The Effects of Central Bank Independence and Inflation Targeting on Macroeconomic Performance: Evidence from Natural Experiments

Michael Parkin

University of Western Ontario

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Does a central bank that is independent of political influence deliver a better macroeconomic performance than one that implements monetary policy decisions taken by government? Does an inflation targeting agreement between central bank and government improve macroeconomic performance? And does the combination of an independent central bank and inflation targeting deliver an even better performance than either on its own? This paper addresses these questions by examining the outcomes of some natural experiments.

Questions about the design of the monetary policy framework—the set of institutional arrangements under which monetary policy decisions are made and executed—have always been important but have not always, indeed not often, occupied an agenda topping position. They have taken second place to questions about the appropriate choice of policy targets and instruments and the appropriate rules or discretion considerations in their setting. Yet the institutional arrangements play a crucial role in either constraining or failing to constrain the monetary policy process; and they are central to the current monetary policy debate on how to support expansion and eventually exit an era of extraordinary monetary stimulus.

Making a fiat money system work has never been easy and such a system stands in permanent threat from inflationary forces that have two sources. The first is the ever-present temptation faced by the sovereign (regardless of whether it is a despot or a constitutional democracy) to finance expenditure by creating money. The second is the appealing but wrong idea that inflation and its concomitant, currency depreciation, stimulate employment and economic growth.

We have seen these two forces at work since the mid-1960s. As inflation pressures emerged in different countries at different rates, the Bretton Woods fixed-exchange rate system came under severe stress. This stress became so acute that on August 15, 1971, the United States closed the gold window, and initiated the modern era of monetary arrangements—a world of multiple fiat monies with no common nominal anchor. The 1970s were the opening years of a rare period in history in which the world is without a global standard of value, a situation that required central banks to develop an entirely new approach to monetary policy.

For the two decades that followed, the world struggled to contain inflation and was unable to return the real economy to a growth path that matched that of the 1960s. Eventually, and working against these forces, advances in our understanding of how monetary policy influences the economy led to a new calm. During the 1990s, some central banks became more independent, some adopted inflation targeting, and some just got better at making monetary policy decisions, learning from experience and implementing ideas from advances in the theory of monetary policy. Inflation was checked, and the Great Moderation took hold.

But inflationary forces had not disappeared and during 2004 and 2005, the Federal Reserve departed from its price-stability script and kept the federal funds rate too low for too long facilitating a house prices bubble. Omitting all detail, when the interest rate started to rise, as it

did relentlessly through 2006, and as house prices fell, bringing a global financial crash, the response was to create ever more money and flood the banks with reserves.

After more than 3 years of near-zero interest rates, and trillions of dollars of quantitative easing, and with no signs of a return to pre-crisis growth rates and employment levels, the call again goes out for more inflation. Central bank independence and inflation targeting must be the problem. Create more money, run larger deficits, target unemployment and real GDP growth, dress it up by targeting nominal GDP, raise inflation expectations, and depreciate the currency. The call is the same in all the major countries. With central bank independence and inflation targeting under threat, it is timely to evaluate these institutional arrangements.

The literature on the effects of central bank independence on macroeconomic outcomes is large[1]. It begins with Bade and Parkin (1978), which found limited effects of central bank independence on inflation. Three decades and 59 empirical studies later, Klomp and de Haan (2010),[2] concluded that there exists a significant negative relationship between central bank independence and inflation—independent central banks deliver lower inflation—and the particular measure of central bank independence used has little effect on its estimated effect.

Fry, Julius, Mahadeva, Roger, and Sterne (2000) provided the most comprehensive measurement of central bank independence "over a range of characteristics covering legal objectives, goals, instruments, finance of the government deficit, and term of office of the Governor" with data for 93 central banks generated by a survey conducted in 1998 by the Bank of England Centre for Banking Studies. Carlstrom and Fuerst (2009) used these data along with earlier indexes to argue that not only does central bank independence lower the inflation rate but the 1990s had lower inflation than earlier decades *because* central banks became more independent. They attribute nearly two-thirds of the fall in inflation to this cause—central bank independence is the source of two-thirds of the Great Moderation.

Cargill (2013) challenges the prevailing consensus and argues that the negative correlations between measures of central bank independence and inflation are not robust and that actual (*de facto*) independence dominates legal (*de jure*) independence.

A further concern about the consensus view is that the cross-country data are contaminated by social and political variables that might influence both the nation's central bank law and its attitude toward inflation. For example, Germany's social memory of hyperinflation might be the cause of the independence of its post-war central bank and its low inflation rate and that given Germany's strong inflation-aversion, even a government-dominated central bank might have delivered the same low inflation. Similarly, the equivalent memory in the psyche of the United

[1] Parkin (2012) surveys and provides a critical appraisal of this large literature. This paper also contains an earlier and now superseded version of the natural experiments reported here.
[2] Klomp and de Haan provide the details of the 59 studies.

Kingdom is the depressed inter-war years. A social memory of this period might be the cause of the U.K. government taking over and running the Bank of England in 1946 and of the country's pursuit of full employment at the cost of rising inflation and occasional devaluation. And given the British aversion to unemployment, even an independent Bank of England might have delivered the same inflation performance.

To control for these possible deeper influences and isolate the effects of central bank law, we need natural experiments in which some central banking arrangements change and some do not. When the central bank laws literature started, such experiments were unavailable. But we now have several examples of changes in central banking arrangements that make it possible to examine the relationship between the *changes* in inflation and other aspects of macroeconomic performance and the *change* in central bank independence. The only existing attempt at this exercise is Carlstrom and Fuerst, but this attempt is not convincing.

There is less controversy about inflation targeting. A consensus has emerged that inflation targeting delivers lower inflation. When the central bank and government agree an inflation control target, which is pursued by the central bank setting the policy interest rate in a transparent, rule-like manner that satisfies the Taylor principle[3] and that is well explained in a periodic clearly written report, the inflation rate falls. A comprehensive study by Bernanke, Laubach, Mishkin, and Posen (1999) concludes, "The clearest finding from the international experience is that inflation targeting does indeed lead to lower inflation. In all the cases we have studied, countries using inflation targets significantly reduced both the rate of inflation and the public's expectations relative to their previous experience and, probably, relative to what they would have been in the absence of inflation targets."[4]

The effects of central bank laws and inflation targeting on real macroeconomic performance are less studied than the effects on inflation. The most cited work, Alesina and Summers (1993) finds no effects of central bank laws on the real economy.

Who is correct about central banking independence and macroeconomic performance? And is the consensus on the effectiveness of inflation targeting well-founded? This paper attempts to answer these questions by studying some natural experiments. It begins by defining a framework for assessing the effects of greater independence and inflation targeting. It then describes the data and events that constitute the natural experiments. Finally, it reports and interprets the results of the experiments and considers alternative interpretations.

The main conclusions are: (1) When a central bank becomes more independent, it lowers the inflation rate and lowers the variability of inflation but has no effect on real GDP or unemployment. (2) When a central bank becomes an inflation targeter, it lowers the inflation

[3] The real interest rate must move in the same direction as the inflation rate to satisfy the Taylor principle.
[4] Bernanke *et al* p. 297. The cases they studied were New Zealand, Canada, United Kingdom, Sweden, Israel, Australia, and Spain.

rate, lowers the variability of inflation, lowers the variability of real GDP growth and the output gap, raises the real GDP growth rate, and has no adverse effect on the unemployment rate. (3) An inflation targeter that becomes more independent delivers a similar outcome to that of a more independent bank that does not target inflation.

I FRAMEWORK FOR ASSESSING EFFECTS

The monetary policy framework might influence macroeconomic activity in three ways. It might operate through its effects on:

1) The short-run tradeoff between the *levels* of inflation and unemployment (or output)—the Phillips curve tradeoff;
2) The long-run tradeoff between the *fluctuations* in inflation and real activity—the Taylor curve tradeoff;
3) The trend growth rate of real GDP.

The Short-Run Phillips Curve Tradeoff

When a central bank becomes more independent with a price stability mandate, or when inflation targeting is adopted, short-run macroeconomic activity might change in either of two ways. The expected inflation might fall and bring a lower inflation rate with no change in the unemployment rate—a downward shift of the short-run Phillips curve. Or the actual inflation rate might fall with no change in the expected inflation rate, so that the unemployment rate increases–a movement downward along the short-run Phillips curve.

Figure 1 illustrates these two possibilities. The curves, $SRPC_0$ and $SRPC_1$ are two short-run Phillips curves and the vertical line *LRPC* is the long-run Phillips curve, located at the natural unemployment rate. For a given expected inflation rate and natural unemployment rate the short-run Phillips curve describes the tradeoff faced by the central bank. Monetary policy can deliver any inflation target at the natural unemployment rate. For example, the central bank can target point *A* or point *C*.

If inflation is at point *A* and the central bank wants to move to point *C*, there are two paths, a direct one with no change in the unemployment rate or an indirect one by way of point *B*. To move directly from *A* to *C*, a central bank must lower the expected inflation rate in step with lowering the actual inflation rate. By lowering the expected inflation rate, it shifts the short-run Phillips curve downward and avoids unemployment rising above the natural rate.

If the central bank lowers the inflation ahead of a fall in the expected inflation rate, the economy moves downward along $SRPC_0$ to point *B.* Eventually, the expected inflation rate falls and the unemployment rate returns to the natural rate. In the transition from high inflation at *A* to

low inflation at *C*, the unemployment rate exceeded the natural rate and the economy had a higher average unemployment rate than one that moves directly from *A* to *C*.

