimes can actually achieve credibility in view of the inability of a central bank to commit itself irrevocably to targets. The resulting "time inconsistency" problem, it is argued, results in an inflationary bias in monetary policy[7]; in theory at least, this might be offset to some degree by pre-commitment rules, appointment of conservative central bankers, performance-

---

[6] In the U.S. case, it has been argued that inflation targeting might counteract what some regard as a tendency for U.S. inflation to ratchet up following a shock. The process continues, it is alleged, until an intolerably high level of inflation is reached, at which point a large and costly adjustment is required. For a discussion and analysis of this aspect of U.S. inflation performance, see, for example, Clark, Laxton, and Rose (1995).

[7] See Barro and Gordon (1983a,b) and Kydland and Prescott (1977).

related costs or rewards for central bankers, or other "second best" arrangements.[8] Perhaps

more importantly, targeting regimes also risk a major loss of credibility in the event that

announced goals are not achieved. With this in mind, in countries where inflation targeting

regimes already have been implemented authorities have incorporated a certain amount of

conditional flexibility (but not too much, it is hoped) to allow for unforeseen shocks --

especially those for which a central bank should be deemed less accountable. But whether

such operational flexibility is adequate to deal with the full range of possible economic

shocks and still sufficiently offset agents' fundamental doubts regarding authorities' resolve

has not been established.

Several countries -- New Zealand, Canada, the United Kingdom, and Sweden -- have

employed inflation targets for several years, long enough to present an opportunity for an

evaluation. In Ammer and Freeman (1995), the authors explored various aspects of earlier

performances of these inflation targeting countries ("IT countries", for short) up to roughly the

trough of their latest business cycles.[9] At that time, the record showed that inflation in all

four IT countries had declined steeply from high levels, while long-term nominal interest rates

also had come down significantly. On average, the decrease in inflation in the IT countries

from peak to trough (roughly coinciding with corresponding periods of inflation targeting)

was about 4-1/2 percentage points, considerably larger than the decline in average inflation in

---

[8] See, for example, Rogoff (1985), Lohman (1992), Person and Tabellini (1993), Walsh (1994b), and Svensson (1995).

[9] In that paper, only the experiences of New Zealand, Canada, and the United Kingdom were reviewed.

other OECD countries during the same period.[10] Of course, rather than measuring the effectiveness of inflation targeting per se, this outcome merely may have reflected the fact that IT countries tended to start from higher initial rates of inflation and/or that IT authorities may have had a comparatively stronger determination to bring inflation down. But the greater deceleration of inflation also may be indirect evidence of a disciplinary effect of targets on authorities in the IT countries.[11]

An overriding problem in evaluating inflation targeting earlier was that the IT regimes all were implemented in a deflationary global economic environment, making it difficult to differentiate the separate contribution of targeting from the general easing of price pressures at that time. Lately, however, as IT countries (and most of the industrial world) have begun to recover and reduce economic slack, inflationary pressures have revived and inflation has begun to move toward the upper limits of target ranges, presenting a clear challenge to the resolve of central banks. In fact, in New Zealand, Sweden, and Canada consumer-price

---

[10] Slowdowns of growth and increases in unemployment also appeared to have been commensurately greater in IT countries, with no evidence of a favorable outcome in terms of average sacrifice ratio vis-a-vis that of other OECD countries.

[11] The impact of the targets on market participants' inflation expectations was somewhat clouded. Surveys indicated that inflation expectations fell as actual inflation declined, but with a lag that was not noticeably different from response patterns during previous non-targeting periods. In many instances, inflation expectations in surveys stayed above the official target range, even after inflation was brought within the range. (An exception was Canada, where inflation slowed to rates below the target range, and inflation expectations in most surveys came down to very low levels.) Information from financial markets (as inferred from both indexed securities and movements in long-term nominal interest rates) also suggested that inflation expectations (and/or risk premiums) declined during the deflationary period. However, the ideal of a quick, direct convergence of expectations to target norms apparently was not realized.

Chart 1

New Zealand

Inflation and Target Ranges

4-quarter percent change

announcement
of targets

1989   1990   1991   1992   1993   1994   1995   1996

GDP

Q4/Q4 percent change

1989   1990   1991   1992   1993   1994   1995   1996

Interest Rates

percent

5-year government bond rate

3-month bank bill rate

announcement of targets

1989   1990   1991   1992   1993   1994   1995   1996

Chart 2

Canada

Inflation and Target Ranges

4-quarter percent change

announcement
of targets

GDP

Q4/Q4 percent change

Interest Rates

percent

long-term government bond rate

3-month paper rate

announcement of targets

Chart 3

United Kingdom

Inflation and Target Ranges   4-quarter percent change

ERM entry

ERM departure:
target announcement

1989   1990   1991   1992   1993   1994   1995   1996

GDP   Q4/Q4 percent change

1989   1990   1991   1992   1993   1994   1995   1996

Interest Rates   percent

long-term government bond rate

3-month interbank rate

ERM entry

ERM departure:
target announcement

1989   1990   1991   1992   1993   1994   1995   1996

Chart 4

Sweden

Inflation and Target Ranges

4-quarter percent change

announcement of targets

1989 1990 1991 1992 1993 1994 1995 1996

GDP

Q4/Q4 percent change

1989 1990 1991 1992 1993 1994 1995 1996

Interest Rates

percent

long-term government bond rate

3-month interbank rate

announcement of targets

1989 1990 1991 1992 1993 1994 1995 1996
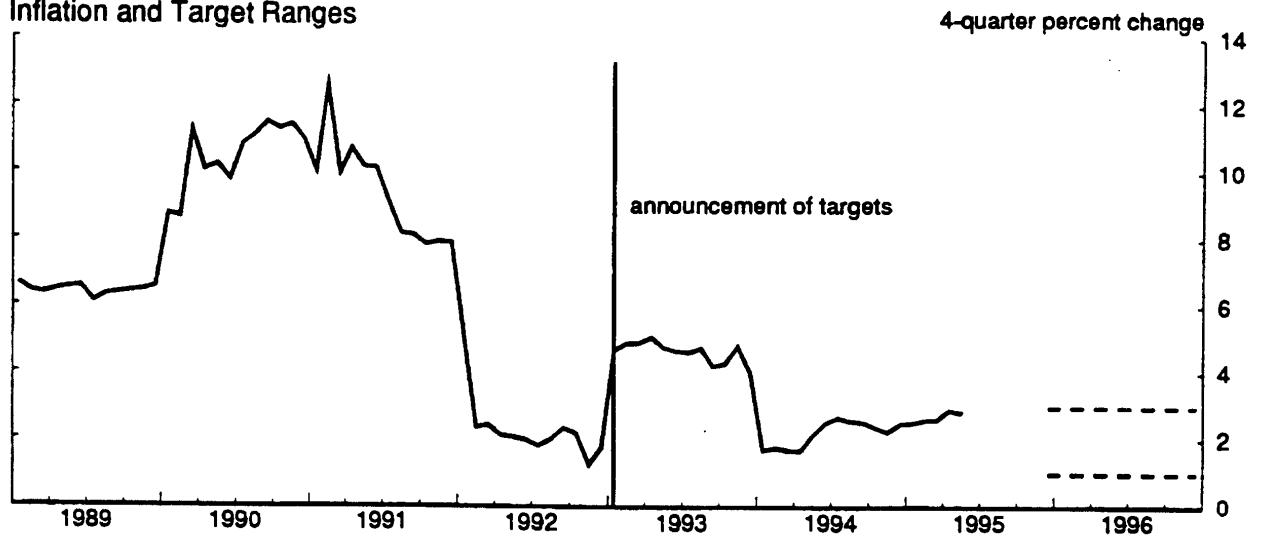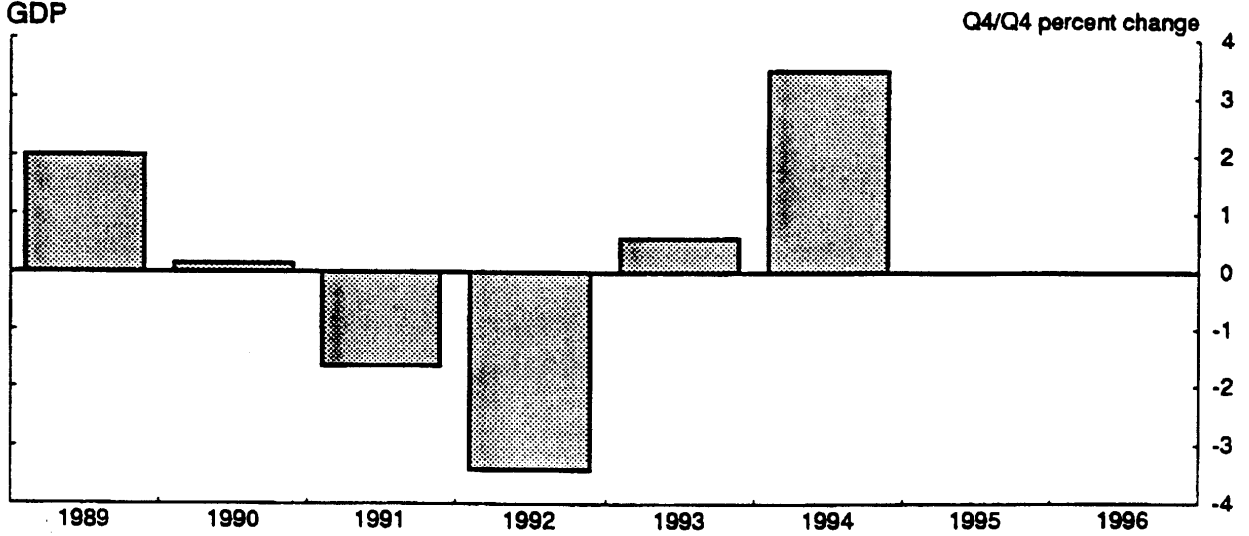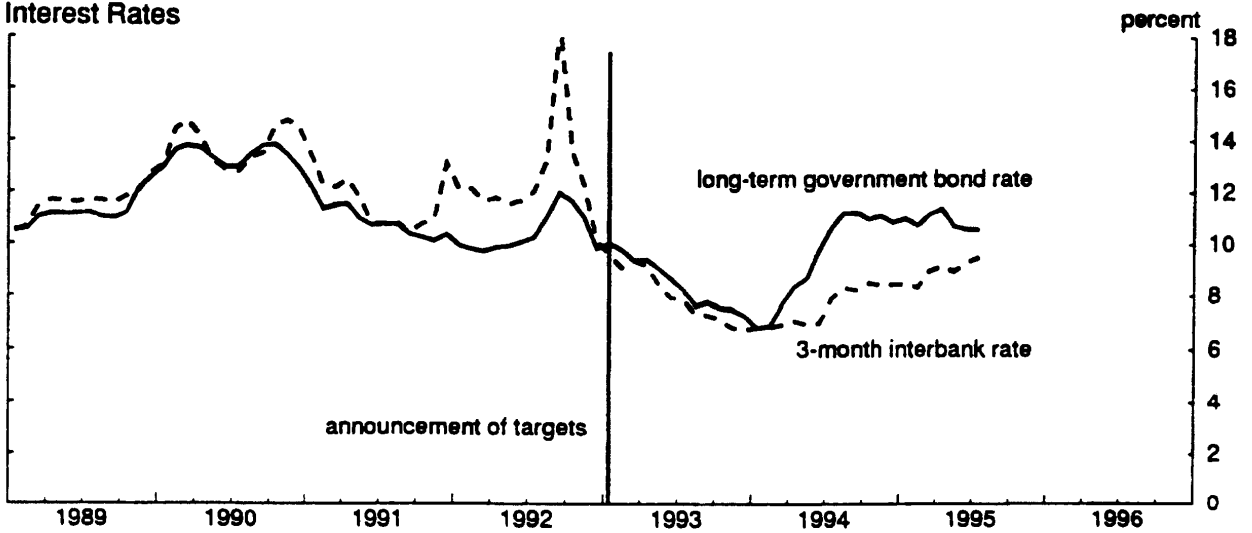
inflation either has exceeded the upper end of the respective target range already or is likely to do so soon.

In this paper, we will examine evidence on how the credibility of inflation targeting appears to have fared during the recent cyclical upswing in the four IT countries identified above. Section 2 provides a brief review of their performances under inflation targeting and recent developments. In Section 3 we present a simple test of target credibility that employs financial market data to construct inflation-target-consistent (ITC) real yield curves. Because inferences about credibility based on the ITC real yield curves in Section 3 depend importantly on estimates of real long-term interest rates, in Section 4 we try to estimate the impacts on real long-term interest rates of two key factors -- spillovers from international markets and cyclical developments. Section 5 offers some additional evidence based on comparisons of pre- and post-IT conditional variances of nominal interest rates that is aimed at assessing whether or not inflation targets have reduced uncertainty regarding future inflation and the variability of inflation expectations.

