Understanding the disinflations in Australia, Canada and New Zealand using evidence from smooth transition analysis

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Abstract

This paper investigates the disinflation experiences of three countries, Australia, Canada and New Zealand. Unlike previous approaches which have sought to use institutional data to pre-determine the causes, speed and duration of the transitions to low inflation regimes this paper allows price data itself to determine the speed and timing of the reforms using smooth transition analysis. The results show that the process of transition is related to two factors: central bank independence and the general slowdown in economic activity which occurred during the early 1990s in all OECD countries. Other reforms to the labor market and fiscal policy were less influential. © 1999 Elsevier Science Ltd. All rights reserved.

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1. Introduction

The 1990s have seen a major shift of emphasis in the objectives and operation of macroeconomic policy in industrialized countries. For many countries, the move towards quantified inflation targets set by governments and tracked by newly independent central banks has marked a distinct regime change from an era of more discretionary policy aimed broadly at full employment. The adoption of inflation
targets and the role of central bank independence in achieving them has received a considerable amount of attention in the literature, yet often the monetary policy reforms have been accompanied by other changes in fiscal policy, labor markets and general economic conditions.\(^2\) While the vast majority of the empirical papers consider the direct link between inflation targets, central bank independence and inflation performance fewer consider the impact of other simultaneous reforms.\(^3\) In this paper we introduce a method of endogenously determining the timing and duration of the transition process in price series before matching the results to the institutional changes to central banks, labor markets, fiscal policy and general economic conditions. In so doing we can remain objective about the precipitating causes of the transition, since we do not have to specify in advance exactly which reforms influenced the trend path of prices or how they may have done so.\(^4\) In previous work other authors have used prior institutional knowledge to suggest the likely speed and duration of reforms, which is then tested against the data itself by allowing the disinflation process to alter during the period of the reforms. There are evident pitfalls that exist when specifying the transition a priori from institutional data, however, since the methodology requires that the process is correctly identified and that the timing of its impact is known.

The smooth transitions analysis, due to Leybourne et al. (1997), endogenously determines the transition length and speed, which can then be matched up to timing of reforms. Thus, the heart of our approach is to endogenously pre-determine the timing and duration of the transition in prices and then to compare this with the timing of reforms.\(^5\) The smooth transition analysis provides information on the actual speed and duration of the transition between regimes, which is only obtainable directly from the price data itself. Only after the transition path has been determined is the institutional data consulted. This enables us to make an objective assessment of the timing and impact of various reforms on the transition process. If the reforms have been successful in reducing inflation the results should be evident in the coincident timing of the reforms and the transition in the trend of price indices for these countries.

The paper proceeds as follows, Section 2 explains the institutional reforms of central banks in Canada, Australia and New Zealand that offer three examples of significant macroeconomic policy reforms with respect to the control of inflation.

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\(^2\) Examples of papers in the literature that have dealt with central bank independence and inflation performance include Cukierman (1992), McCallum (1995a,b), Lohmann (1992), Waller and Walsh (1996) and Walsh (1995a,b).

\(^3\) A notable exception is Bleaney (1996) who makes this the main focus of his paper. He seeks to explain inflation performance in 17 OECD countries over two sample periods using indices of central bank independence and centralization of wage bargaining.

\(^4\) The countries concerned have targeted inflation but the effects of the change in regime, amounting to a disinflation, should be apparent in the trend path of the relevant price series. Even if there is base drift the effects of the reforms, when successful, will be apparent in a change in trend to prices.

\(^5\) We do not attempt to use regression analysis, based on an arbitrary assessment of the timing and impact of reforms using dummy variables, to explain the disinflation process. Rather we turn the process on its head and establish the transition period and compare this to the timing of institutional reforms.
Section 3 then explains the smooth transition analysis methodology. Section 4 discusses the likely causes of disinflation based on the speed and duration of transition in the trend of the price series. Section 5 concludes.

2. Policy reforms

In this section we discuss the policy reforms that took place in Australia, Canada and New Zealand. The main focus of attention is on the adoption of inflation targets and central bank independence, but we also give attention to other reforms in fiscal policy, labor markets as well as the general downturn in economic activity over the period.

During the sample period there have been two regimes in Australia, Canada and New Zealand and a period of transition between them. The first regime was characterized by discretionary monetary policy directed towards a range of policy targets, while the second has directed attention to the particular objective of inflation targeting. It has been the policy of the governments of Australia, Canada and New Zealand, to create an environment in which the central bank, and specifically the Governor, is accountable for inflation performance. To do so it has agreed targets for inflation set by a consultative process between the Finance Minister and the Governor of the central bank and allowed the central bank varying degrees of independence to achieve it, with penalty clauses for failure to do so.

In New Zealand the original Reserve Bank Act of 1964, which directed monetary policy to address price stability as one of a number of other potentially conflicting objectives, was replaced by the Reserve Bank Act of 1989, making price stability the sole objective. The reform aimed to create an accountable, independent central bank and was initially announced in the Budget statement of 1988. The Act specified three important changes that made the central bank more independent. First, monetary policy should be formulated and implemented to achieve “stability in the general level of prices”. Second, the government should fix policy targets for monetary policy in agreement with the Governor. The responsibility for meeting the targets would be held by the Governor who could be dismissed for failing to meet the agreed targets. Changes to these agreed targets could only be made by agreement between the government and the Governor and would have to be reported in the Gazette of the House of Representatives. Third, the Reserve Bank should be independent of political influence. The Act ruled out the participation of members or servants of the government on the Board of the Bank, both directly, through monetary policy making, and indirectly, through choice of the Governor or other Board members.