It is generally supposed that if a central bank raises the interest rate and slows the pace of monetary expansion, but takes no special steps to signal its resolve to lower inflation, it will create a recession. Unemployment will rise above the natural rate as the inflation rate slowly falls. It is hoped that either by changing the independence status and price stability focus of the central bank, or by implementing an inflation targeting regime, the credibility of the banks plan to lower inflation will bring a simultaneous fall in expected inflation and avoid recession.

Is this hope justified? Does a move toward greater central bank independence lower the inflation rate? Does inflation targeting deliver a lower inflation rate? And does an independent central bank or one that targets inflation deliver lower inflation without the cost of higher average unemployment?

The short-run Phillips curve is a temporary tradeoff. It moves when the expected inflation rate changes, and in the long run expected inflation equals actual inflation. The second tradeoff confronting a central bank is more durable.

The Long-Run Taylor Curve Tradeoff

The Taylor curve[5] is a tradeoff is between the *variability* of output and the *variability* of inflation. In a Taylor curve graph, the *x*-axis measures the variability of inflation as its standard deviation over some relevant period and the *y*-axis measures the variability of aggregate output (again, as the standard deviation over the same relevant period). Figure 2 shows two Taylor curves, TC_0 and TC_1.

In any given setting, the curve describes the tradeoff faced by the central bank. It is an efficiency frontier. It the tradeoff is TC_0, points below this curve are unattainable. Points above TC_0 are inefficient—there is a better monetary policy that delivers a point on the curve.

On the Taylor curve, monetary policy can target inflation closely only by permitting output to fluctuate more widely. For example, when a negative aggregate supply shock occurs, with no policy response the inflation rate rises and real GDP falls. If the central bank's policy response in such a situation is to increase aggregate demand, the fall in real GDP is smaller but the rise in the inflation rate is larger. Conversely, if the central bank's policy response to a negative supply shock is to lower aggregate demand in order to avoid a rise in the inflation rate, real GDP falls by a larger amount. These alternative policy responses to an aggregate supply shock are two points on a tradeoff between inflation variability and output variability—two points on a Taylor curve.

[5] See Taylor (1979) The Taylor curve graph is on p. 1281.

If the Taylor curve is TC_0, a central bank that responds in a neutral manner and tries with similar firmness to avoid volatility in both output and inflation operates at point *A*. A central bank that has a greater dislike of inflation and is less concerned about output volatility operates at point like *B*.

The position and shape of the Taylor curve depends on features of the economy that include the size and persistence of exogenous shocks, the degree of wage and price rigidity, and the credibility and transparency of monetary policy. For example, an economy with large and persistent exogenous shocks, rigid wages and prices, and a reputation for arbitrary monetary policy, might be on curve TC_0, while an economy with smaller and less persistent exogenous shocks, more flexible wages and prices, and credible and transparent monetary policy, might be on curve TC_1.

Central bank independence, its focus on price stability, and whether it is an inflation targeter are among the institutional settings that might influence the credibility and transparency of monetary policy and might, therefore, influence the position of the Taylor curve. These institutional features of monetary policy might also influence the point on the Taylor curve at which the economy operates.

So the second set of questions to be investigated are: Does the position of the Taylor curve depend on whether the central bank is independent with a price stability focus or on whether the central bank is an inflation targeter? Or do these features on the monetary policy institutions have little effect on the position of the Taylor curve and merely influence the point on the curve chosen by the central bank. Put differently, do greater independence and the pursuit of an inflation target bring greater real volatility? Or is there a free lunch with the variability of both inflation and the real economy subsiding?

The third effect is that of low inflation on long-term economic growth.

The Effect of Inflation on Long-Term Growth

Studies of the relationship between inflation and economic growth have found that low inflation is good for growth[6]. The relationship is not strong and has not so far been detected at low inflation rates. Barro describes it thus: "The basic finding is that higher inflation goes along with a lower rate of economic growth. Moreover, the adverse effect of higher inflation on economic outcomes is quantitatively important. This pattern shows up clearly for inflation rates in excess of 15–20% annually, but cannot be isolated statistically for the more moderate experiences. However, there is no evidence in any range of a positive relation between inflation and growth. The analysis also suggests that the estimates isolate the direction of causation from inflation to growth, rather than the reverse." Low variability of inflation is also a contributor to

[6] See, Barro (1998).

faster real growth. The view that low inflation promotes economic growth is widely accepted and even finds a place in central bank monetary policy reports[7].

So the third set of questions for investigation are do central bank independence and inflation targeting lower the level and the variability of inflation and boost the real GDP growth rate?

We now turn to the data and the events that constitute the natural experiments.

II DATA AND EVENTS

A nation's macroeconomic performance will be described by the mean and standard deviation of its inflation rate and real GDP growth rate, the standard deviation of its output gap, and its mean unemployment rate.

Inflation, Real Fluctuations, and Unemployment

The macroeconomic performance of 26 advanced economies is described using annual data on CPI inflation, the real GDP growth rate, the output gap (the percentage deviation of real GDP from potential GDP), and the unemployment rate from 1980 through 2011[8]. Using data starting in 1980 has the advantage that it avoids contaminating the experiments with the confusions of the early post-Bretton Woods world in which central banks were groping for procedures to cope with the new flexible exchange rate world.

Annual data rather than higher frequency quarterly or monthly data are used because the objective of this investigation is discover how long term average measures of macroeconomic performance respond to structural changes in monetary policy arrangements. Annual data serves this purpose better than nosier high frequency data.

CPI inflation is used in preference to the other available measures such as the GDP deflator or the PCE deflator for two reasons. First, for most countries, the CPI is the index on which the central bank focusses for making monetary policy decisions. Second, the correlation between the CPI and other broad price indexes is high.

The output gap is the variable of choice for measuring real fluctuations but it is available for only 22 advanced economies. The real GDP growth rate is available for all of them. There is a marked difference in the variability of the two measures and the correlation between them is only 0.34. For this reason, two sets of results are reported, one based on real GDP growth for the full 26-country sample and another based on the output gap for the smaller 22-country sample.

[7] The Bank of Canada Monetary Policy Report preamble repeats each issue the view that "Canada's experience with inflation targeting since 1991 has shown that the best way to foster confidence in the value of money and to contribute to sustained economic growth, employment gains and improved living standards is by keeping inflation low, stable and predictable."

[8] The data source is the International Monetary Fund, World Economic Outlook Database, October 2012, downloaded 31 January 2013 and the initial sample is the 35 economies that the IMF defines as "Advanced".

The unemployment rate data in the IMF World Economic Outlook database is a mixture of national definition for 14 economies, the ILO harmonized measure for 11 economies, and the OECD harmonized measure for one economy.

The samples of 26 (and 22) countries are a subset of the 35 economies that the IMF classifies as "Advanced." Seven of the countries were excluded because their data runs are seriously incomplete or because they are too small to be given the same weight as the other countries[9]. A further two countries, Iceland and Israel, were excluded because their average inflation rates and variability of inflation place them in a different distribution than the other countries. For the 26 countries remaining in the sample, between 1980 and 2011, the mean inflation rate is 4.1 percent and the standard deviation of inflation is 4.5 percent. For Iceland and Israel, the mean inflation rate over the same period is 28 percent and the standard deviation is 60 percent. On the scale of these two countries, the other 26 compress to a single data point and the significance of the variability across them that we want to reveal is lost.

Central Bank Independence and Inflation Targeting Events

The central banking arrangements in the 26 economies are examined focusing on central bank independence and inflation targeting. Between 1989 and 2001, these arrangements changed in 16 of the 26 economies in ways that constitute natural experiments that enable us to isolate the effects of central bank independence and inflation targeting on macroeconomic performance. **Table 1** summarizes the changes in chronological order.

The information in Table 1 enables us to place the economies in four groups:

1) More independent
2) Inflation targeters
3) More independent inflation targeters
4) Others (controls)

More Independent

A central bank is independent if its governor and board set the monetary policy instrument (typically the overnight interest rate target) without political pressure in pursuit of goals that include, and ideally alone include price stability. Previous attempts to estimate the influence of central bank independence on macroeconomic performance have coded the features of central banks and created independence indexes. But as shown in earlier work, this detailed approach to describing central bank independence turns out to be no more informative than a dichotomy between more and less independent[10]. We can exploit that finding by looking for central banks that have become *more* independent.

[9] The 7 countries are Cyprus, Czech Republic, Estonia, Malta, San Marino, Slovak Republic, and Slovenia.
[10] See Cargill (2013) and Parkin (2012).

New Zealand made the first move toward greater central bank independence with the sweeping Reserve Bank of New Zealand Act 1989[11], which created an independent central bank with the single mandate to achieve price stability. The Bank of Japan Act, 1997[12], the Bank of Korea Act, 1998[13], the Bank of England Act, 1998[14], and the Bank of Sweden Act, 1999[15] all saw a similarly clear enunciation of a commitment to price stability by the policy decisions of an independent central bank. The details differ but the broad thrust is common: explicit instrument independence for the central bank in pursuit of the goal of price stability. These events are regarded as creating more-independent central banks.

The ECB became fully operational on January 1, 1999. Before that date, Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain had their own central banks. After January 1, 1999, these country's central banks ceded their monetary policy powers to the ECB. Other nations joined the Eurozone and their central banks were replaced by the ECB in the years that followed (1 January 2001, Greece; 1 January 2007, Slovenia; 1 January 2008, Cyprus and Malta; 1 January 2009, Slovakia; and 1 January 2011, Estonia).