2. Inflation targeting in four countries: recent experiences

Charts 1 - 4 show CPI inflation, GDP, and nominal interest rates from 1989 through this year for New Zealand, Canada, the United Kingdom, and Sweden. Each country's inflation target ranges and inflation performance are displayed in the upper panels. The substantial recessions that accompanied deflation in the IT countries in the early 1990s are apparent in the middle panels, as are their strong recoveries since about 1992. The lower panels indicate the considerable extent to which nominal interest rates declined during the

targeting period. As noted earlier, assessing whether or not deflation and recession were policy-induced is difficult, but if the degree of monetary tightening is indicated by the slope of yield curves, it appears that it was only during the initial stages of targeting (or preceding them) that monetary conditions actually were tight. Thereafter, short-term rates (3-month rates) generally were below long-term rates.[12]

More recently economic activity has revived vigorously in the IT countries. Last year GDP growth averaged nearly 5 percent accompanied by renewed inflationary pressures. The patterns of interest rate movements during recovery suggest that some monetary tightening has occurred, as both short- and long-term interest rates have moved up and lately yield curves have flattened. Additional details of recent developments in individual countries and how authorities have reacted to the latest challenge to their targets are presented briefly below.

New Zealand

The inflation-targeting program in New Zealand was announced in early 1990 following many years of high inflation and low growth. In many respects New Zealand's program is the most elaborate and stringent, and it has been widely cited as a model. Price stability is mandated by law as the central objective of monetary policy, and the specific targets are set in a formal Policy Targets Agreement between the Governor of the Reserve Bank and the Minister of Finance. Once the targets are set, the Reserve Bank has a high degree of operational independence, inasmuch as the government is legally barred from

---

[12] Except for New Zealand, long-term interests rates are market yields on roughly 10-year government bellwether bonds; for New Zealand, 5-year bond yields are shown.

instructing the Bank on operation of monetary policy. The New Zealand program also emphasizes transparency and accountability. Every six months the Bank must publish an official statement that reviews progress toward price stability, and the Bank's Governor regularly is questioned in parliament on inflation performance and prospects. Authorities have indicated that the targets are meant to be "clear yardsticks" against which the Bank's leadership is accountable -- at the potential cost of dismissal. To provide flexibility, the current agreement also includes a limited list of formal exemptions for certain economic shocks deemed not to be under control of the Bank, such as changes in the value-added tax. Mid-period overrides can be initiated by the government as well, but this step requires formal, public review. To support its inflation-reduction efforts, the government also has set up specific targets for budget deficit reduction that have been met.[13]

New Zealand's targets originally were set as ranges of two percentage points for the four-quarter rate of change of the basic CPI to be achieved at several widely spaced dates (denoted with the "I-bars" in the upper panel of Chart 1); after 1993, the target was extended indefinitely with a continuous range of 0 - 2 percent. As indicated by the solid line in the upper panel, until last year inflation in the "all groups" CPI (the series that is the official basis for the target) had fallen within or below the Reserve Bank's targets. During the second half of last year, however, the 12-month rate of inflation breached the upper bound of the range and in mid-1995 was above 4-1/2 percent. To some extent higher "headline" inflation in the all-items CPI has resulted from increases in mortgage interest rates and other special

---

[13] In 1994 the New Zealand government budget was in surplus for the first time in 16 years.

factors that qualify for temporary exemption under the Policy Targets Agreement. Accordingly, since last year the Reserve Bank has been emphasizing and reporting on an underlying rate of inflation that adjusts for these factors, which it estimates to have been about 2-1/4 percent recently. The Reserve Bank also has indicated that it expects the underlying rate to slow after mid-1995 to roughly the middle of the target range.[14] In response to increased inflationary pressure, short-term interest rates have been raised in New Zealand by more than 400 basis points during the past year, and the yield curve has become downward sloping.

Canada

Although Canada (Chart 2) did not have as chronic an inflation problem as New Zealand, inflation did rise sharply in the late 1980s as the economy became overheated. In February 1991 inflation targets were set jointly by the Bank of Canada and the Department of Finance. Later that year proposals before a parliamentary subcommittee to amend the Bank of Canada Act to make "price stability" the Bank's official goal failed, leaving inflation targeting as discretionary policy. In contrast to New Zealand, inflation targeting in Canada has not been accompanied by any notable new measures for central bank independence, transparency of policy, or accountability of policymakers. The government did introduce

---

[14] There is some precedent for mid-course corrections in New Zealand. New Zealand's targets were first announced in March 1990 (and officially set in April) at: end-1990, 3-5%; end-1991, 1.5-3.5%; end-1992, 0-2%. Following an election and change in government, in December 1990 the targets were revised and extended to: end-1991, 2.5-4.5%; end-1992, 1.5-3.5 %; end-1993 0-2%. In late 1990, the 12-month inflation rate threatened to come in at year-end slightly above the original target range -- or "guidepost" as it was referred to then. In fact, end-1990 12-month inflation turned out to be barely within the original range, but the first target already had been advanced to one year later.

concurrent budget deficit reduction goals, but the budget situation in Canada has worsened and those goals have not been met.

Arrangements for flexibility in the face of shocks are less formal than in New Zealand, but the Bank has identified limited circumstances (such as oil-price shocks and indirect tax changes) when the targets (or the inflation measure) may be altered temporarily. Longer-term adjustments are to be undertaken only "in very unusual circumstances." In Canada, the CPI is the basis for the official inflation target set jointly by the Bank of Canada and the Department of Finance, but the rate of increase of the "underlying" CPI (which excludes food, energy, and temporary effects of indirect taxes) is used as an operational objective. For several years following announcement of the Canadian target ranges in early 1991, official emphasis was placed on the mid-points of the ranges. After a change in government and leadership at the Bank of Canada in early 1994, greater attention has been given to the full ranges, suggesting to some observers that the targets are being interpreted more flexibly.

The top panel of Chart 2 shows that after the targets were implemented in 1991 Canadian inflation fell sharply, but that decline had much to do with Canada's slide into recession. Since then until this year, inflation -- as measured by 12-month changes in the CPI excluding food and energy -- has stayed within (or below) the lower half of its target range, even as the economy recovered. (Measured inflation was depressed in 1994 by removal of the Canadian cigarette tax; after adjustment for tax changes, inflation was near the interpolated bottom limit of the target range.)

In 1995, despite the economy's sluggish performance, 12-month inflation in the all-items CPI has moved up to just under 3 percent, due in part to weakness of the Canadian

dollar. (The rate of increase of the CPI adjusted for food and energy has been about 2-3/4 percent.[15]) This has raised concerns about medium- to long-run inflation prospects and the standing of the official inflation targets. Although the Bank of Canada has acknowledged the possibility of some upside risk for inflation (related mainly to exchange rate pressures), in public statements it has sought to reassure the public that the current inflation outlook is consistent with the Bank's inflation-control targets. During 1994 and early 1995, the short-run stance of monetary policy often was affected by the need to offset periodic downward pressure on the Canadian dollar. That pressure has subsided lately, but on balance 3-month interest rates have been raised nearly 300 basis points since early 1994.

United Kingdom

As shown in Chart 3, shortly after the United Kingdom withdrew from the ERM in September 1992, the U.K. government announced a medium-term target for underlying inflation of 1-4 percent. It also adopted a longer-run goal of an inflation rate of 2-1/2 percent or less to be achieved by mid-1997. The U.K. inflation targets are defined on the retail price index excluding mortgage interest payments and are set by the Treasury. Although a few modest steps have been taken to give the Bank more autonomy,[16] its scope for independent monetary policy remains limited. To increase the transparency of policy, the Bank publishes quarterly a detailed review and analysis of its inflation-targeting arrangements, and since

---

[15] Increases in 12-month inflation this year also have been due in part to removal from the all-items CPI of effects from tax reductions last year.

[16] The Bank now is allowed to choose the best timing for changes in official interest rates that have been determined by the Treasury.

April last year minutes of monthly meetings between the Bank's Governor and the Treasury have been made public within about six weeks. Until last year, U.K. budget deficits had widened during the inflation-targeting period.

As the upper panel of Chart 3 indicates, U.K. inflation decelerated substantially -- as did U.K. growth (the middle panel) -- during the ERM period that preceded inflation targeting. This deceleration continued into the targeting period, and since early 1994 the rate of inflation has been in the lower end of the target range. Lately, however, inflation has picked up and approached the 2-1/2 percent mid-point that marks the government's longer-run objective. In addition, in recent months political problems of the present government and proposals from the opposition for reform of various aspects of U.K. monetary policy have added to uncertainty regarding the degree of commitment to the targets. Although the upper bound of the current inflation target range (4 percent) does not appear to be threatened, recently the Bank of England has indicated that it expects that it will be difficult to meet the 2-1/2 percent longer-run target in 1997.

Sweden

Sweden's inflation targeting program was announced by the Riksbank in January 1993, near the trough of one of that country's most severe recessions and shortly after Sweden had abandoned its attempts to maintain a unilateral exchange rate peg versus other European currencies. As shown in the upper panel of Chart 4, inflation in 1992 already had fallen precipitously to roughly a 2 percent rate from double-digit rates in previous years.[17] In

---

[17] The 12-month inflation rate was increased temporarily during 1993 by new taxes; on an adjusted basis inflation in Sweden remained close to 2 percent.

setting its first target, the Riksbank allowed itself three years to achieve its goals; the target was set as a 1 - 3 percent range to be met by year-end 1995. The measure that is the official basis for targeting in Sweden is an adjusted CPI that excludes effects from indirect taxes, subsidies, direct import prices, and petroleum and crude oil prices. Although there have been expressions of government support for inflation targeting in Sweden, inflation targeting is not legally mandated and is a discretionary policy of the Riksbank (which has a moderate amount of operational independence).

As the economy recovered last year, price pressures began to edge up, even though the gap from potential was still large. Uncertainties about progress in reversing previous deterioration of Sweden's budget and official debt positions contributed to downward pressure on the krona, which intensified in late 1994 and early this year. Short-term interest rates have been moved up by more than 250 basis points since early 1994, and long-term interest rates have increased almost 400 basis points. Earlier this year the 12-month rate of inflation (measured on the official adjusted index) edged above 3 percent, in part because of effects from weakness of the krona. Wage pressures particularly in the tradables sector of the economy, which has been booming, also pose a risk of further near-term acceleration. The Riksbank has acknowledged that inflation may exceed the 3 percent target this year, and that it could remain above the target range in 1996. In recent discussions and pronouncements, it also has begun to emphasize the standard all-items CPI, which has registered a somewhat lower 12-month inflation rate this year because of the removal of some tax effects.

3. Credibility of inflation targeting: a simple test

In a recent paper[18] Lars Svensson proposed a simple practical procedure for evaluating

the credibility of inflation targeting that involves constructing inflation-target-consistent (ITC)

real yield curves. This is done by deflating a given IT country's nominal yield curve for a

particular date by the corresponding path of average inflation from that date onward (to

future-dated points on the yield curve) that is exactly consistent with meeting the inflation

target.[19] (From the ITC yield curve it also is possible to construct a corresponding path for

implied ITC future real interest rates over the same time horizon.) Differences in real interest

rates along a particular ITC yield curve can occur when either nominal interest rates differ

along the curve and/or the average inflation rate consistent with meeting the targeting

program at the corresponding two future time horizons differs. Similarly, shifts over time in

the position of an ITC yield curve can happen when either nominal rates change or when the

inflation rates required to meet particular target benchmarks change. (The latter might occur

because of the passage of time and closer approach of future benchmarks, but also if the

targets themselves are altered.)

---

[18] Svensson (1993).

[19] The IT countries generally have established target ranges for the end-of-year, 12-month CPI inflation rate, with varying degrees of emphasis on the central rates. In this exercise, we used the central rates to form the ITC deflators, but one could supplement these with similar, ITC deflators based on the upper and lower boundaries of the range. To produce a continuous path for inflation at intermediate points between official end-year benchmark dates, we interpolated the required path of 12-month CPI inflation. Whether a deviation of inflation from the target range in mid-year should be taken as an indication of failure or only a warning signal is open to market interpretation. The concept of inflation that we used to construct the ITC curves conformed to that of the official targets.