The ECB was established as an independent central bank with a mandate to achieve price stability, defined as an inflation rate of around 2 percent per year. Most of the national central banks replaced by the ECB were not independent, so for most of the Eurozone economies, the change was to a more independent central bank. But there was no such change for Germany. The independence of the ECB is similar to that of the Bundesbank. Further, the Bundesbank is the most influential owner of the ECB.

Also, there was no material change in independence status of four other Eurozone members: Austria, Belgium, Luxembourg, and the Netherlands. The reason why these countries had no change in independence is that the exchange rates of their national currencies were pegged to the Deutsch mark (DM). The Austrian schilling was pegged at 7.04 per DM and the Dutch guilder at 1.12 per DM for the entire period from 1980 to 1999. The Belgian franc was effectively pegged at 20.5 per DM after 1982 and the Luxembourg franc was pegged at 1 Belgian franc. With rigidly fixed exchange rates against the DM, the monetary policy actions of these countries were constrained by those of the Bundesbank, which effectively set their monetary policies.

Summarizing the above, we have 11 countries with more independent central banking arrangements: New Zealand, Japan, Korea, the United Kingdom, Sweden, Finland, France, Ireland, Italy, Portugal, and Spain.

[11] See http://www.legislation.govt.nz/act/public/1989/0157/latest/DLM199892.html and http://www.rbnz.govt.nz/about/acct.pdf
[12] See http://www.japaneselawtranslation.go.jp/law/detail/?id=92&vm=02&re=01 and http://www.boj.or.jp/en/announcements/release_1996/un9611a.htm/
[13] See http://www.akes.or.kr/akes/downfile/01_Thomas_Cargill_rev_.pdf
[14] See http://www.bankofengland.co.uk/about/Documents/legislation/act1998.pdf
[15] See http://www.riksbank.se/en/The-Riksbank/Historia1/Sveriges-Riksbank-10-years-as-an-independent-central-bank/

Inflation Targeting

Inflation targeting is an approach to monetary policy-making with three key features. First, a price index and a target range for its inflation rate is set. The target might be agreed with government, imposed by the government, or self-imposed by the central bank. Second, the central bank aims to achieve the mid-point of the range but *flexibly* moves toward either extreme to moderate fluctuations in the real economy. Third, a frequent report (variously titled "inflation report" or "monetary policy report" or "monetary policy statement") provides a detailed account of the bank's forecasts and explanation for its policy decision. More succinctly, inflation targeting is the credible, transparent, and flexible pursuit of an inflation target along with minimum attainable output and inflation variability.

This description of inflation targeting is clearly not the single-minded pursuit of an inflation target to the exclusion of real output and employment objectives. It is effectively a dual mandate, but one in which the dual goals are low inflation and low *variability* of output and employment, not low inflation and a high *level* of output or employment. The distinction is a vital one. Monetary policy does influence variability, so the dual mandate of the flexible inflation targeter is attainable. In contrast, monetary policy is powerless to influence the level of real variables, except temporarily, so the pursuit of a real level objective is not compatible with price stability.

To emphasize the dual mandate nature of the approach, one prominent targeter now uses the phrase *Flexible Inflation Targeting*[16] to describe its approach.

Many central banks count themselves among the ranks of inflation targeters, but only five of the advanced economies belong to this group: New Zealand, Canada, the United Kingdom, Australia, and Sweden, and they are all 'flexible inflation targeters'.

New Zealand's inflation targeting is mandated by the 1989 Act and carries penalties against the governor for failure to achieve the target. Canada's targeting is done under an explicit 5-year (renewable) agreement between the Bank of Canada and central government. Inflation targeting in the United Kingdom and Sweden began as voluntary targets set by the respective central banks and then became formal with Acts that made the central banks more independent.

Australia is different from the other four countries in the manner of its adoption of inflation targeting. The political environment made it necessary for the Reserve Bank to proceed surreptitiously. Consequently, Australia's adoption of inflation targeting was gradual, initially unannounced, later floated as a trial balloon by Governor Bernie Fraser[17], and eventually but long after the event, ratified in a joint agreement by the Treasurer and Governor.[18]

[16] The Bank of Canada uses this term, with the words capitalized for further emphasis.
[17] See Bernie Fraser (1993) and Glenn Stevens (1999).
[18] Ian Macfarlane (1998) provides a detailed and authoritative account of the political environment navigated by the Reserve Bank in its under-the-radar and gradual adoption of inflation targeting and its eventual ratification with a joint agreement.

All of these central banks go on the record every few months with their view of the likely future course of inflation and other macroeconomic variables over a period that usually runs two years into the future. Two of them, the Bank of England and the Riksbank, quantify their own uncertainty by publishing fan charts that capture the forecast distribution. And the Riksbank even publishes forecasts of its own future interest rate decisions. This clarity and transparency is a crucial feature of inflation targeting.

More Independent Inflation Targeters

Three countries, New Zealand, Sweden, and the United Kingdom became more independent *and* adopted inflation targeting. New Zealand made these two changes simultaneously, but Sweden and the United Kingdom first became inflation targeters and subsequently became more independent. So these three countries are both inflation targeters and more independent inflation targeters.

Treatment Groups and Control Group

The central banks that became more independent or adopted inflation targeting are those that received treatments. By comparing the performances of the treatment groups with those that didn't change—with controls—we can isolate the effects of the treatments,

Table 2 lists the 26 economies and their assignment to the three treatment groups and a control group. The table also shows the years in which a country's central bank became more independent and/or adopted inflation targets[19].

IIILOOKING FOR THE EFFECTS

If central bank independence and inflation targeting influence monetary policy outcomes, these influences should be visible after countries modified the central bank laws and after countries became inflation targeters.

To reveal these influences, we must control for other factors that act on inflation and macroeconomic performance that were different during the 2000s from the 1980s and 1990s. Listing and measuring all these potential influences is neither feasible nor necessary. Instead, we can regard the countries with more independent central banks as one treatment group, the countries that adopted inflation targeting as a second treatment group, and those that made both changes as a third treatment group. We can compare the *changes* in macroeconomic performances of the countries in these groups with those of a control group of countries, a group of otherwise similar countries in otherwise similar times that did not change their central bank

[19] The dating of the adoption of inflation targeting in Australia is the generally accepted one and based on the date of Governor Bernie Fraser's trial balloon.

law or become inflation targeters. The natural choice for the control group is the advanced economies listed in **Table 2**.

"Before" and "After"

For the 26 countries listed in Table 2 and for a "before" and an "after," the mean and the standard deviation of inflation rates and real GDP growth rates, the mean unemployment rate were calculated. Also for the 22 countries for which output gap data are available, "before" and "after" standard deviations were calculated.

For the 3 treatment groups, the "before" period ended 1 year after the policy change date shown in Table 2 and the "after" period began 2 years after the change date. The rationale for this time lag is that it reasonably represents the types of lags found in time-series studies. These lags also provide time for the new institutional arrangement to be clear of any transition effects that follow the change.

For the control group of economies, 11 "before" and "after" sets correspond to the 11 different break dates for the 3 treatment groups: 1997, 1998, 1999, and 2001 for the more independent comparisons; 1991, 1993, 1993 – 1998, and 1993 – 1999 for the inflation targeters; and 1990, 1999, and 2000 for the more independent inflation targeters.

What Do Greater Independence and Inflation Targeting Achieve?

Table 3 provides summary statistics that show how macroeconomic performance changed after a country made its central bank more independent or after it became an inflation targeter, or after both of these changes occurred.

The changes described in Table 3 are those that accompanied the change in central bank status. They are not the *effects* of the change. To see the effects, we must compare the changes in the treatment economies with the changes in the control economies. First the changes will be summarized, then the treatment changes will be compared with changes in the control economies, and finally the findings will be interpreted in terms of the framework established earlier.

Absolute Changes: More Independent

The countries in which the central bank became more independent lowered their annual inflation rates by almost 5 percentage points from 7.05 percent before the change to 2.18 percent after the change. They also lowered the variability of inflation, with a fall in the standard deviation of annual inflation from 5.34 percent to 1.06 percent. The standard errors of these changes are small: The changes are strongly significant. These are the only significant changes that accompany a change in the independence of the central bank. Changes in both the mean and

standard deviation of real GDP growth, changes in the variability of the output gap, and changes in the mean unemployment rate are small and insignificant.

Absolute Changes: Inflation Targeters

Central banks that became flexible inflation targeters but did not change their independence status delivered strong and widespread changes in macroeconomic performance. The annual inflation rate fell by almost 5 percentage points from 6.56 percent before targeting to 1.86 percent with targeting. The variability of inflation *and* the variability of real GDP—both its growth rate and output gap—also fell. Further, the mean annual growth rate of real GDP rose by almost 1 percentage point. All these changes have small standard errors and are significant. The inflation effects are particularly strongly significant with very high t-statistics. Of the variables studied, unemployment alone was unaffected by the adoption of inflation targeting.

These numbers provide a ringing endorsement of flexible inflation targeting as a procedure for delivering all round improved macroeconomic performance at no cost in terms of lost jobs.

Absolute Changes: More Independent Inflation Targeters

Three central banks combined more independence with inflation targeting. For New Zealand, these two events occurred at the same time and for Sweden and the United Kingdom, greater independence came some years after inflation targeting had started. These central banks performed almost exactly the same as the central banks that became more independent but did not adopt inflation targeting. They lowered the inflation rate and lowered the variability of inflation by amounts similar to those for the central banks that became more independent but did not become inflation targeters. No other significant changes occurred for this group.

Absolute Changes: Controls

The absolute changes achieved by the central banks in the control group are averages for "before" and "after" of the 11 sets of dates weighted by the number of treatments at each of the 11 dates. The bottom panel of Table 3 shows the results of these weighted average changes. Like the central banks that became more independent, these central banks significantly lowered the inflation rate and its variability and saw no other significant changes.

Notice that the mean inflation rates in Table 3 for the control groups are lower than for the three treatment groups. So, although the treatment groups saw large falls in their inflation rates, they began with higher rates than the control countries. But note further that the control group includes Germany and the other Eurozone economies linked to it and Switzerland, considered to be the countries with the most independent central banks.

For present purposes, what matters is not the independence status of the control central banks but the fact that during the sample time period, neither their independence nor inflation targeting status changed.

Changes Compared to Control

Absolute changes in monetary policy outcomes don't tell us the *effects* of the change in central bank status. To see those effects, we need to ask how the changes for the three treatment groups compare with the changes for the controls. **Table 4** provides the relevant data.

More Independent Relative to Control

The countries in which the central bank became more independent lowered their annual inflation rates by 3 percentage points more than in the controls and the difference is significant. They also lowered the variability of inflation by significantly more than did the control group. These are the only significant effects. The other large effect is on unemployment, which the more independent group lowers and the control group increases. But the confidence in this change is low.

Inflation Targeters Relative to Control

The inflation targeting countries beat the controls on both the mean and standard deviation of both inflation and real GDP growth. They lowered the annual inflation rate by 2 percentage points more than did the control countries and they increased the annual real GDP growth rate by 1.5 percentage points more than the control countries achieved. They also achieved better outcomes for the unemployment rate and the output gap, though these differences are not significant.

More Independent Inflation Targeters Relative to Control

The more independent inflation targeters have only two significant differences from the controls and one of these goes the wrong way. They lowered the variability of inflation but increased the variability of the output gap. None of their other effects is significant.

More Independence versus Inflation Targeting

We can also compare the treatments against each other. Does being a more independent inflation targeter give a better performance than just being more independent? Does it improve on just being an inflation targeter? And which delivers the better outcome, being an inflation targeter or becoming more independent?

Table 5 provides the relevant data to address these questions.

More Independent Inflation Targeter Relative to Inflation Targeter

Only one significant difference is present in the comparison between more independent inflation targeters and more independent: The more independent inflation targeter delivers a higher mean real GDP growth rate, and the difference is large 1.86 percentage points. The other differences between these two groups are small and insignificant.

More Independent Inflation Targeter Relative to More Independent

Two significant differences are present in the comparison between more independent inflation targeters and inflation targeters, and they both favor the inflation targeter that does not become more independent. The inflation targeter delivers a less volatile real GDP, in both its growth rate and output gap. Again, the differences are large. The differences in inflation and unemployment between these two groups are small and insignificant.

More Independent Relative to Inflation Targeter

The comparison between more independent and inflation targeters reveals a tradeoff. A central bank that becomes more independent does significantly better on inflation variability while an inflation targeter wins on the mean and variability of real GDP.

IVINTERPRETING THE RESULTS

The results of these experiments have ready interpretations in terms of the framework laid out earlier.

The Short-Run Tradeoff

Figure 3 shows the outcomes of the experiments in Phillips curve space—the inflation rate (*y*-axis) and unemployment rate (*x*-axis). The open dots show the data before the change and the black dots show the data after the change. The grey dots show what the data would have been if the change had equaled the average change of the control group. The large dots are the sample means and the small dots are the data for the individual economies.

Figure 3(a) shows that central banks that became more independent massively lowered the inflation rate, and from widely different initial inflation rates they converged on similar rates. But the unemployment rates in these economies, presumably the natural unemployment rates because they are averages over many years, remained highly dispersed across the economies.

Figures 3(b) and 3(c) show a similar outcome for inflation targeters and more independent inflation targeters, but in these two graphs, it is possible to see the distance between the ‘before’ and ‘after’ data points and see why the effects on inflation are significant and those on unemployment are small, dispersed, and insignificant.

The data in all three parts of Figure 3 are consistent with the natural rate hypotheses. The natural unemployment rate (averaged over all the economies) is 8.4 percent for 'more independent', 7.6 percent for 'inflation targeters', and 6.4 percent for 'more independent inflation targeters.'

The short-run Phillips curves shifted downward. The scatter of unemployment rates is wide, hence the lack of statistical significance in the changes in unemployment but the changes in inflation are clearly seen in the graphs with the 'after' dots distinctly lower than the 'after control' dots and the 'before' dots.

Figure 4 illustrates this interpretation. The three sets of experiments deliver sufficiently similar outcomes for them to be examined on average rather than individually. The natural unemployment rate is in the range 6.9 percent to 8.1 percent. Before the changes, the short-run tradeoff was $SRPC_0$. With no change in the institutional arrangements, an outcome the same as that of the controls would have lowered the inflation rate and the expected inflation rate to shift the short-run tradeoff to $SRPC_1$. But greater independence and/or inflation targeting shifted the short-run tradeoff by more to $SRPC_2$.

Basically, the short-run tradeoff is too short-lived to show up on the time-scale of these experiments. It constrains monetary policy on the time-scale of months and quarters, but not on the time-scale of multi-year averages.

The two dots in Figure 4 A' and B' show respectively the 'before' and 'after' points for the control economies. These economies have a lower natural unemployment rate than the treatment economies and began with a lower inflation rate but after the treatments of greater independence or inflation targeting, the treatment economies end up with a slightly lower (though insignificantly lower) average inflation rate than that of the control economies.

The Taylor Curve Tradeoff

Figure 5 shows the outcomes of the experiments in Taylor curve space—the standard deviation of inflation on the x-axis and the standard deviation of the real GDP growth rate[20] on the y-axis. The dots use the same conventions as those for the short-run tradeoff in Figure 3.

In all three parts of the figure, the clearest effect is the large and significant fall in the variability of inflation. The black 'after' dots cluster at or below a standard deviation of 1 percent but have a large spread in the standard deviation of real GDP growth rates.

Figure 5(b), inflation targeters, contrasts with 5(a) and 5(c), more independents, in the direction of change of output variability. For both cases of greater independence, the real GDP growth rate becomes more variable, while for the inflation targeters it becomes less variable.

[20] Figure A1 shows the equivalent scatter diagrams with the variability of the output gap (the output measure normally used do depict the Taylor curve) replacing the variability of the real GDP growth rate.

Both a move to greater independence and the adoption of inflation targeting make monetary policy more efficient in the sense that they improve the Taylor curve tradeoff. But only the inflation targeters exploit this efficiency gain to lower the variability of both inflation and real economic activity. The central banks that become more independent take the entire efficiency gain in the form of a decrease in the variability of inflation and keep the variability of real GDP growth unchanged.

Figure 6 illustrates this interpretation of the effects on the Taylor curve. Part (a) illustrates the effects of greater independence. These central banks begin at point *A* on TC_0. Improving by the same amount as the controls would take them to point *B* on TC_1. But they performed much better than this and moved to a point on TC_2. Point *C* on TC_2 lies on a ray between the origin and point A, and is where the more independent central banks would have operated if they maintained the same ratio for the two standard deviations. Instead, they chose to put a greater emphasis on targeting inflation and keeping its variability low and ended at point *D*, where all the gains were assigned to lowering inflation variability and none to lowering output variability.

The control central banks started at point *A′* and ended at *B′*, a point almost identical to *D*. The near equality of performance of the control and more independent central banks and large improvement in performance after becoming more independent is consistent with the view that central bank independence does deliver lower and more predictable inflation. That the controls and more independent end up in the same place is a consequence of the independence of the controls, which, as noted earlier include the United States, Germany and its associated countries pegged to the D-mark, and Switzerland. Although the U.S. Federal Reserve is less independent than was the Bundesbank or is the Swiss National Bank, this group occupies a space toward the more independent end of the range of central bank types.

The effects of inflation targeting are larger than those of greater independence and Figure 6(b) illustrates why. These central banks begin at point *A* on TC_0. Improving by the same amount as the controls would take them to point *B* on TC_1. But they performed much better than this and moved to a point on TC_2. Point *C* on TC_2 lies on a ray between the origin and point *A*, and is where the inflation targeters would have operated if they maintained the same ratio for the two standard deviations. That is almost where they ended up. They chose to put slightly greater emphasis on targeting inflation and keeping its variability low and moved to point *D*. Unlike the more independent central banks that assigned all their efficiency gains to inflation and none to lowering output variability, the inflation targets almost maintained their earlier balance between nominal and real volatility.

The contrast between the inflation targeters and their control group is also instructive. The inflation targeting control central banks started at point *A′*, a point close to where the targeters started out, and ended at *B′* with greater variability of both inflation and real activity.

Flexible Inflation Targeting and Real GDP Growth

The increase in the mean real GDP growth rate of flexible inflation targeters is a remarkable outcome. Is it truly an effect of good monetary policy, or does the credit for it lay elsewhere?