The ITC construct provides a simple "test" of credibility of inflation targeting to the extent that real interest rates on a given ITC yield curve (or corresponding curve for implied future real interest rates) are consistent with plausible independent measures of real rates at corresponding maturities. More specifically, assuming that the Fisher equation,

$$(1) \qquad\qquad i_t \;=\; r_t \;+\; E(\pi)_t \;+\; \theta \;,$$

where i_t is the nominal interest rate of a given maturity,

r_t is the corresponding real interest rate,

$E(\pi)_t$ is expected average inflation over the same time horizon, and

θ is a risk-premium term,

holds, then at any given maturity expected inflation (plus the risk-premium term) must account for the difference between nominal and real interest rates. Accordingly, if an inflation targeting program is fully credible, ITC real rates should be closely equivalent to plausible measures of corresponding real interest rates at all maturities.[20] Similarly, to the extent that the ITC curve at any point is above (below) its real-rate counterpart, that gap measures the extent to which market-based inflation expectations -- plus the risk premium -- exceed (fall short of) the regime's objectives. Moreover, even if the ITC real rate is imperfectly related to an accurate measure of the true real rate (because of the presence of a

---

[20] The presence of a non-zero risk premium prevents the equivalence from being exact. It may not be inappropriate, however, to include the risk premium implicitly in the measure of credibility, as a fully credible program should affect the risk premium as well as the level of expected inflation.

significant risk premium, for example), as long as that error remains constant, changes

between two dates in the gap between ITC rates and reference real rates still would provide a

measure of the extent to which credibility has been lost or gained over time.

The upper panels of Charts 5 - 8 show ITC yield curves for the four IT countries at

several selected benchmark dates. Corresponding curves for ITC real 1-year future rates

(derived from their counterparts in the upper panel) are displayed in the lower panels. In

each country's chart, curves are shown for: (1) a month about one-half year prior to

implementation of the target regime[21]; (2) at the latest trough in nominal long-term interest

rates, usually around the end of 1993 or beginning of 1994; (3) at the latest peak in long-

term rates (between August 1994 and January 1995, varying from country to country) and:

(4) for the latest month available. In general, all four countries display substantial drops in

ITC yield curves between the initial date (the thin solid lines in the upper panels) and several

years later (the coarse broken lines). These declines -- roughly between 3 and 5 percentage

points -- suggest that a substantial gain in credibility likely occurred in this interval. By year-

end 1993, when long-term interest rates were at their lowest recent levels, long-term ITC real

interest rates had fallen to around 5 percent or less in all four targeting countries -- quite

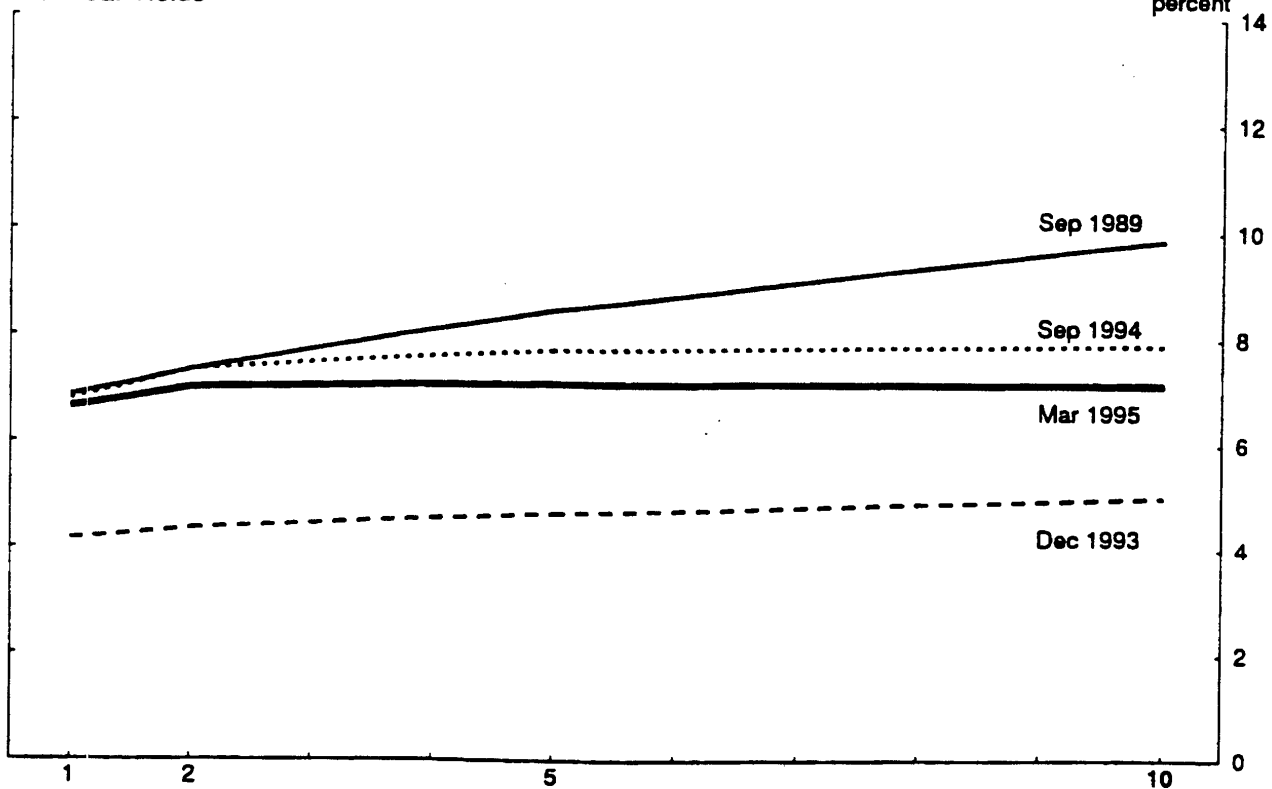close to plausible estimates of equilibrium long-term real interest rates.[22]

---

[21] This timing was selected so as to avoid the period immediately prior to announcement of
the targets, when the program may have been anticipated and already factored into market
expectations.

[22] As noted earlier, the ITC curves shown are based on the mid-point of official announced
ranges. If, for example, we were to allow a 1 percent margin (1-1/2 percent in the United
Kingdom) to meet only the upper ends of a target ranges, the corresponding ITC curves
would be correspondingly lower.

Chart 5

New Zealand

ITC Real Yields

percent

Sep 1989

Sep 1994

Mar 1995

Dec 1993

Implied 1-year Forward ITC Real Rates

percent

Sep 1989

Sep 1994

Mar 1995

Dec 1993

Chart 6

Canada

ITC Real Yields

percent

Aug 1990

Jan 1995

Apr 1995

Jan 1994

Implied 1-year Forward ITC Real Rates

percent

Aug 1990

Jan 1995

Apr 1995

Jan 1994
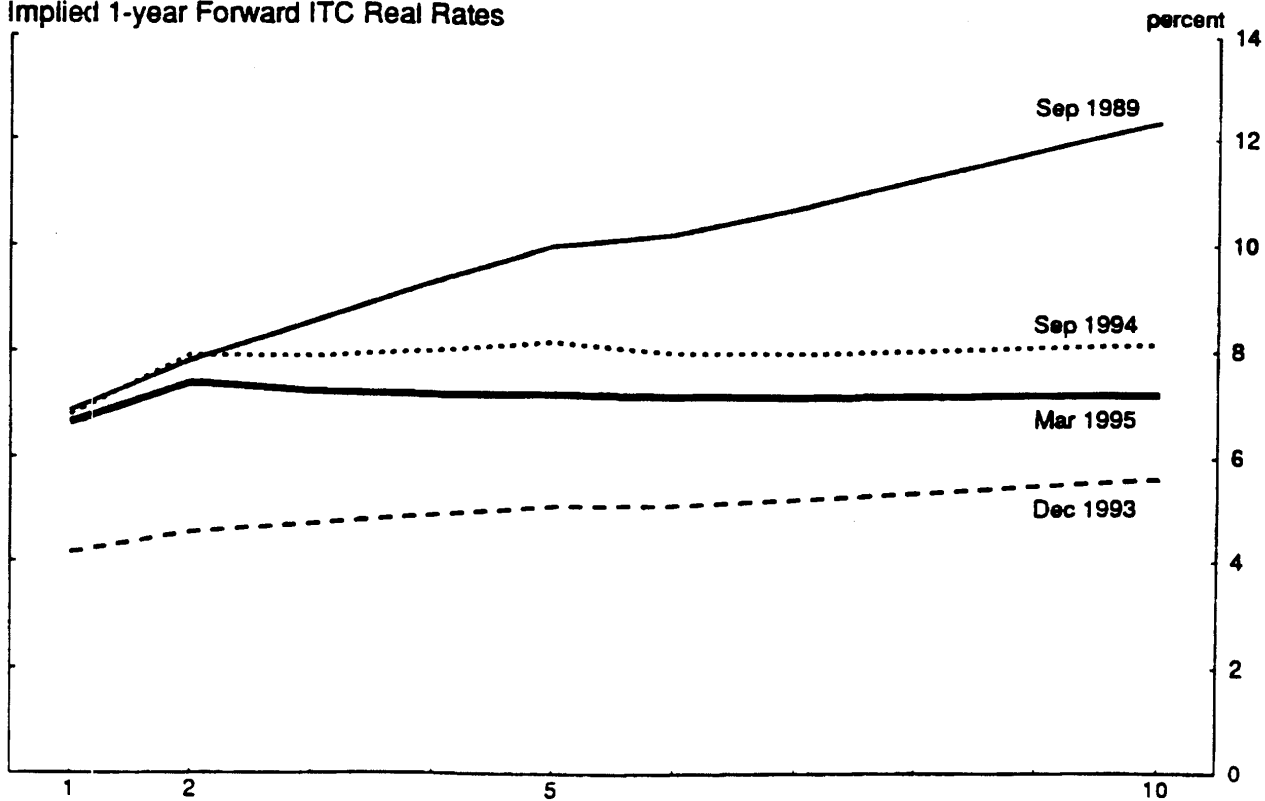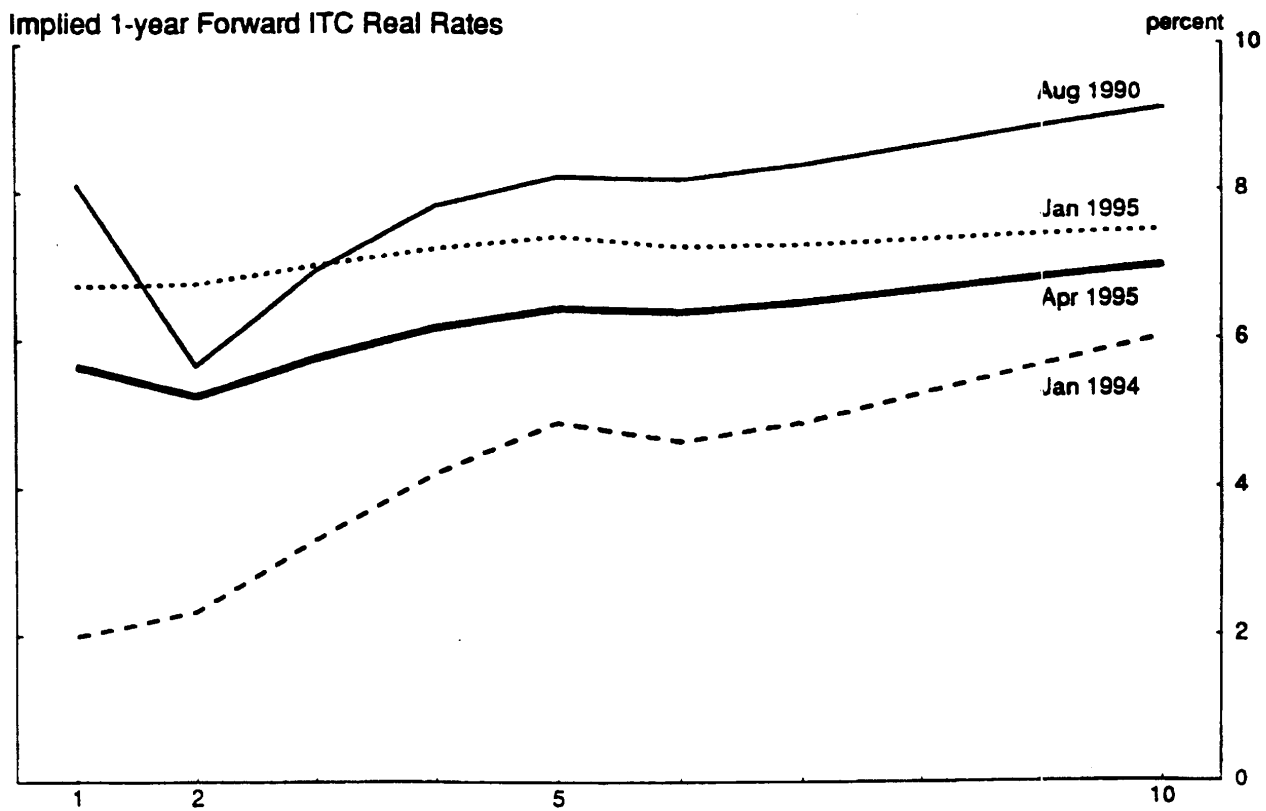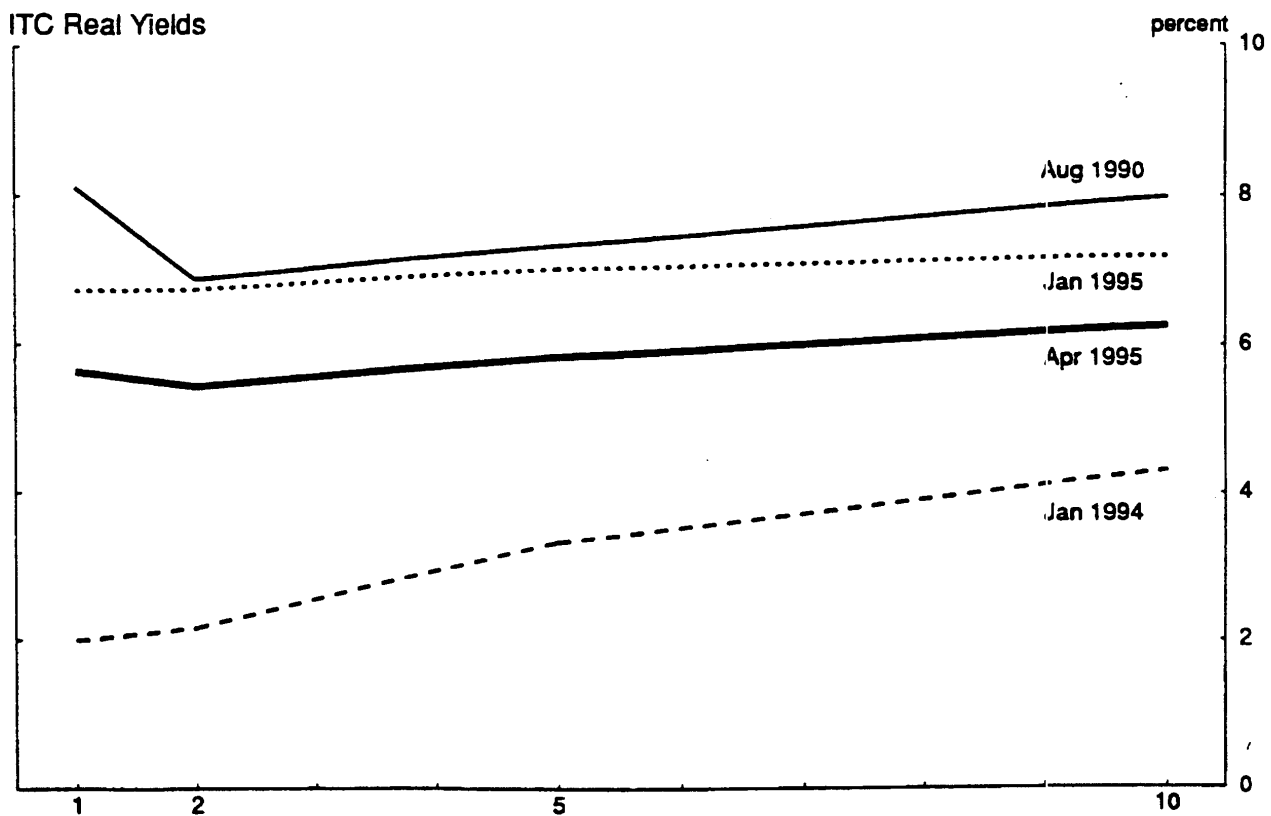
Chart 7