The magnitude of the effect suggests that other forces must have contributed to the increase in real GDP growth. The standard view, based on Barro (1996), is that a 1 percentage point fall in the inflation rate increases the real GDP growth rate by 0.04 percentage points. In Table 4, inflation targeters lower the annual inflation rate by 4.70 percentage points and raise the annual growth rate of real GDP by 0.88 percentage points. If no other changes influenced the real GDP growth rate, these numbers imply that a 1 percentage point fall in the inflation rate increases the real GDP growth rate by 0.19 percentage points, an effect almost 5 times as large as Barro's estimate.

A further reason to doubt the magnitude of the increase in real GDP growth comes from the distribution of the increase across the four flexible inflation targeting economies. The individual country effects of a 1 percentage point fall in the inflation rate on the real GDP growth rate implied by the data are: Australia +0.08, Canada +0.12, Sweden +0.27, and United Kingdom +0.23. The changes for Sweden and the United Kingdom are the source of the large average effect. Sweden was classified as an inflation targeter until 2000, when its classification changed to more independent inflation targeter. The United Kingdom has the same reclassification in 2000. If we continue to classify these countries as inflation targeters through to 2011, the estimated effects of a 1 percentage point fall in the inflation rate on the real GDP growth rate are +0.13 for Sweden and −0.02 for the United Kingdom. The average effect of a 1 percent fall in the inflation rate becomes an increase in the annual growth rate of real GDP of 0.08 percentage points. The change remains significant. It also looks more reasonable, being only twice the size of Barro's estimate of the effect.

V ALTERNATIVE INTERPRETATIONS OF THE DATA

Are there alternative interpretations of the data that weaken our confidence in the estimated effects of central bank independence and inflation targeting on macroeconomic performance? Three possible reasons for caution merit attention. First, inflation rates were already low before the treatment events in the control economies. Did this fact provide too little room for improvement in the control economies and bias upward our estimates of the effects on the treatments? Second, did central banks first get inflation under control and then embark on inflation targeting so that causation run in the opposite direction to that assumed? And third, is

there a common joint cause of institutional change and improvement in macroeconomic performance that creates a lack of independence among the treatments?[21]

Are the Estimated Effects Biased Because Controls Have Lower Inflation?

It is a feature of the data that the average inflation rate of the control economies was lower than that of the treatment economies, both before and after the treatments. Annual inflation in the controls decreased from 4.08 percent to 1.85 percent while in the treatment economies, it decreased from 6.91 percent to 2.07 percent. But the treatments do correlate with a large fall in the inflation rate. They also correlate with other aspects of macroeconomic performance that are independent of the mean inflation rates.

For example, the standard deviation of inflation was lower in the control economies before treatments but after the treatments, it was higher, decreasing from 2.94 percent to 1.22 percent in the controls and from 4.76 to 1.03 in the treatment economies. Real GDP growth fell but by more in the control economies than in the treatment groups. The standard deviation of real GDP increased for the controls and the more independents, but decreased for the inflation targeters.

There is no reason to suppose that these comparative changes are biased by the inflation differences.

What is the Direction of Causation?

No serious case could be made that the creation of the ECB was caused by lower inflation in the European nations whose central banking arrangements became more independent when they adopted the euro. But a case might be made that a fall in inflation caused the adoption of inflation targets. The argument would be that having lowered its inflation rate and long-term inflation expectations, a central bank formally adopts inflation targeting knowing that it is now safe to do so. The formal adoption would be an *ex-post* ratification of an objective already achieved and inflation targeting would be incorrectly credited with the lower inflation rate. A more detailed examination of the data rejects this possible reverse causation.

Figure 7 shows the inflation rates in the five inflation targeters with each country aligned on the same *x*-axis date of adoption of targeting. It is clear that inflation rates had not fallen before targeting was formally adopted. The mean inflation rate in the three years to when targeting began is 4.7 percent and in the three years after targeting it is 2.0 percent. There is an interesting variability across the five countries. Comparing the three years before targeting with the three years after, the inflation rate fell in Canada (5.1 to 1.2), in New Zealand (6.1 to 1.6), in Sweden (5.5 to 1.7), and in the United Kingdom (4.7 to 2.4). But in Australia, inflation increased from 2 percent to 3 percent.

[21] Peter Tulip and his colleagues in the research department of the Reserve Bank of Australia pressed me on the last two of these reasons for caution.

As noted earlier, Australia is different from the other four countries in the manner of its adoption of inflation targeting because of the political environment in which the Reserve Bank was operating. If we date the start two years earlier (1991), when the Reserve Bank was already pursuing in inflation-targeting-like policy, we would find that in Australia too, the inflation rate had not fallen before *de facto* targeting began. The country's average inflation rate in 1989 – 1991 was 6.0 percent, and in 1992 – 1994, it was 1.6 percent. During those years, a global recession lowered the inflation rate in the control countries from 4.1 percent in 1989 – 1991 to 3.4 percent in 1992 – 1994. So with unannounced inflation targeting, the Reserve Bank beat the controls by 3.7 percentage points (down 4.4 compared to 0.7). In the light of the outcomes of the other four targeting experiences, it is a reasonable bet that much of Australia's lower inflation resulted from the Reserve Bank's surreptitious inflation targeting.

A further check on the direction of causation is provided by indirect evidence on changes in long-term inflation expectations. Did a fall in the expected inflation rate precede the adoption of inflation targeting, and was this fact rather than targeting itself, the source of the lower inflation rate?

The behavior of long-term interest rates answers this question. **Figure 8** shows the government bond yields in the inflation targeting economies, again with each country aligned on the same *x*-axis date of the start of targeting. Nominal interest rates fell by an average of 2.2 percentage-points, which is a fall similar to that of the inflation rate. A fall in nominal interest rates of this magnitude suggests that medium to long-term inflation expectations also fell. It is clear that inflation expectations fell *after* targeting began: not before.

The credibility of reverse causation is further weakened by the timing of the "before" and "after" date breaks adopted in the calculations, the break being one year after the adoption of targeting.

The behavior of inflation rates and nominal interest rates immediately before and after the adoption of inflation targeting, and taking due account of Australia's exceptional transition to targeting, suggest that the significant changes in macroeconomic performance found in the data are not capable of a reverse causation interpretation.

Is There a Common Influence that Invalidates the "Natural Experiment"?

Is there a common influence that makes the institutional changes proposed as independent natural experiments a single event? If there were such an influence, we would have a sample with one data point and no degrees of freedom.

The leading candidate common influence is ideas about monetary policy, which changed dramatically during the 1970s. The Keynesian view of the world lost popularity and the idea of a permanent output (or unemployment) and inflation tradeoff was replaced by the natural rate

hypotheses. Adaptive expectations were replaced by rational expectations. The seminal work of Kydland and Prescott (1977) demonstrated the general superiority of rules versus discretion. The Taylor Rule[22] viewed both as prescription and description revolutionized central banker's ideas about how to conduct monetary policy. There can be little doubt that the fall in inflation rates during the Great Moderation owes much to this intellectual revolution and that it was a common influence on all central banks. But does it render the "natural experiments" too interdependent to be a source of valid inferences?

One basic fact says that we can make inferences about the effects of the treatments: Some central banks became more independent and some did not; some adopted inflation targeting and some did not. The fact that central banks display variety in their responses to this common intellectual milieu provides at least one observation for each type of response.

But we can do better. The decisions that led to central banks becoming more independent were clearly not driven exclusively by a single joint influence. The European nations that decided to join the euro did so for a variety of their own self-interested reasons. Some decided to not join. The decisions in Japan, Korea, Sweden and the United Kingdom to strengthen the independence of their central banks were the subject of separate and independent political debates. In the light of this variety of reasons and decision processes, it is entirely reasonable to treat these 8 events as independent random natural experiments.

Inflation targeting is a little different: It had some origins in the intellectual revolution described above and there can be no doubt that its adoption was contagious. But the events were spread over a period of almost four years and they differed in the detailed targets chosen. In the light of the details of how inflation targeting began and its timing, it is reasonable to assume that the events constitute independent natural experiments.

Nonetheless it is worth exploring an alternative view of the adoption of inflation targeting. New Zealand clearly started the process and that action counts as one natural experiment. If we treat the copiers, Canada, Australia, Sweden, and the United Kingdom, as constituting a second experiment, we can look for the effects of inflation targeting based on two independent experiments rather than five.

Table 6 summarizes the effects of inflation targeting viewed as only two independent events: NZ and the copiers. All the previously found significant effects remain. Viewed either as two independent events or as five events, inflation targeting lowers the inflation rate, raises the real GDP growth rate, and lowers the variability of both inflation and real GDP growth.

There is a final alternative interpretation of the data to consider: We've been lucky and cannot count on sustained success with the tools that have worked well for most of the past 20 years.

[22] John Taylor (1979)

Have We Been Lucky?

During most of the past 20 years, even through the Great Recession, most central banks have enjoyed the benefits that arise from inflation expectations anchored at around 2 percent per year. For the central banks in the control group, this inflation rate is only modestly lower than their earlier rate. For the treatment group, a 2 percent inflation rate is substantially lower than their previous rate. What determines inflation expectations and why they have been steady and low for so many years is not well understood. So long as inflation expectations remain anchored, inflation will be tame and monetary policy will make its best contribution to overall macroeconomic performance, even if that performance is not ideal. But if inflation expectations drift away from the current anchor, in either direction, inflation (or deflation) will ensue and the real economy will perform below its potential.

Two features of current monetary policy arrangements lend support to the worrying idea that expected inflation will break loose of its anchor, regardless of the institutional arrangements.