United Kingdom

ITC Real Yields

percent

Oct 1994

Apr 1992

Apr 1995

Jan 1994

Implied 1-year Forward ITC Real Rates

percent

Oct 1994

Apr 1992

Apr 1995

Jan 1994
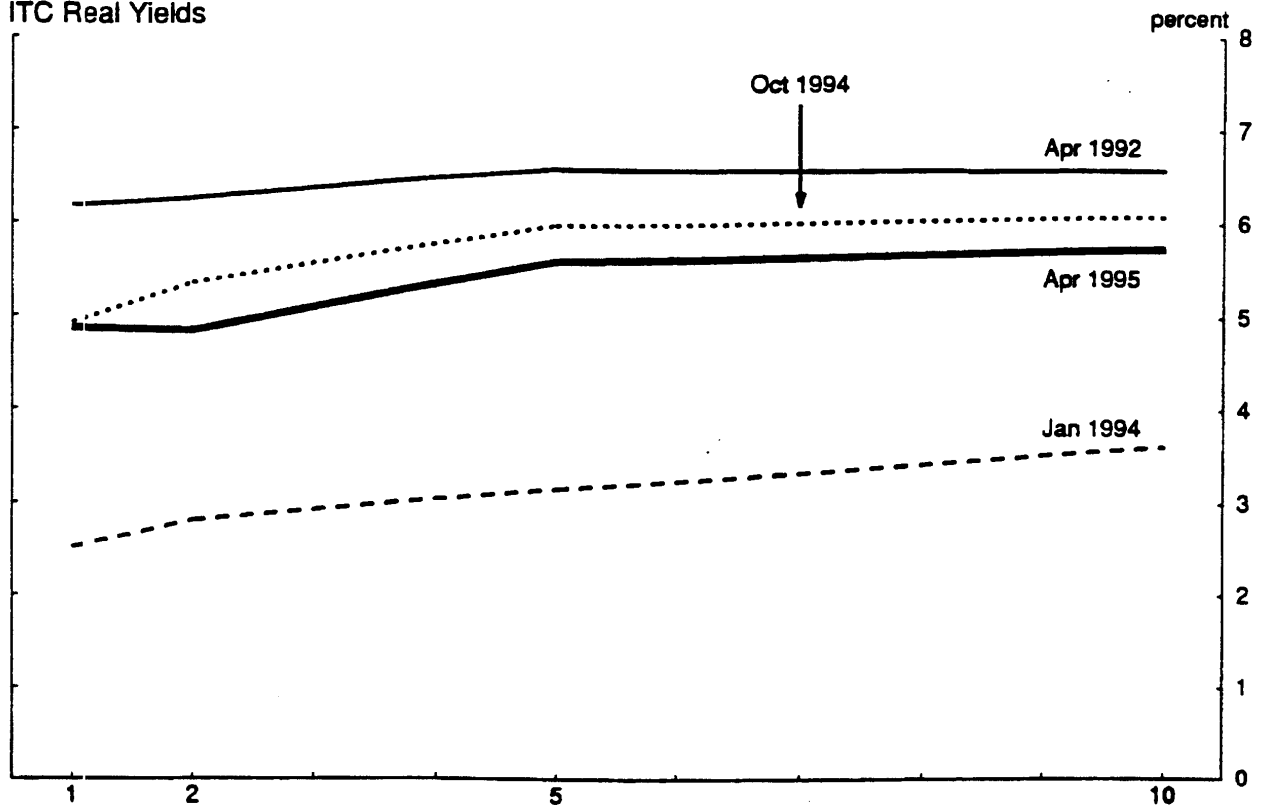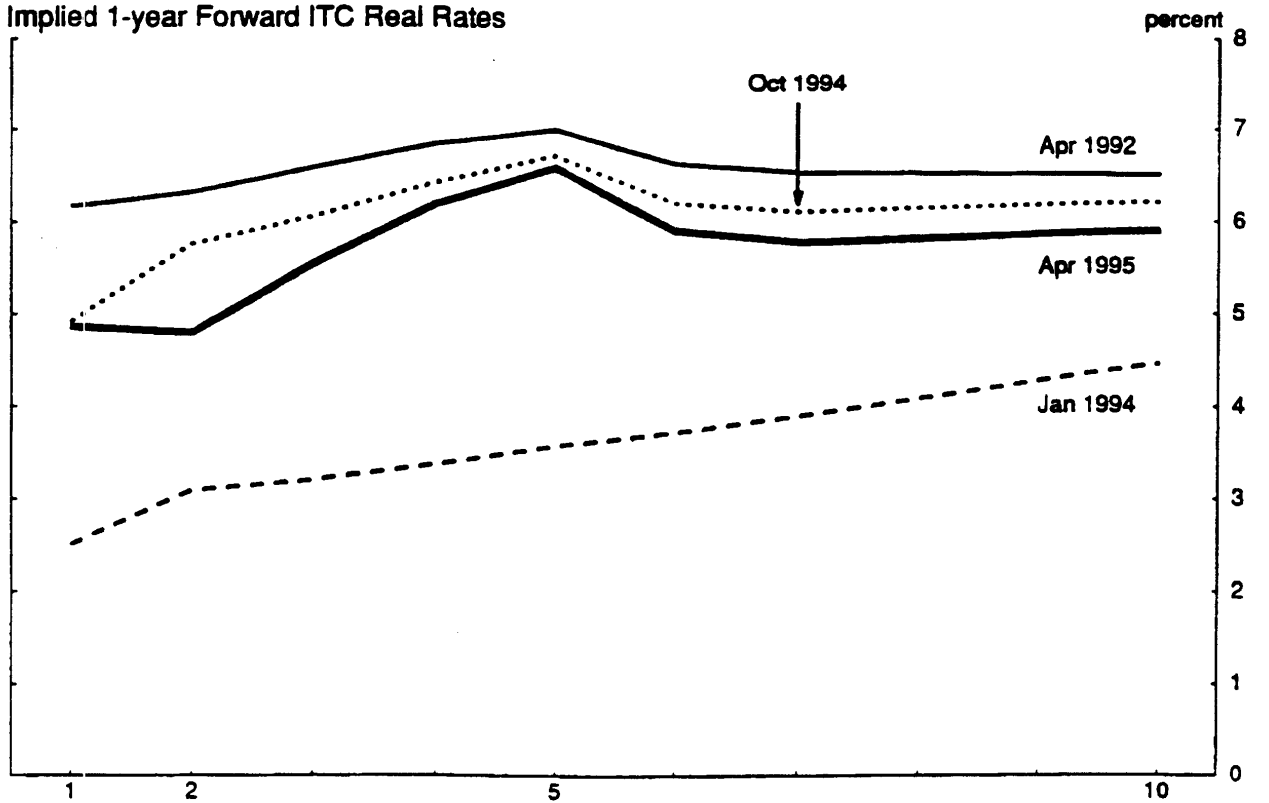
Chart 8