First, inflation targeting is beyond the reach of current forecasting capabilities. It is widely accepted that monetary policy operates with a long and variable time lag, and the consensus is that it takes about two years for a policy action to influence the inflation rate. But we have no reasonable chance of knowing what influences will be operating on the inflation rate two years hence when today's monetary policy decisions are having their effects. Further, we don't know with any precision the effect of an *x*-basis point change in the interest rate on the inflation rate.

Forecasting uncertainty is recognized by central bankers and two of them, the Bank of England and the Sveriges Riksbank (Bank of Sweden) graphically illustrate it in their inflation reports with the help of the 'fan chart', a projection of inflation and real GDP over the next two years with a probability distribution around the mean that widens as the projection becomes more distant. The Bank of England's fan chart for March 2013 has an initial actual inflation rate of 2.5 percent tracking to 2 percent by 2016 with a distribution fanning out to a range of 4.5 percent to – 0.5 percent by mid-2014. The Riksbank has a projection starting from a zero inflation rate at the beginning of 2013 to 2.5 percent by 2015 but with range of zero to 5 percent.

These forecasts rely on anchored inflation expectations with no chance that they will become unanchored, even if the inflation rate reaches one of the extremes of the fan. In other words, the fan charts show massive uncertainty about future inflation even assuming a well-anchored inflation expectation. There can be no reasonable assurance that this assumption will be correct. Luck is a necessary ingredient.

Second, there is a great deal of uncertainty about future monetary policy. This uncertainty works two ways on inflation expectations. With a wide, possibly uniform, Bayesian prior, there is no reason for inflation expectations to change. Uniform uncertainty is an anchor. But it is a high-risk anchor. If some event occurs that increases the probability of a rise in inflation, that

event would trigger a shift in inflation expectations and bring an immediate and potentially large departure of inflation from its anchor.

VICONCLUSIONS

The conclusions that emerge from the experiment of more independence agree with earlier findings on the effects of central bank independence. Lower inflation and lower inflation variability with no change in output variability are what earlier cross-country studies have shown.

The conclusions from the flexible inflation targeting experiment suggest that this institutional arrangement is even more effective than central bank independence. Flexible inflation targeting, credibly and transparently pursued, can apparently do a very good job of keeping inflation low, volatility low, and real growth high. As practiced in Australia, Canada, Sweden, and the United Kingdom, this approach to monetary policy has been extremely successful. It perhaps can be refined and improved upon, but not by placing a misguided emphasis on the wrong dual mandate. Flexible inflation targeting is the best currently known dual mandate policy. It is today's "gold standard".

TABLES

Table 1 Events that Changed Central Banking Arrangements

Date	Event
December 20, 1989	Reserve Bank of New Zealand becomes more independent and begins inflation targeting
February 26, 1991	Bank of Canada begins inflation targeting
September 1, 1992	Bank of England begins inflation targeting
January 1, 1993	Bank of Sweden begins inflation targeting
March 31, 1993	Reserve Bank of Australia begins inflation targeting
June 18, 1997	Bank of Japan becomes more independent
December 27, 1997	Bank of Korea becomes more independent
June 1, 1998	Bank of England becomes more independent
January 1, 1999	European Central Bank assumes full powers and issues euro
September 11, 1999	Bank of Sweden becomes more independent
January 1, 2001	Greece joins the Eurozone

Table 2 Treatment Groups and Control Group

More Independent		Inflation Targeter		More Independent Inflation Targeter		Control
Japan	1997	Canada	1991	New Zealand	1990	Austria
Korea	1998	United Kingdom	1993–1998	United Kingdom	1999	Belgium
Finland	1999	Sweden	1993 – 1999	Sweden	2000	Denmark
France	1999	Australia	1993			Germany
Ireland	1999					Hong Kong
Italy	1999					Luxembourg
Portugal	1999					Netherlands
Spain	1999					Norway
Greece	2001					Singapore
						Switzerland
						Taiwan
						United States

Table 3 Before and After: Absolute Changes[23]

	Inflation		Real GDP growth		Output gap	Unemployment
	Mean	Standard Deviation	Mean	Standard Deviation	Standard Deviation	Mean
More independent						
Before	**7.05**	**5.34**	3.35	2.48	2.52	8.94
After	**2.18**	**1.06**	1.61	2.74	2.33	7.87
Change	**-4.87**	**-4.27**	-1.74	0.25	-0.20	-1.06
Standard error	**1.25**	**0.71**	1.76	0.48	0.37	1.84
t-statistic	**3.90**	**5.99**	0.99	0.52	0.54	0.58
Inflation targeters						
Before	**6.56**	**3.62**	**2.38**	**2.31**	**2.01**	7.76
After	**1.86**	**0.87**	**3.26**	**1.07**	**1.16**	7.39
Change	**-4.70**	**-2.75**	**0.88**	**-1.24**	**-0.85**	-0.38
Standard error	**0.53**	**0.24**	**0.31**	**0.35**	**0.38**	1.47
t-statistic	**8.78**	**11.30**	**2.84**	**3.55**	**2.28**	0.26
More independent inflation targeters						
Before	**6.99**	**4.56**	2.17	2.03	1.78	6.52
After	**2.05**	**1.12**	2.29	2.50	2.17	6.30
Change	**-4.95**	**-3.44**	0.12	0.47	0.39	-0.22
Standard error	**1.83**	**0.42**	0.06	0.33	0.34	1.23
t-statistic	**2.70**	**8.22**	1.91	1.43	1.13	-0.18
Controls (average all)						
Before	**4.08**	**2.94**	3.76	2.26	2.73	5.04
After	**1.85**	**1.22**	2.69	2.39	1.85	5.42
Change	**-2.23**	**-1.72**	-1.07	0.13	-0.88	0.39
Standard error	**0.44**	**0.38**	0.75	0.39	0.66	1.13
t-statistic	**5.09**	**4.48**	1.43	0.35	1.33	0.34

[23] **Bold faced** entries in the table indicate significant at the 95 percent level on a one-tail test

Table 4 Treatments Relative to Controls[24]

	Inflation		Real GDP growth		Output gap	Unemployment
	Mean	Standard Deviation	Mean	Standard Deviation	Standard Deviation	Mean
More independent						
Change for more independent	**-4.87**	**-4.27**	-1.74	0.25	-0.20	-1.06
Change for control MI	**-1.87**	**-1.67**	-1.87	0.37	-0.76	1.14
Difference	**-3.00**	**-2.60**	0.13	-0.12	0.57	-2.21
Standard error	**1.05**	**0.72**	0.13	0.45	0.64	1.54
t-statistic	**2.86**	**3.60**	0.99	0.26	0.89	1.43
Inflation targeters						
Change for inflation targeters	**-4.70**	**-2.75**	**0.88**	**-1.24**	-0.85	-0.38
Change for control IT	**-2.70**	**-1.81**	**-0.65**	**-0.21**	-1.18	2.19
Difference	**-1.99**	**-0.94**	**1.53**	**-1.03**	0.32	-2.57
Standard error	**0.77**	**0.53**	**0.54**	**0.35**	0.73	5.95
t-statistic	**2.60**	**1.78**	**2.84**	**2.97**	0.44	0.43
More independent inflation targeters						
Change for more independent inflation targeters	-4.95	**-3.44**	**0.12**	0.47	***0.39***	-0.22
Change for control MI IT	-2.11	**-1.69**	**-2.11**	0.23	***-0.70***	1.64
Difference	-2.83	**-1.74**	2.23	0.23	***1.09***	-1.86
Standard error	1.78	**0.52**	1.17	0.43	***0.46***	3.88
t-statistic	1.59	**3.32**	1.91	0.55	***2.37***	0.48

[24] **Bold faced** entries in Tables 4, 5, and 6 indicate that the means are significant different at the 95 percent level on a one-tail test. ***Italic bold*** indicates significant but adverse effect.

Table 5 Alternative Treatments Compared

	Inflation		Real GDP growth		Output gap	Unemployment
	Mean	Standard Deviation	Mean	Standard Deviation	Standard Deviation	Mean
Does MIIT improve on MI?						
Change for more independent inflation targeter	-4.95	-3.44	**0.12**	0.47	0.39	-0.22
Change for more independent (control)	-4.87	-4.27	**-1.74**	0.25	-0.20	-1.06
Difference	-0.08	0.84	**1.86**	0.21	0.58	0.84
Standard error	1.97	0.79	**0.74**	0.58	0.42	1.74
t-statistic	0.04	1.06	**2.52**	0.37	1.37	0.48
Does MIIT improve on IT?						
Change for more independent inflation targeter	-4.95	-3.44	0.12	**0.47**	**0.39**	-0.22
Change for inflation targeters (control)	-4.70	-2.75	0.88	**-1.24**	**-0.85**	-0.38
Difference	-0.25	-0.69	-0.76	**1.71**	**1.24**	0.15
Standard error	1.86	0.51	0.75	**0.51**	**0.29**	2.18
t-statistic	0.13	1.36	1.02	**3.32**	**4.24**	0.07
Does MI improve on IT?						
Change for more independent	-4.87	**-4.27**	**-1.74**	**0.25**	-0.20	-1.06
Change for inflation targeters (control)	-4.70	**-2.75**	**0.88**	**-1.24**	-0.85	-0.38
Difference	-0.17	**-1.53**	**-2.62**	**1.49**	0.66	-0.69
Standard error	1.16	**0.72**	**0.46**	**0.52**	0.48	-1.89
t-statistic	0.15	**2.12**	**5.70**	**2.85**	1.36	0.36