Sweden

ITC Real Yields

percent

Apr 1995

Aug 1994

Jul 1992

Jan 1994

Implied 1-year Forward ITC Real Rates

percent

Apr 1995

Aug 1994

Jul 1992

Jan 1994
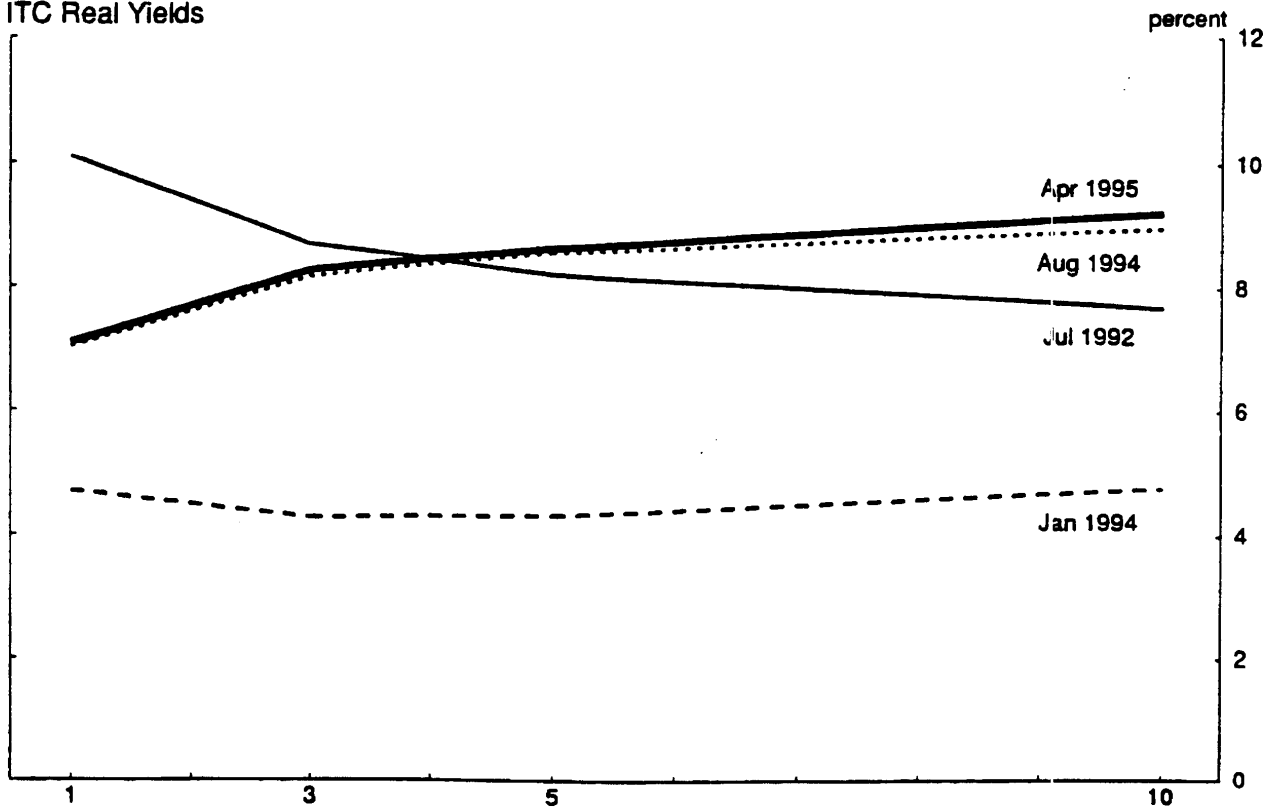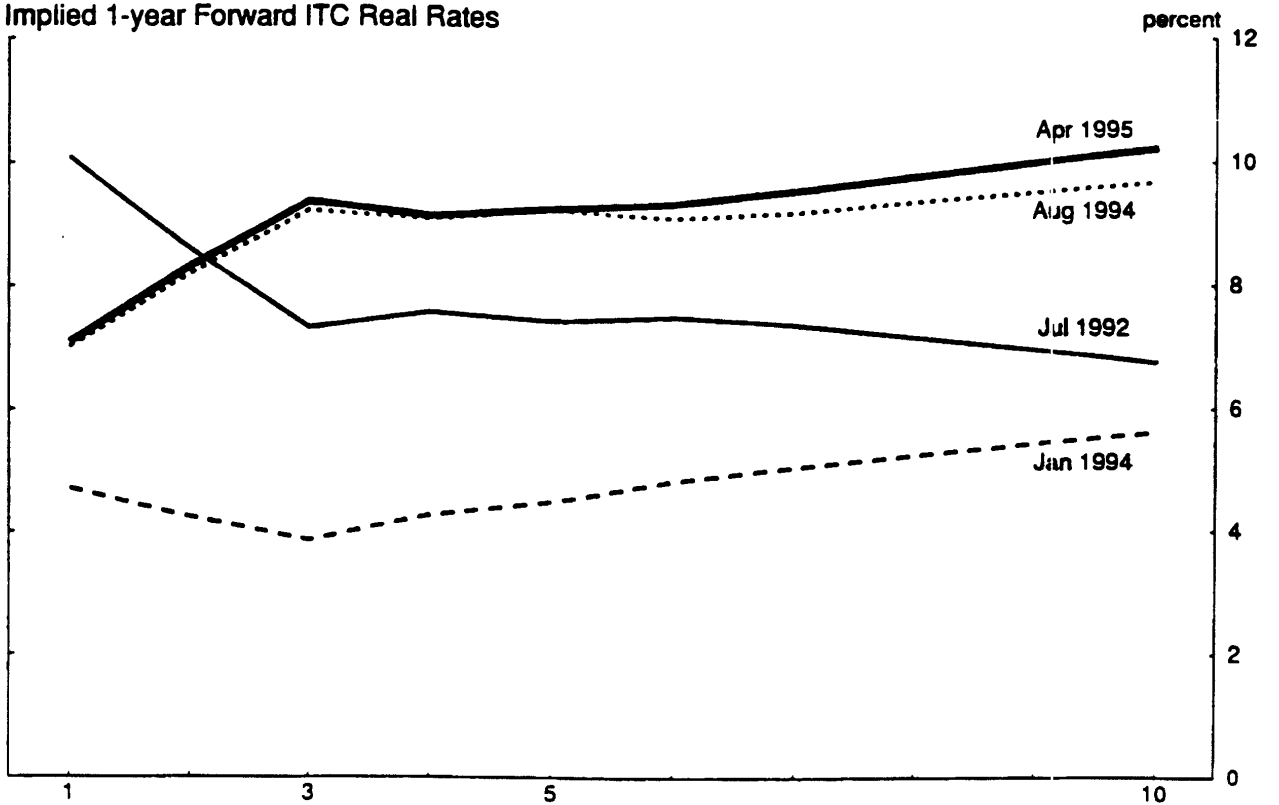
Since then all four ITC curves have retraced most or all of their previous declines, as indicated by the fine broken lines and solid lines. In New Zealand, for example, the long-term ITC rate in September last year reached 8 percent, as nominal long-term interest rates increased sharply. More recently, nominal interest rates in New Zealand have eased back somewhat, but the long-term ITC real rate still is quite high at about 7 percent.[23] The patterns of recent shifts in other IT countries have been similar, with seemingly a particularly large implied deterioration of credibility in Sweden; by April of this year, the Swedish ITC curve had risen at the long-maturity end to a level almost 2 percentage points above the pre-IT curve of July 1992. In some countries, ITC yield curves also have begun to tip upward, either in entirety or in part. In the United Kingdom and Sweden, for example, the pattern of 1-year future ITC rates suggests an expected period of sharply increased tightening in the medium-term (about 2 to 5 years from now). This is not surprising in view of recent recognition by authorities in both countries that achievement of medium-term inflation goals is in doubt. It may also reflect a market expectation that monetary policy may have to tighten in the approach to EMU, although at this point it is not clear whether either country will participate in Stage Three before the end of the decade.

---

[23] However, if the latest ITC curve is deflated by inflation in the adjusted New Zealand CPI, consistent with the Reserve Bank's latest effort to emphasize that measure, the corresponding ITC curve at short maturities and also near-term one-year future ITC rates would be considerably higher. In terms of our test, this would suggest that credibility of the program evaluated against the adjusted inflation rate had eroded by even more.

4. Adjustment for External and Cyclical Effects

One serious limitation of the ITC curves as a basis for assessing progress on policy credibility is that the associated real-rate benchmark may vary, especially at the short end of the maturity range. Long-term real interest rates are more likely to be stable since, over the very long-run, the long-term real interest rate in an economy is arguably a deep parameter that is tied to the long-run rate of return to capital. However, over a shorter time horizon -- say, at the frequency of the typical business cycle or less -- even long-term real rates may not be constant. Shifts in demand for resources and financial capital over the business cycle, along with changes in the current and expected stance of monetary policy, could be important sources of cyclical variation of long-term real rates. Other fundamental factors -- including changes in fiscal positions, private saving and investment patterns, and technical change (both real and financial) in an economy -- might influence real rates as well. For economies that are highly open in both trade and financial transactions (which characterizes the countries in our study, at least in the 1990s), there also could be important spillovers from changes in real interest rates from global markets into domestic real long-term interest rates.[24] Movements in long-term nominal interest rates during the past several years suggest that this latter factor has become increasingly important.

Clearly, in assessing whether or not the pattern of recent shifts of real ITC curves indicates a loss (or gain) in credibility, it is important to know the extent to which foreign

---

[24] Persistent deviations from purchasing power parity -- or changes in the equilibrium long-term real exchange rate -- could also affect real long-term interest rates.

real-rate spillovers, cyclical effects, and possibly other factors may have influenced real interest rates in IT countries. Unfortunately, reliable measures of real long-term interest rates have proved to be elusive, mainly because of the difficulty of pinning down inflation expectations.[25] Accordingly, to provide some insight into this issue, we developed several measures of real long-term interest rates in international markets along with comparable estimates of real long-term interest rates for the IT countries. All of these measures have in common that nominal long-term interest rates (at roughly 10-year maturities) are deflated by a centered 36-month moving average of realized (or projected) consumer-price inflation that is meant to proxy for long-run expected inflation.[26]

Next using these various measures of real long-term interest rates, we tried to assess the extent to which real long-term interest rates in the IT countries may have been affected by spillovers from global markets and by cyclical factors. As a first step, we assumed that real long-term interest rates are serially correlated, as below:

$$(2) \qquad r_t = \alpha + \rho_{t-1} r_{t-1} + \rho_{t-2} r_{t-2} \cdots + u_t \; ,$$

---

[25] Yields on index-linked securities potentially could be used to meet this need, but markets for the few such securities that have been issued in industrial countries have several shortcomings, including the fact that they tend not to be widely traded and often are subject to special tax treatments. The market for indexed-linked U.K. gilts comes closest to providing a useful benchmark, and some evidence from U.K. real yields is discussed below. See also Deacon (1994) and Deacon and Derry (1995).

[26] For time periods within 18 months of the present, staff projections for consumer-price inflation were used for some forward terms of the deflator.

and
$$r_t^* = \alpha^* + \rho_{t-1}^* r_{t-1}^* + \rho_{t-2}^* r_{t-2}^* \dots + u_t^* \,,$$

where r_t is the domestic real interest rate in an IT country,

r_t^* is an external real interest rate, and

u_t and u_t^* are error terms for domestic and external shocks.

The two error terms were assumed to be related as follows to reflect the process by which shocks from external markets spill over into domestic real interest rates:

(3)
$$u_t = \beta u_t^* + \varepsilon_t \,,$$

where ε_t is the country-specific component of the domestic shock, and

β measures the size of spillover effects.

Equations (2) and (3) then were combined -- and an estimate of the contemporary domestic output gap in each IT country was added to capture cyclical effects -- producing the following equation for real interest rates:

(4)
$$r_t = \overline{\alpha} + \sum_{j=1}^{m} \rho_{t-j} r_{t-j} + \beta r_t^* - \beta \sum_{k=1}^{n} \rho_{t-k}^* r_{t-k}^* + \gamma g_t + \varepsilon_t \,,$$

where g, measures the gap between potential and actual GDP.[27] An equation of this form was estimated for each of the four IT countries using several alternative measures of external real long-term rates (e.g., a "world" rate, a "big-three" rate, and rates on long-term instruments denominated in U.S. dollars, DM, and yen separately[28]) for the time period 1984-93. In the estimations, LM tests were applied sequentially to eliminate insignificant lags for both domestic and external interest rates.[29] The results of selected estimations are summarized in Table 1.[30]

As may be seen in the table, almost all coefficients on lagged domestic rates and both current and lagged external rates had the expected sign and were significant at the 5 percent level or better, and adjusted R^2s all were fairly high. The New Zealand results were

_____

[27] The output gap measures are staff estimates (based in part on IMF and OECD estimates of quarterly output gaps); for New Zealand, the output gap was obtained by applying an H-P filter to quarterly data. Monthly values for all countries were interpolated by applying cubic splines.

[28] The world rate was derived from a cross-section/time-series panel regression on real long-term interest rate data from 12 industrial countries; the big-three rate is a weighted average of dollar-, DM-, and yen-denominated real long-term interest rates. See the appendix for further details on procedures used to generate the panel-based world long-term real interest rate.

[29] In the estimations for Canada, the United Kingdom, and Sweden -- which used monthly data -- LM tests generally identified lags of two periods on domestic rates and one period on external rates as statistically significant; in the best New Zealand estimation -- which was based on quarterly data -- the longest significant domestic and external lags were one quarter for both.

[30] ADF tests on the real interest rate data indicated possible presence of a unit root in most cases. (Gagnon and Unferth [1993] also found some evidence of unit roots in short-term real interest rate data.) Accordingly, equation (4) was estimated in first-difference form as well, and results are reported in Appendix III.

Table 1

Regression results: equation (4)

\ equation regressor \	Canada (world rate)	Canada (U.S. rate)	U.K. (world rate)	Sweden (world rate)	N.Z. (world rate)
constant	0.41 (0.24)	0.27 (0.14)	0.29 (0.24)	-0.80 (0.39)	3.80 (1.90)
r_{t-1}	1.15 (0.08)	1.04 (0.06)	1.11 (0.08)	1.12 (0.09)	0.71 (0.11)
r_{t-2}	-0.23 (0.08)	-0.11 (0.06)	-0.25 (0.08)	-0.22 (0.09)	--
g_t	-0.01 (0.01)	-0.01 (0.01)	-0.04 (0.01)	-0.02 (0.02)	-0.15 (0.14)
r_t^*	0.91 (0.15)	0.85 (0.07)	1.01 (0.16)	0.88 (0.25)	0.56 (0.50)
r_{t-1}^*	-0.91 (0.16)	-0.82 (0.08)	-0.96 (0.17)	-0.61 (0.26)	-1.01 (0.55)
adjusted R^2	0.94	0.97	0.95	0.92	0.76

Note: Cells show estimated coefficients with standard errors in parentheses. Regressions were OLS on monthly data, except for New Zealand which was on quarterly data.

$$(4) \quad r_t = \bar{\alpha} + \sum_{j=1}^{m} \rho_{t-j}\, r_{t-j} + \beta r_t^* - \beta \sum_{k=1}^{n} \rho_{t-k}^*\, r_{t-k}^* + \gamma g_t + \varepsilon_t \,,$$

somewhat an exception. New Zealand regressions based on interpolated monthly data (not shown) were of low overall quality; only the best estimation using quarterly data is reported, and it is the least satisfactory in the group.[31] The coefficients measuring spillover effects from the external sector (β, the coefficient on r^*_t) vary somewhat from only about 0.5 for New Zealand (and not significant) to essentially unity for the United Kingdom. For Sweden and the two versions of the Canadian model, the spillover coefficients are in a range of .85 to .91. (The two Canadian models that use the world rate and U.S.-dollar denominated real long-term rates, respectively, as the external rate are similar in most respects, but the model with U.S. rates -- which also had a slightly lower passthrough coefficient -- produced the better statistical fit.[32])

Interestingly, although the coefficients on output gaps generally were not significant, they were all negative, which suggests a number of possibilities. One is that movements of long-term real rates reflect (faintly) a counter-cyclical tendency in monetary policy. Another possibility is that our deflator may systematically mis-measure (overstate) changes in inflation expectations over the cycle and, for example, cause nominal interest rates near a cyclical peak

---

[31] The low coefficient value and larger standard error for external interest rates in the case of New Zealand may be attributable in part to capital controls that were in effect during a portion of the sample period and a generally lower degree of international integration of New Zealand financial markets.

[32] In general, the world rate (and for Canada, U.S. dollar-denominated long-term rates) dominated the other competing explanatory variables, such as the big-three rate, and DM- and yen-denominated long-term interest rates in terms of goodness of fit for all IT-countries.

to be overdeflated.[33]   In any event, the coefficients for the effect of gaps are small, and variations of output gaps generally explain only a minor part of the total variance of the regressions.

Using the results of these equations, we then generated projections of levels and movements of real long-term interest rates in IT countries in the post-1993 period. In Table 2 we have tabulated changes in projected long-run real rates between recent key dates (corresponding to dates in Charts 5 - 8), along with corresponding changes in ITC long-term rates. We also show in the right-most pair of columns the differences between the two changes in order to provide a rough assessment of the extent to which movements in real long-term rates can be attributed to spillovers and cyclical effects. (The entries in those columns provide an inverse measure of net credibility gain in the sense that we have used it earlier -- i.e., positive values indicate a loss of credibility.)   It is evident that, during the recent period of general upswing in long-term nominal interest rates, ITC rates in targeting countries (except Sweden) rose more than did our projected real long-term rates, suggesting an erosion of credibility. The difference in movements was the greatest in New Zealand where the estimated differential was nearly 300 basis points; however, given the lower quality of the New Zealand estimations, one should not make too much of this result. The fact that the sign on differential movements since the latest peak (the final column) turned negative for

---

[33] This would be consistent with a tendency for actual inflation expectations to be based on very long-term historical inflation performance. Our use of realizations of actual inflation in forming both backward *and forward* components of the proxy deflator then would tend to produce a counter-cyclical pattern in movements of our real rate measure, especially near turning points.

Table 2

Recent changes in ITC and real long-term interest rates
(basis points)

	ITC long-term rate		Real long-term rate (projected)		ITC less real rate change	
	trough - peak	peak - latest	trough - peak	peak - latest	trough - peak	peak - latest
Canada (world rate)	288	-93	213	-76	75	-17
Canada (U.S. rate)	288	-93	194	-48	94	-45
United Kingdom (world rate)	246	-35	189	-37	57	2
Sweden (world rate)	420	24	468	-23	-48	47
New Zealand (world rate)	289	-75	-3	12	292	-87

Note:

Canada: trough Jan. 1994; peak Jan. 1995; latest Apr. 1995.
United Kingdom: trough Jan. 1994; peak Oct. 1994; latest Apr. 1995.
Sweden: trough Jan. 1994; peak Aug. 1994; latest Apr. 1995.
New Zealand: trough Dec. 1993; peak Sep. 1994; latest Mar 1995.

New Zealand and Canada similarly suggests that some credibility may have been regained. In the two countries where authorities have been fairly candid lately about the increased likelihood that targets will be missed -- the United Kingdom and Sweden -- the patterns of changes have been different. There was essentially no change in the credibililty measure for United Kingdom in the latest period, while in Sweden credibility appears to have deteriorated. Table 2 also makes it clear that the net change over the full time span (roughly 1-1/2 years) since the latest trough in three of the four IT-countries (all except Sweden) has been in the direction of credibility loss.[34] The implied losses in credibility have been a good deal less, however, than might be suggested by naive comparisons of nominal interest rate movements, unadjusted for underlying changes in real rates.[35]

5. Stabilization of Inflation Expectations

---

[34] Appendix table A.3, which is constructed similarly to Table 2 uses fitted values from equation (4) to measure changes in real rates during for the pre-IT to trough period. When they are compared with changes in real rates on the corresponding ITC curves, they indicate that there was a sizeable gain in credibility during this period for most IT countries, except the United Kingdom.

[35] In the most recent period, financial markets have focussed on fiscal problems in countries with large government budget deficits and high levels of outstanding official debt. In Canada and Sweden particularly, this has been a factor in periodic episodes of downward pressure on exchange rates, and it likely added upward pressure on nominal long-term interest rates as well. To the extent that fiscal problems did raise nominal rates, our measure of credibility decline would be larger. However, if one adopts a broader standard for inflation credibility that encompasses effects from fiscal policy, this omission (and its tendency to raise the differential between ITC and estimated real long-term interest rates lately) may not be inappropriate.

The analysis above assumed that the risk premium term in equation (1) remained constant. However, the risk premium could be affected by inflation targeting as well, and any resulting changes in its value would influence the comparison of ITC rates and estimated real rates of interest. Specifically, it is possible that inflation targeting may have fostered convergence of inflation expectations to the official targets, reduced the variability of inflation expectations, and thereby lowered the risk premium. One possible manifestation of this might be a reduction in the variability of *nominal* interest rates -- on the assumption that changes in inflation expectations generate a significant part of shorter-frequency (month-to-month) variations in nominal long-term rates. Accordingly, we tested to see if conditional variances of nominal long-term interest rates in IT countries appear to have fallen following the introduction of targeting. Our basic set-up for these tests, equation (5), was parallel to that of equation (4) for real interest rates, except that in (5) we substituted nominal long-term interest rates, as noted below. Thus, the underlying model for nominal long-term interest rates was:

$$(5) \qquad i_t = \overline{\alpha} + \sum_{j=1}^{m} \rho_{t-j}\, i_{t-j} + \beta i_t^* - \beta \sum_{k=1}^{n} \rho_{t-k}^*\, i_{t-k}^* + \gamma g_t + \varepsilon_t \; ,$$

where i_t and i_t^* are domestic and external nominal long-term interest rates. The residual sum of squares from this regression (adjusted for degrees of freedom) is χ^2 distributed and can be used as an estimator of the conditional variance of domestic nominal rates. The ratio of adjusted residual sum of squares from pre- and post-IT sub-periods (which has an F-distribution) provides a statistic to test whether or not the conditional variance of long-term

nominal interest rates may have shifted.[36] The same equation also can be used to test whether or not there may have been structural shifts in coefficients of the model, and in particular whether or not the coefficients on lagged dependent variables appear to have changed in the post-IT period (possibly becoming smaller, for example).[37]

Results from various tests of these hypotheses are summarized in Table 3. From entries in the first column, it is apparent that for all four countries it is not possible to reject the null hypothesis of no structural shift in the coefficients of the lagged dependent variables in the post-IT period. Accordingly, this suggests that inflation targeting does not appear to have affected the underlying parameters of the process of inflation-expectations formation. Similarly, tests for shifts in all coefficients jointly (column 2) provided no basis for rejecting the null hypothesis of no structural change. Accordingly, for the tests involving comparisons of conditional variances, we relied on the model estimated over the full sample period, but used the sum of squared residuals from each sub-period separately. The results from these tests (column 3) do indicate a statistically significant reduction of conditional variance in the post-IT period in New Zealand and the United Kingdom. Evidence to support a similar conclusion for Canada and Sweden was lacking. The fact that the tests are positive for

---

[36] Note that, because in this form the estimated variance is conditional on spillover effects, it should take into account, in part at least, effects on IT-country variance from a general global increase in variability of long-term nominal interest rates. Accordingly, it provides a measure of the variability of nominal interest rates over-and-above the general variability of interest rates in international markets.

[37] Changes in structural coefficients also would affect the *unconditional* variance of nominal interest rates, which could be misleading if variance tests were conducted without controlling for lags, spillovers, and cyclical effects.

Table 3

Tests for structural changes and shifts in conditional variance

	Structural change; lagged dependent variables only	Structural change; full model	Pre-/post-IT variance ratio
Canada (world rate)	1.20; 8, 117 [30.3]	1.75; 7, 112 [10.4]	1.49; 66, 46 [7.6]
Canada (U.S. rate)	0.02; 7, 118 [100.0]	2.05; 6, 114 [6.5]	0.95; 67, 47 [58.0]
United Kingdom (world rate)	1.78; 5, 120 [12.2]	0.71; 5, 116 [61.9]	3.59; 88, 28 [0.01]
Sweden (world rate)	1.67; 7, 118 [12.2]	1.54; 6, 114 [17.2]	1.31; 90, 24 [27.8]
New Zealand (world rate)	0.47; 5, 36 [79.3]	1.06; 5, 32 [40.0]	3.58; 16, 16 [0.75]

Note: Entries above show F-statistics and associated degrees of freedom; corresponding levels of significance in percent (for one-tailed tests in columns 1 and 2 and two-tailed tests in column 3) are shown in brackets below each entry. Column 1 reports results from (joint) tests for structural change in lagged-variable coefficients only. Column 2 reports results of joint tests for structural change in any or all coefficients.

For the estimations reported above, the full sample of long-term nominal interest rates ran from January 1985 to the latest month available. The numbers of significant lags on domestic and external interest rates varied across countries, with two lags each for domestic and external rates for the Canadian model (using world rates), two lags on domestic interest rates and one on external rates for both the Canadian model (using U.S. rates) and the Swedish model, and one lag each on domestic and external rates for the U.K. and New Zealand models. The sample break points (IT-announcement dates) for testing for structural changes in each country were: Canada, Feb. 1991; United Kingdom, Oct. 1992; Sweden, Jan. 1993; New Zealand, Apr. 1990.

possible shifts in conditional variances for the United Kingdom and New Zealand likely reflects in part that both countries experienced fairly large, erratic swings in interest rates early in the pre-IT period (in the U.K. case related to exchange rate pressures).

6. Conclusions

During a large part of their periods of inflation targeting, the four countries that are the subject of this paper -- New Zealand, Canada, the United Kingdom, and Sweden -- have been in recession with substantial gaps from potential output. Accordingly, price pressures have been subdued, and for the most part the commitment of authorities to inflation targets has not been questioned. As the four IT countries have moved into economic recovery recently, economic slack has narrowed and inflationary pressures have returned, generating the first meaningful challenges to the targeting regimes.

This paper has attempted to evaluate the effectiveness of inflation targeting -- as perceived in financial markets -- by using long-term interest rate data from the recent period of economic recovery to estimate changes in long-term real interest rates. These estimates then were used to compare with and adjust changes in constructed inflation-target-consistent real rates that incorporate inflation paths consistent with the targets themselves. A concern in making such comparisons was the extent to which real long-term interest rates have risen in these countries because of cyclical factors and, particularly, spillovers from increases in long-term interest rates in international markets. Accordingly, using panel estimates of real long-

term interest rates for 11 industrial countries over 12 years, we developed a measure of a world real long-term interest rate. This and other measures of external rates were used, with measures of output gaps, to control for at least two factors that may have had important impacts on real long-term rates in IT countries. Estimates from our models did not detect significant effects from output gaps, but spillover effects from external real interest rates appear to have been important. These spillover effects were least significant in New Zealand, but were larger and more statistically robust in the other three countries. In Canada, approximately 85 to 90 percent of increases in external real long-term interest rates -- whether measured by the world rate or U.S.-dollar denominated interest rates -- was estimated to pass through into Canadian rates. Estimated spillover effects were similar for Sweden, and in the United Kingdom the spillover coefficient was estimated to be near unity.

When projected changes in real rates in IT countries based on our models were used to adjust recent changes in ITC real rates, it appeared that three of the four IT countries (all except Sweden) experienced a loss of credibility of their targeting programs since the latest trough in nominal long-term interest rates near the end of 1993. Because real long-term interest rates appear to have risen largely because of spillovers from external markets, however, the implied credibility loss is much less than would have been estimated had long-term interest rates been assumed to be unchanged. Since the latest peak in nominal rates, Canada and New Zealand appear to have regained a modest amount of credibility after adjusting for real interest rate declines. This has occurred despite indications of increasing upward pressure on prices and growing concern about the status of inflation targets (as well as some maneuvering by authorities with target definitions, etc., to try to preserve credibility).