Table 6 Inflation Targeting as Two Events

	Inflation		Real GDP growth	
	Mean	Standard Deviation	Mean	Standard Deviation
Change for inflation targeters	**-6.52**	**-3.49**	**1.09**	**-0.65**
Change for control IT	**-2.41**	**-1.75**	**-0.93**	**0.01**
Difference	**-4.11**	**-1.74**	**2.02**	**-0.66**
Standard error	**1.15**	**0.95**	**0.73**	**0.31**
t-statistic	**3.58**	**1.83**	**2.77**	**2.11**

FIGURES

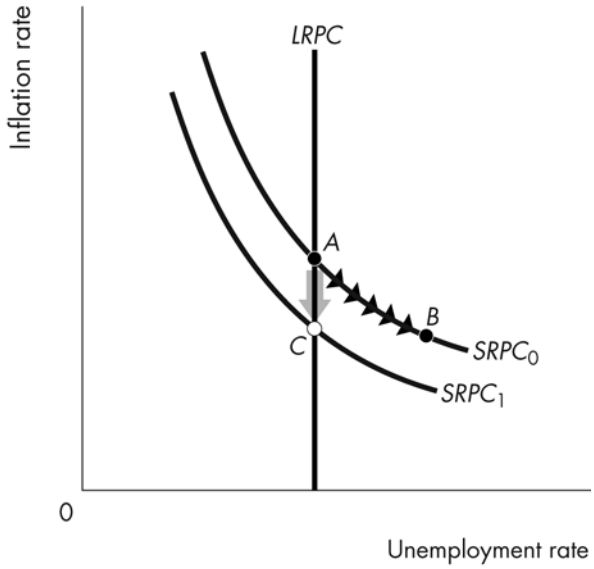

Figure 1 Possible Short-Run Effects of Central Bank Independence and Inflation Targeting

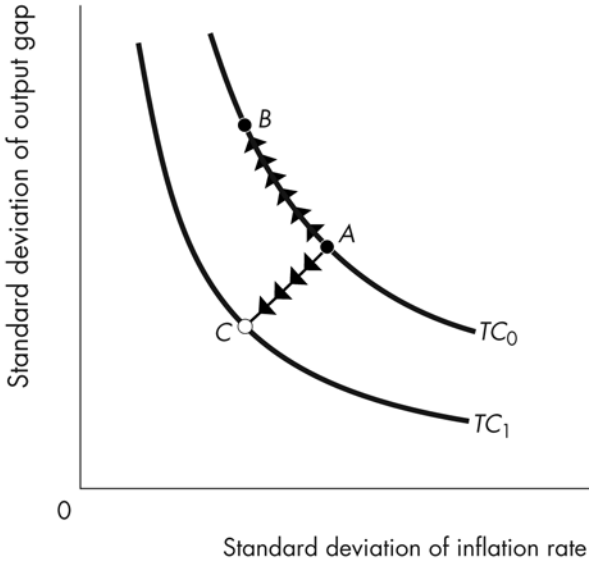

Figure 2 Possible Long-Run Effects of Central Bank Independence and Inflation Targeting

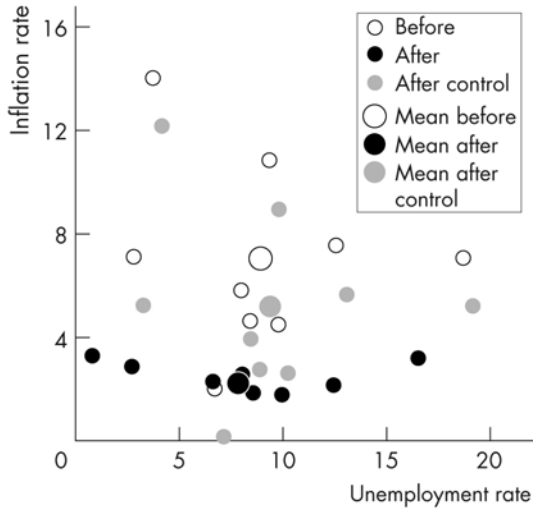

Figure 3(a) Outcomes in Phillips Curve Space for More Independent

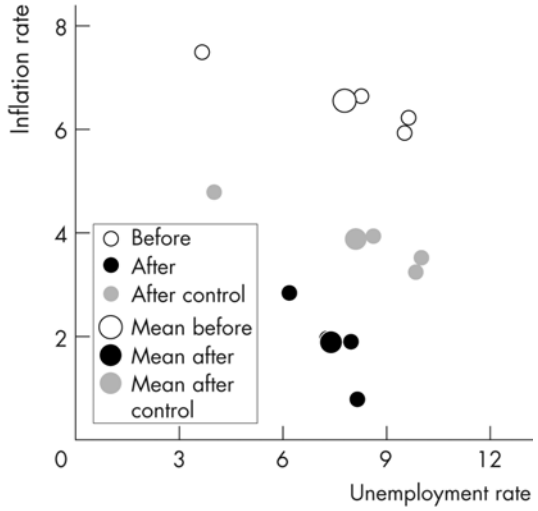

Figure 3(b) Outcomes in Phillips Curve Space for Inflation Targeters

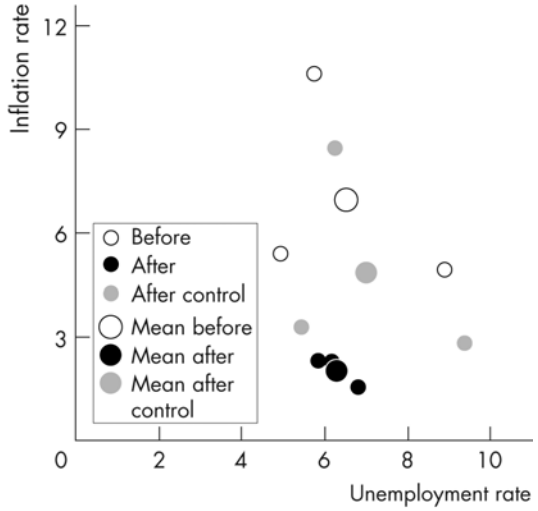

Figure 3(c) Outcomes in Phillips Curve Space for More Independent Targeters

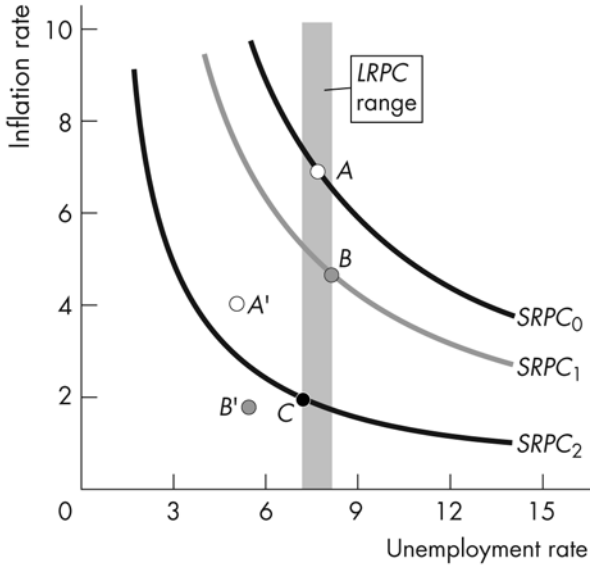

Figure 4 Interpreting the Short-Run Effects of Central Bank Independence and Inflation Targeting