The latter changes have been smaller, however, and on balance credibility appears to have eroded during the past year and a half. Thus, even after accounting for spillovers from external rates and cyclical effects, recent increases in long-term interest rates appear to be incompatible with the possibility that market expectations for inflation have remained on track with official objectives.

Other evidence suggests that, although inflation targets have not had any detectable effect in altering the time-series characteristics of nominal interest rates (and, by implication, of inflation-expectations formation), inflation targets may have helped stabilize inflation expectations and possibly lowered the inflation-risk premium in some countries.

Appendix I: Panel regressions for the world long-term interest rate

One measure of real long-term rates in global markets that was used to evaluate

spillovers from external markets into domestic real long-term interest rates was based on

results from cross-sectional/time-series panel regressions.[37] The panel consisted of series on

monthly (and quarterly) real long-term interest rates[38] for 12 major industrial countries (the G-

10, plus Switzerland and New Zealand) over the decade 1983-1994.[39] Two sets of centered

dummy variables were included as explanatory variables to capture individual country effects

and time-period effects. Thus, real long-term interest rates were represented as follows:

$$(A.1) \qquad r_{it} = \mu + \omega_i c_i + \tau_t d_t + \varepsilon_{it} ,$$

where r_{it} are real long-term interest rates,

---

[37] A similar approach was used in Gagnon and Unferth (1993) to assess properties of real short-term interest rates in global markets and, in particular, whether or not markets are sufficiently integrated that there is a statistically meaningful world short-term real interest rate.

[38] Long-term real rates were formed from long-term nominal interest rates (average during the month or quarter) deflated by a centered 36-month moving average of 12-month CPI inflation. The nominal rates in most cases were rates on bellwether instruments, for which there is a small premium in financial markets, making this measure likely to be slightly below other measures of real rates.

[39] This time period was selected, after some experimentation, because it does not include the immediately previous years of the early 1980s when real interest rates appear to have moved quite erratically. It ends just before the latest period of economic recovery, allowing the model to project real rates into recent quarters and months.

c_i are country dummies for the 12 countries noted above,

d_t are time-period dummies for the 120 months (or 40 quarters)

of the sample period, and

ε_{it} is a random error term.[41]

A summary of the results is presented in Table A.1 below. As noted, the panel

regression based on (A.1) was fairly robust with almost all country dummies significant,

providing support for use of the equation's fitted values as a potential explanatory variable to

evaluate spillovers from international markets.[42]

The intercept term of equation A.1 (with an estimated value of 4.9 percent) provides a

direct measure of the average global long-term interest rate (with equal weights for each

country's rates) over the full decade of the sample. By application of time-period add-factors

(derived from the estimated time-period dummy coefficients), we obtained a measure of the

average "world" real long-term rate that varied over time. As an alternative measure of long-

term rates in global markets, we also constructed a "big- three" weighted-average (with global

trade weights) from dollar-, yen-, and DM-denominated long-term interest rates.[43] Both series

---

[41] To avoid collinearity with the constant term, the number of dummies in each set was reduced by one. The estimated coefficients for the country and time-period dummies (together with the constant term) can readily be converted into country and time-period add-factors.

[42] For purposes of evaluation of spillovers into any given IT country's real rates, that country was deleted from the panel and the equation was re-estimated. Results from panel regressions with such 11-country sets were similar to those from the full 12-country panel.

[43] We also used dollar-, DM- and yen-denominated real long-term interest rates (defined in the same fashion) separately as potential measures of external rates.

Table A.1

Panel Regressions Results: Long-term Real Interest Rates
(equation A.1)

Country	ω_i (percentage points)	t-value	add-factor (percentage points)
[constant]	4.90	175.44	--
Germany	--	--	-0.13
United States	0.07	0.52	-0.06
Japan	-0.92	-6.70	-1.04
France	1.14	8.30	1.01
Italy	0.84	6.16	0.72
Netherlands	0.60	4.35	0.47
Belgium	1.04	7.60	0.91
Switzerland	-2.79	-20.37	-2.91
United Kingdom	-0.29	-2.14	-0.42
Canada	1.09	7.95	0.96
Sweden	0.46	3.39	0.34
New Zealand	0.28	2.04	0.15

Adjusted R^2 : .505

Note: The country dummy for Germany was eliminated from the full 12-country set for regression runs.

(A.1) $$r_{it} = \mu + \omega_i c_i + \tau_t d_t + \varepsilon_{it}$$

are displayed in the upper panel of Chart A.1. It is apparent that they track fairly closely, although the big-three rate has tended to lie below the world rate recently (and above it earlier in the sample period).

Table A.2 provides some additional information on the variances of individual countries' real interest rates and corresponding panel-regression residuals and also on the correlation between each country's real interest rate and the estimated world interest rate. As may be seen in column 4, correlations between the real interest rates and the estimated world rate generally were quite high; only for Italy and New Zealand were they noticeably below 0.50. Also, in the majority of cases the variance of a country's real interest rate was larger than the regression residual, indicating that a large share of movements in real interest rates for each country can be explained by time effects that are incorporated into the world rate.

It is also possible to derive from the panel exercise an estimated country-specific real long-term interest rate for any single country by applying the appropriate country add-factor to the world average. The basic panel regression assumed that these country add-factors were constant over time, but it is also possible to test whether or not there may have been structural shifts in a country add-factor -- for example, in the targeting countries from the pre-IT to post-IT periods. Results from such tests indicate that the null hypothesis of no structural break can be rejected for three of the four targeting countries (all but Canada); the tests indicate that add-factors increased in the post-IT period for these countries.

As an additional indirect "quality check" on our world-rate measure, we examined whether estimates of U.K. real long-term rates from indexed securities tended to move in parallel with the U.K. real rate derived from our panel data (using the estimated add-factor for

World and Big-3 Real Long-term Interest Rates
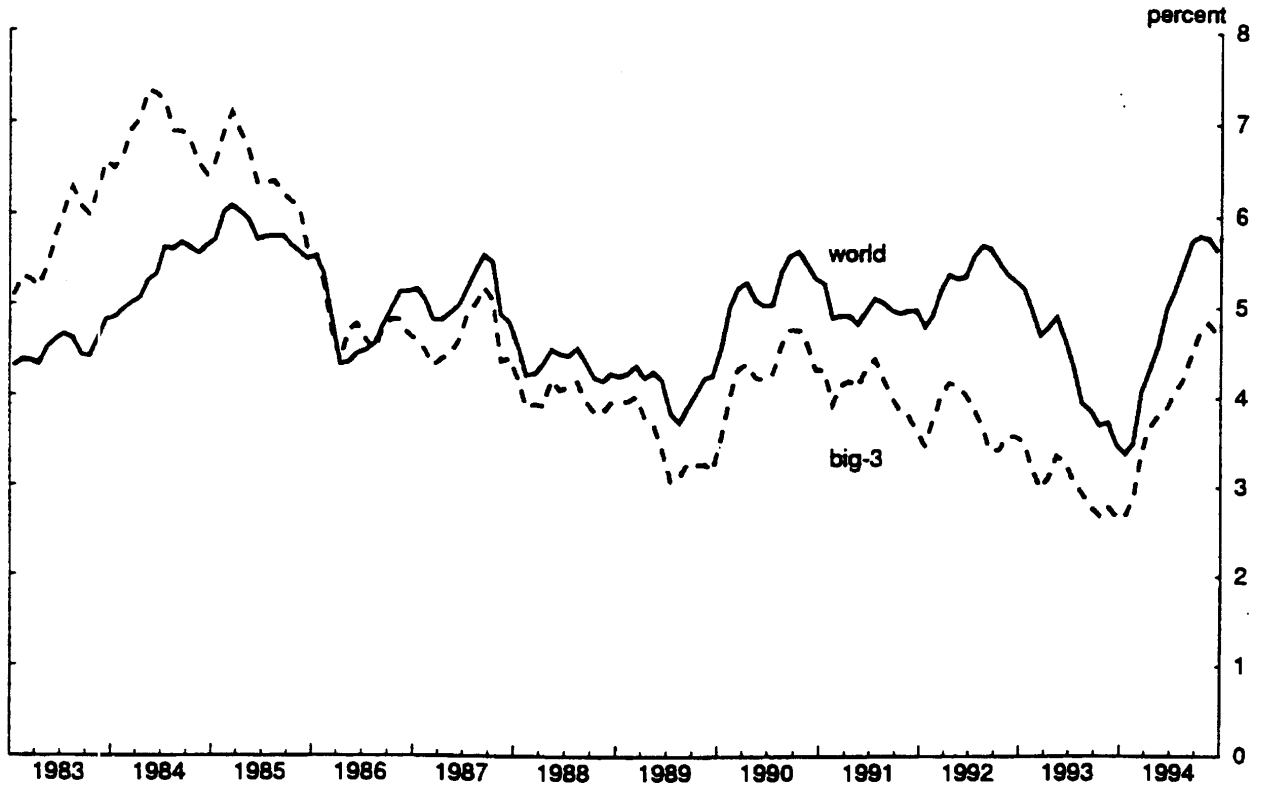
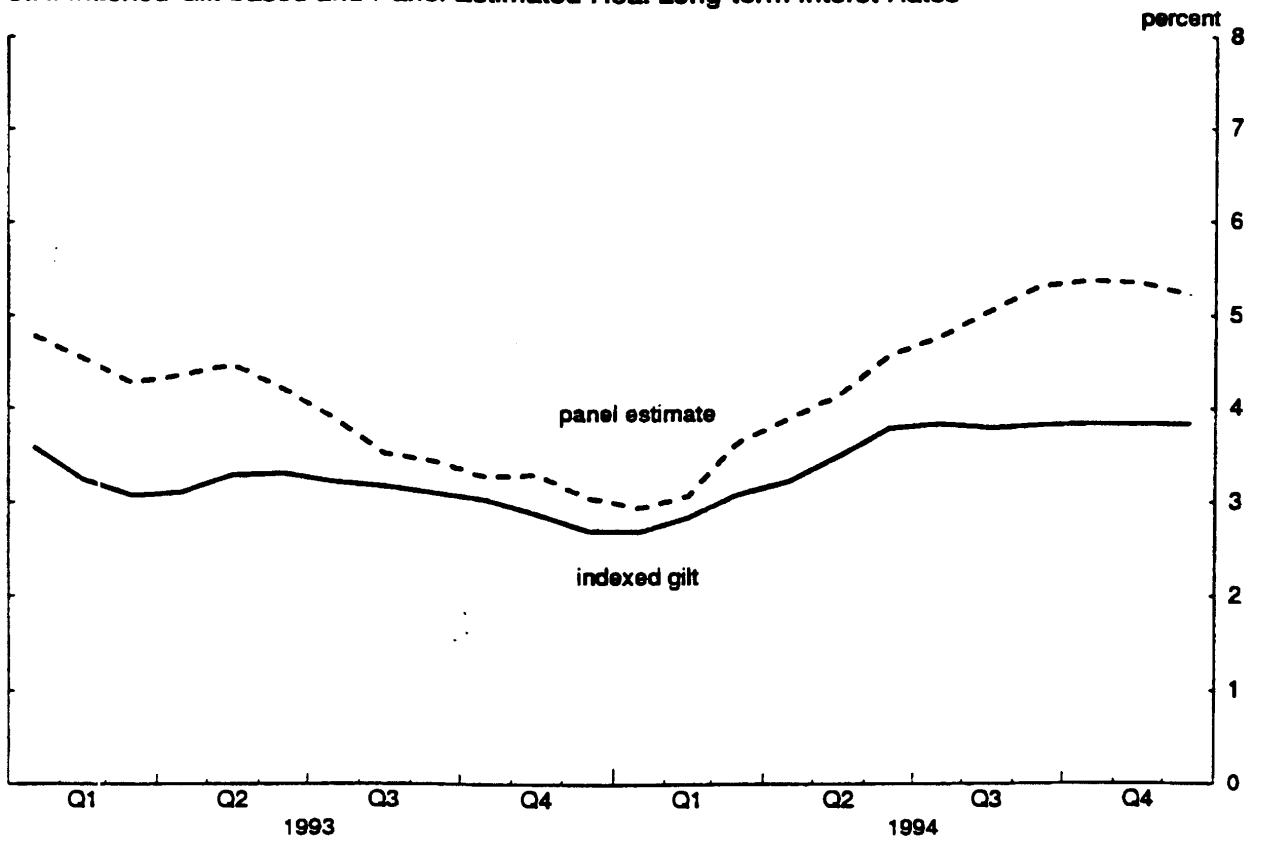## U.K. Indexed Gilt-based and Panel Estimated Real Long-term Interst Rates

Table A.2

Selected Panel Regression Statistics
(equation A.1)

Country	Variance of country real interest rate	Variance of world interest rate	Variance of country residual	Correlation of world and country real rates
Germany	0.94	0.34	0.62	0.58
United States	3.19	0.34	3.50	0.49
Japan	0.78	0.34	0.55	0.55
France	0.57	0.34	0.13	0.89
Italy	1.45	0.34	1.41	0.27
Netherlands	0.73	0.34	0.25	0.50
Belgium	0.66	0.34	0.55	0.79
Switzerland	0.72	0.34	0.57	0.51
United Kingdom	1.17	0.34	0.71	0.63
Canada	1.23	0.34	0.78	0.61
Sweden	2.34	0.34	1.39	0.72
New Zealand	4.94	0.34	5.10	0.07

Note: Results reported above are from model using quarterly data.

the post-IT period in the United Kingdom). The two measures are plotted in the lower panel of Chart A.1 for the past several years. Although the levels of the two measures differ somewhat (a higher average level for the derived rate by about 40 basis points), the correlation coefficient is quite high (92 percent). The presence of this gap may reflect in part the tendency for the interest rate data from the panel estimates to include a higher risk premium. It is also worth noting that the gap is the smallest near the trough of real rates, a pattern that is not consistent with the hypothesis noted earlier that the deflator for interest rates in panel data may mis-measure inflation expectations so as to produce a tendency toward counter-cyclical movements in estimated real rates.