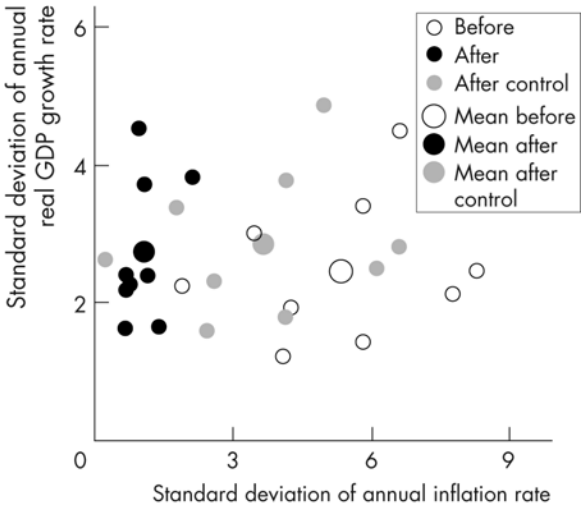

Figure 5(a) Outcomes in Taylor Curve Space for More Independent

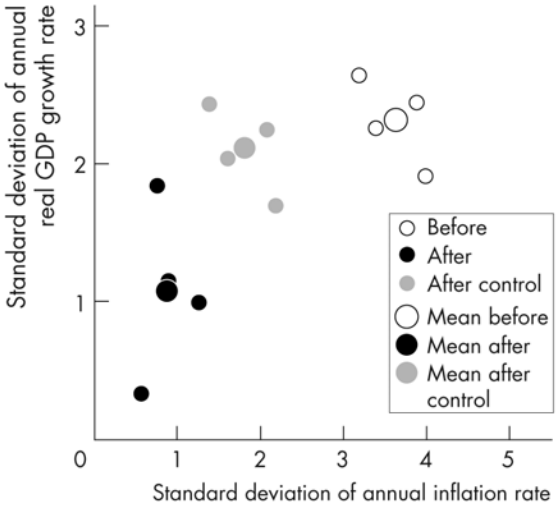

Figure 5(b) Outcomes in Taylor Curve Space for Inflation Targeters

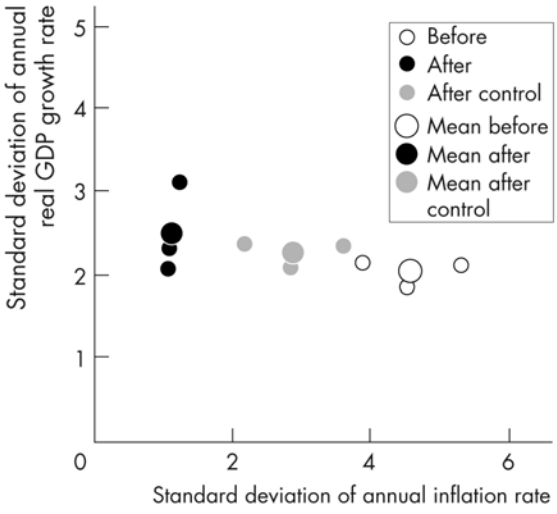

Figure 5(c) Outcomes in Taylor Curve Space for More Independent Targeters

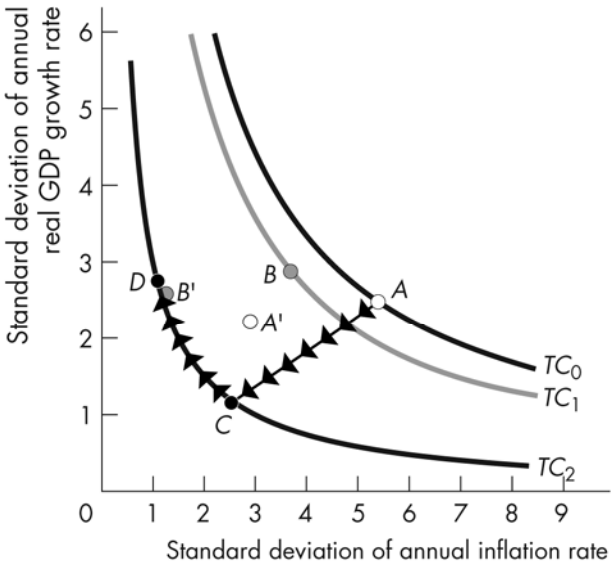

Figure 6(a) Interpreting outcomes in Taylor Curve Space for More Independent

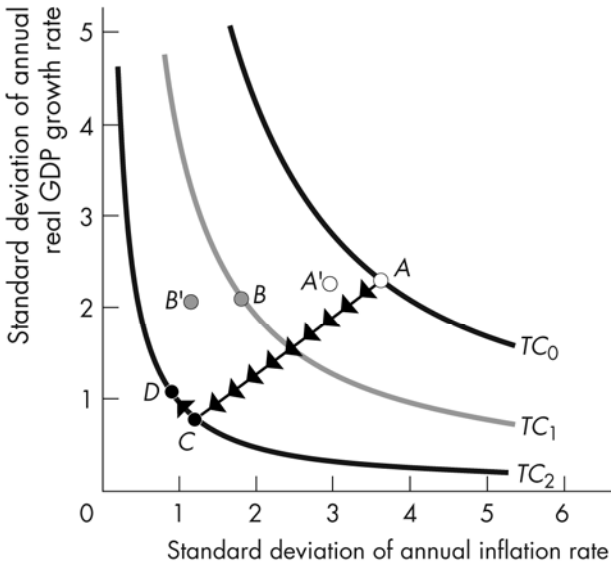

Figure 6(b) Interpreting outcomes in Taylor Curve Space for Inflation Targeters

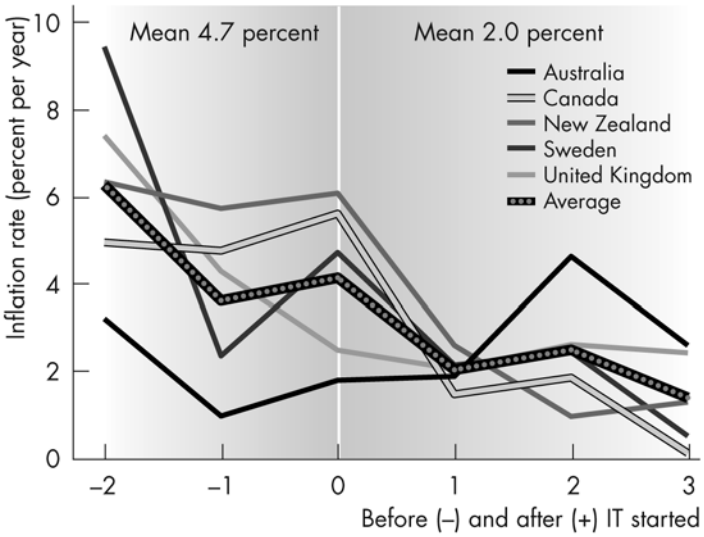

Figure 7 Inflation Rates Before and After

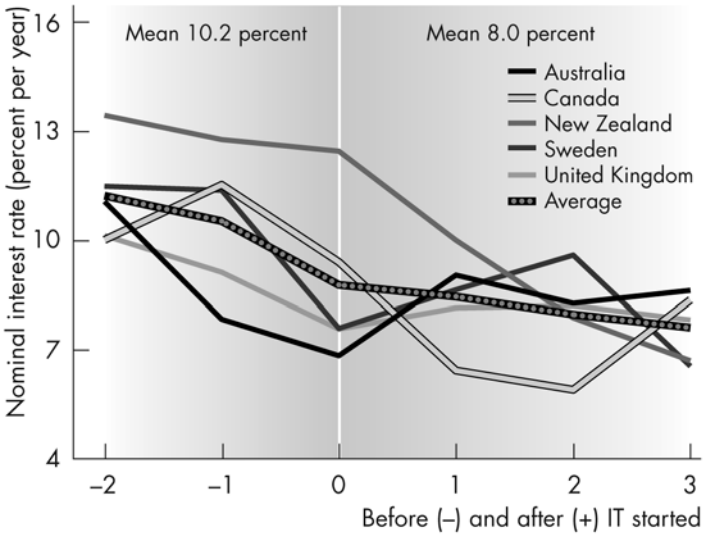

Figure 8 Interest Rates Before and After

APPENDIX

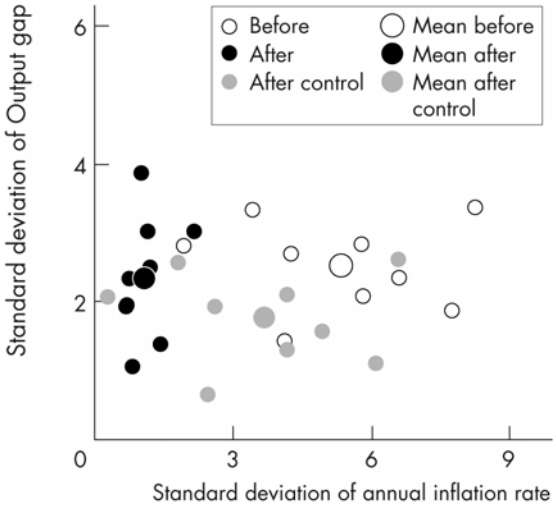

Figure A1(a) Outcomes in Taylor Curve Space for More Independent

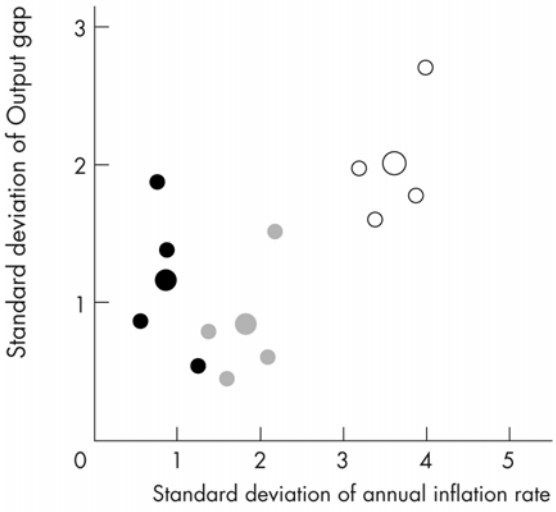

Figure A1(b) Outcomes in Taylor Curve Space for Inflation Targeters

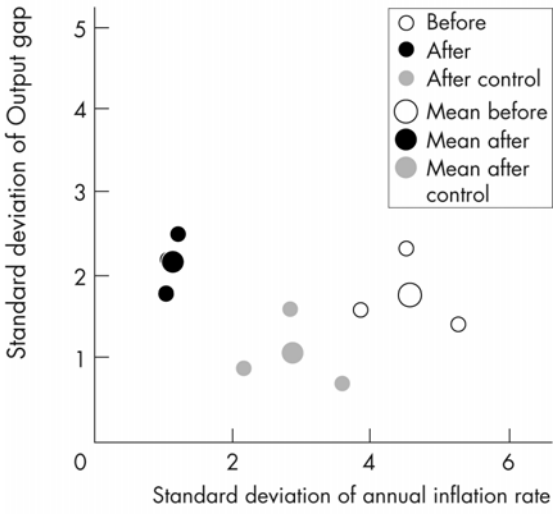

Figure A1(c) Outcomes in Taylor Curve Space for More Independent Targeters

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