Appendix II: Early IT-period credibility tests

Table A.3 below shows relative movements in ITC long-term rates and comparable estimates of real long-term rates for the period between the initial "pre-IT" starting points in Charts 5 - 8 and the troughs of long-term nominal rates around year-end 1993. The estimated real long-term rates are fitted values at appropriate dates in the sample period taken from the regression estimates from equation (4) for each IT country. The negative entries in the third column suggest that substantial increases in credibility were achieved for all countries except the United Kingdom, as ITC rates declined more than did estimated real rates. The United Kingdom likely benefitted least from inflation targeting (on this measure) because its inflation targeting period was preceded by roughly two years of membership in the ERM, which likely resulted in lower long-term interest rates (and lower inflation expectations) at the start of the U.K. inflation targeting period.

Table A.3

Changes in ITC and real long-term interest rates
(Pre-IT to trough; basis points)

	ITC long-term rate	Real long-term rate (in-sample estimate)	ITC less real rate change
Canada (world rate)	-367	-103	-264
Canada (U.S. rate)	-367	-90	-277
United Kingdom (world rate)	-295	-311	16
Sweden (world rate)	-291	-237	-54
New Zealand (world rate)	-486	-206	-280

Note:

Canada:	pre-IT Aug. 1990; trough Jan. 1994.
United Kingdom:	pre-IT Apr. 1992: trough Jan. 1994.
Sweden:	pre-IT Jul. 1992; trough Jan. 1994.
New Zealand:	pre-IT Sep. 1989; trough Dec. 1993.

Appendix III: Alternative estimations (first-difference form)

Because many of the series for real long-term interest rates used to estimate equation (4) above showed evidence of non-stationarity in unit-root tests, as a check we re-estimated the basic model in first-difference form (without the variable for output gaps). The equation used was

$$(4.a) \qquad \Delta r_t = \sum_{j=1}^{m} \rho_{t-j}\, \Delta r_{t-j} + \beta \Delta r_t^* - \beta \sum_{k=1}^{n} \rho_{t-k}^*\, \Delta r_{t-k}^* + \varepsilon_t \; ,$$

and results are summarized in Table A.4. Several coefficients in tests with this alternative specification were significant, although the first-difference equations tended to fit the data less well than in the original specification (especially the equation for New Zealand, for which no results are reported). However, when we compared the alternative models' in-sample estimates of changes in real rates during the inflation-targeting period (up to the lastest trough), as shown in column 2 of Table A.5, the results were reassuringly close to those obtained with the original model (Table A.3). The main qualitative difference was a considerably smaller estimated negative change in U.K. long-term real rates, resulting in a net gain in U.K. credibility (like the other countries tested) during this period, as indicated by the negative sign of the U.K. entry in column 3 of Table A.5.

Table A.4

Regression results: equation (4.a)
(first-difference version of equation (4))

\ equation regressor \	Canada (world rate)	Canada (U.S. rate)	U.K. (world rate)	Sweden (world rate)	N.Z. (world rate)
Δr_{t-1}	0.31 (0.09)	--	0.23 (0.08)	0.24 (0.08)	--
Δr_{t-2}	--	--	--	--	--
Δr^*_t	1.11 (0.17)	0.89 (0.07)	1.08 (0.16)	--	--
Δr^*_{t-1}	-0.52 (0.19)	--	--	--	--
Δr^*_{t-2}	--	--	-0.38 (0.15)	--	--
adjusted R^2	0.33	0.60	0.38	0.19	--

Note: Cells show estimated coefficients with standard errors in parentheses. Regressions were OLS on monthly data, except for New Zealand which was on quarterly data.

(4.a) $$\Delta r_t = \sum_{j=1}^{m} \rho_{t-j}\, \Delta r_{t-j} + \beta \Delta r^*_t - \beta \sum_{k=1}^{n} \rho^*_{t-k}\, \Delta r^*_{t-k} + \varepsilon_t \ ,$$

Table A.5

Changes in ITC and real long-term interest rates
(Pre-IT to trough; basis points)
(first-difference version of equation (4))

	ITC long-term rate	Real long-term rate (in-sample estimate)	ITC less real rate change
Canada (world rate)	-367	-136	-231
Canada (U.S. rate)	-367	-88	-279
United Kingdom (world rate)	-295	-198	-97
Sweden (world rate)	-291	-224	-67
New Zealand (world rate)	-486	–	–

Note:

Canada:	pre-IT Aug. 1990; trough Jan. 1994.
United Kingdom:	pre-IT Apr. 1992: trough Jan. 1994.
Sweden:	pre-IT Jul. 1992; trough Jan. 1994.
New Zealand:	pre-IT Sep. 1989; trough Dec. 1993.

References

Ammer, John, and Richard T. Freeman (1995), "Inflation Targets in the 1990s: The Experiences of New Zealand, Canada, and the United Kingdom," Journal of Economics and Business 47:165-1922.

Archer, David (1992), "Organizing a Central Bank to Control Inflation: The Case of New Zealand," presented at WEA International Conference, San Francisco, California (June 1992).

Ball, Laurence (1992), "Why Does High Inflation Raise Inflation Uncertainty?", Journal of Monetary Economics 29:371-388.

Bank of Japan (1995), "Inflation targeting in selected countries," Bank of Japan Quarterly Bulletin, May 1995, 39-52.

Barro, Robert (1995), "Inflation and economic growth," Bank of England Quarterly Bulletin, May 1995, 166-176.

Barro, Robert and David Gordon (1983a), "Rules, Discretion, and Reputation in a Model of Monetary Policy," Journal of Monetary Economics 12:101-122.

Barro, Robert and David Gordon (1983b), "A Positive Theory of Monetary Policy in a Natural Rate Model," Journal of Political Economy 92(4):589-610.

Blinder, Alan S. (1995), "Central Banking in Theory and Practice: Credibility, Discretion, and Independence," Marshall Lecture, Cambridge University, May 1995.

Breedon, Francis (1995), "Bond prices and market expectations of inflation," Bank of England Quarterly Bulletin, May 1995, 160-165.

Briault, Clive (1995), "The costs of inflation," Bank of England Quarterly Bulletin, February 1995, 33-45.

Clark, Peter, Douglas Laxton, and David Rose (1995), "Capacity Constraints, Inflation, and the Transmission Mechanism: Forward-Looking Versus Myopic Policy Rules," unpublished IMF Research Seminar working paper, June 1995.

Deacon, Mark (1994), "Deriving Estimates of Inflation Expectations from the Prices of U.K. Government Bonds," unpublished manuscript, Bank of England.

Deacon, Mark, and Andrew Derry (1995), "Estimating market interest rate and inflation expectations from the prices of U.K. governement bonds," Bank of England Quarterly Bulletin, August 1994, 232-240.

Debelle, Guy (1994), "The Ends of Three Small Inflations: Australia, New Zealand, and Canada," manuscript, MIT, March 1994.

Fischer, Andreas M. (1993), "Inflation Targeting: The New Zealand and Canadian Cases," Cato Journal 13(1): Spring/Summer 1993, 1-27.

Fischer, Stanley (1995), "The Unending Search for Monetary Salvation," paper prepared for the NBER Tenth Annual Macroeconomics Conference, March 1995 (forthcomng in conference volume).

Flood, Robert, and Peter Isard (1989), "Monetary Policy Strategies," IMF Staff Papers 36(3):612-632.

Ganley, Joe, and Giles Noblet (1995), "Bond yield changes in 1993 and 1994," Bank of England Quarterly Bulletin, May 1995, 154-159.

Gagnon, Joseph G. and Mark D. Unferth (1993), "Is there a World Real Interest Rate?", International Finance discussion paper # 454, Board of Governors of the Federal Reserve System, September 1993 (forthcoming in the Journal of International Money and Finance).

Goodhart, C. and J. Vinals (1994), "Strategy and Tactics of Monetary Policy: Examples from Europe and the Antipodes," LSE Financial Markets Group Special Papers No. 61, August 1994.

Kydland, Finn and Edward Prescott (1977), "Rules Rather than Discretion: The Inconsistency of Optimal Plans," Journal of Political Economy 85(3):473-491.

Lohmann, Susanne (1992), "Optimal Commitment in Monetary Policy: Credibility versus Flexibility," American Economic Review 82(1):273-286.

Persson, Torsten, and Guido Tabellini (1993), "Designing Institutions for Monetary Stability," Carnegie Rochester Conference Series on Public Policy 39:53-84.

Rogoff, Kenneth (1985), "The Optimal Degree of Commitment to an Intermediate Monetary Target," Quarterly Journal of Economics 100(4):1169-1189.

Svensson, Lars (1993), "The Simplest Test of Inflation Target Credibility," NBER Working Paper No. 4604, December 1993.

Svensson, Lars (1995), "Optimal Inflation Targets, 'Conservative' Central Banks, and Linear Inflation Contracts," manuscript, Stockholm University, June 1995..

Walsh, Carl (1994a), "Is New Zealand's Reserve Bank Act of 1989 an Optimal Central Bank Contract?", (forthcomng in the Journal of Money, Credit, and Banking).

Walsh, Carl (1994b), "Optimal Contracts for Central Bankers," American Economic Review 85(1):150-167.

Walsh, Carl (1994c), "When Should Central Bankers Be Fired?", manuscript, University of California, Santa Cruz.

Walsh, Carl (1995), "Recent Central Bank Reforms and the Role of Price Stability as the Sole Objective of Monetary Policy," paper prepared for the NBER Tenth Annual Macroeconomics Conference, March 1995 (forcoming in conference volume).

International Finance Discussion Papers

IFDP Number	Titles	Author(s)

1995

525	Targeting Inflation in the 1990s: Recent Challenges	Richard T. Freeman Jonathan L. Willis
524	Economic Development and Intergenerational Economic Mobility	Murat F. Iyigun
523	Human Capital Accumulation, Fertility and Growth: A Re-Analysis	Murat F. Iyigun
522	Excess Returns and Risk at the Long End of the Treasury Market: An EGARCH-M Approach	Allan D. Brunner David P. Simon
521	The Money Transmission Mechanism in Mexico	Martina Copelman Alejandro M. Werner
520	When is Monetary Policy Effective?	John Ammer Allan D. Brunner
519	Central Bank Independence, Inflation and Growth in Transition Economies	Prakash Loungani Nathan Sheets
518	Alternative Approaches to Real Exchange Rates and Real Interest Rates: Three Up and Three Down	Hali J. Edison William R. Melick
517	Product market competition and the impact of price undertainty on investment: some evidence from U.S. manufacturing industries	Vivek Ghosal Prakash Loungani
516	Block Distributed Methods for Solving Multi-country Econometric Models	Jon Faust Ralph Tryon
515	Supply-side sources of inflation: evidence frp, OECD countries	Prakash Loungani Phillip Swagel
514	Capital Flight from the Countries in Transition: Some Theory and Empirical Evidence	Nathan Sheets
513	Bank Lending and Economic Activity in Japan: Did "Financial Factors" Contribute to the Recent Downturn?	Allan D. Brunner Steven B. Kamin

Please address requests for copies to International Finance Discussion Papers, Division of International Finance, Stop 24, Board of Governors of the Federal Reserve System, Washington, D.C. 20551.

International Finance Discussion Papers