The Governor agreed to a timetable for deflation that set targets for inflation, giving a specific timetable for the reduction of inflation levels. These Policy Target Agreements (PTAs) were defined using the headline consumer price index and allowed deviations only for supply-side shocks such as terms of trade shocks, indirect tax changes, and changes in prices due to natural disasters.6 The Reserve Bank has

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6 There have been three PTAs, the first in March 1990 set a target of 0–2% to be achieved by the end of 1992, with a transition path of 3–5% for the period from February 1990–December 1990. 1.5–
more recently focused on the underlying CPI inflation rate which excludes volatile items and interest components in the headline CPI. The contract is enforced by the Minister of Finance who requires the Governor to publish six monthly reports on performance and strategy, making renewal of tenure conditional on achievement of the inflation targets.\textsuperscript{7}

In Canada, following the appointment of John Crow in 1987, the objective of monetary policy became more focused on inflation control, although no specific legislative changes resulted. In his first public speech as Governor, and in subsequent addresses, Crow stated that “stable prices” was the aim of monetary policy. These announcements signaled a change of regime from a discretionary policy with multiple objectives to a monetary policy aimed specifically at hitting an inflation target. In February 1991, these objectives were specified in the form of published CPI inflation targets of 3\% by the end of 1992, 2.5\% by mid 1994, 2\% by the end of 1995, with a margin of \pm 1\%. The transition paths for headline inflation were 2–4\% until December 1992, 1.5–3.5\% until mid 1994 and 1–3\% to the end of 1998. These were used as guides to monetary policy but in practice policy decisions were based on underlying CPI rather than headline CPI. The Bank of Canada may not have the same kind of legislative backing of the Reserve Bank of New Zealand but it had a clearly articulated policy of inflation targeting.

In Australia the objective of the Reserve Bank of Australia has been to “. . . best contribute to the stability of the currency of Australia; the maintenance of full employment in Australia; and the economic prosperity and welfare of the people of Australia” (defined by the Reserve Bank Act, 1959). Under this legislation, monetary policy decisions and appointments of the Governor and the Board involved significant government input. In 1993 the Australian Reserve Bank adopted a mandate that was more focused on price stability with an immediate horizon. The target was adopted unilaterally by the RBA but was subsequently endorsed by the government and has since received all-party support. The inflation target is informal, and is referred to as a “thick point”, rather than a range or target band, of 2–3\% for underlying inflation over the course of the cycle, which has been “equat[ed] with reasonable price stability” Fraser (1994). It involves no specified transition path, unlike the cases of Canada and New Zealand. If this change of policy has been influential on the price setting process, we would expect to find that inflation has been lower after 1993, and this should appear as a detectable pattern of transition in the CPI series. Assessing the change in policy in 1995, Debelle and Stevens (1995) wrote “It is fair to say that ‘2–3’ has come to occupy a position of prominence in the thinking of many informed observers . . . when they are observing monetary policy. Many market


\textsuperscript{7 In two recent cases where the inflation rate overshot the target the Minister did indeed demand Non-Executive Directors of the RBNZ to report on the Governor’s conduct.}
analysts, for example, interpret economic data in the light of a perceived Reserve
Bank ‘comfort zone’ for inflation” (p. 5).

Central bank independence has coincided with many other reforms that could also
have potentially contributed to lower sustainable levels of inflation in the three coun-
tries we study. In the labor market wage pressure has fallen with reforms, while
changes to fiscal policy have reduced deficits and in some cases producing budget
surpluses. In general the level of national output has fallen below full capacity in
the downswing of the business cycle over the range of the transition period for all
three countries. All of these factors could have had a part to play in the reduction
in the trend growth in the CPI series.

Labor market reforms in all three countries have been credited with improving
the disinflationary environment. In Canada following years of low productivity and
high structural unemployment, the government reduced generous unemployment
insurance payments and introduced other supply-side policies to reduce wage pres-
sure and reform the labor market. In New Zealand, the reform of collective bargaining
arrangements and union powers in the Employment Contracts Act has considerably
diminished inflationary stimuli, creating the most deregulated labor market in the
OECD. Australia has recently introduced some reforms, although its labor market
is still subject to a high degree of collective bargaining by comparison with other
OECD countries.

The fiscal stance of all three countries has also been modified considerably. Targets
for budget deficits and a commitment to a balanced budget in Canada have reduced
deficits from approximately 5% of GDP in the early 1990s to modest surpluses of
0.5% in 1996/97. High debt positions have been reversed as surpluses have been
used to payoff government obligations and in 1997 the debt to GDP ratio fell for
the first time. New Zealand experienced a similar fiscal improvement since it has
achieved a balanced budget in 1994 and a surplus of 3.5% of GDP in 1995/96 despite
the fact that the structural deficit peaked at 7.5% in 1990. Through a radical program
of social benefit cuts, government expenditure caps and structural reforms through
the Fiscal Responsibility Act and the Public Finance Act, New Zealand has reversed
its public sector finance problem. The Australian case shows a similar attempt to
control the budget by ambitious reform. Since 1993 a four year plan to cap the deficit
at A$6bn (1.1% GDP) has delivered a surprise surplus in 1995/6 and a commitment
to a balanced budget for 1997/8.

The strength of labor market reforms and the pattern of fiscal reform are undoubt-
edly influenced by the business cycle. The annual percentage change in real GDP
for each of the countries was below the 1978–87 period average for the years 1989–
93 (Canada), 1990–93 (Australia), and 1989–92 (New Zealand). New Zealand
experienced a very prolonged recession during this period and Australia had its worst
economic performance since the Great Depression. In Canada it took five years to
recover the level of GDP as a result of the general downturn in economic conditions.

8 All data is taken from World Economic Outlook, IMF October 1996.
This accords with the more general experience in the wider OECD group where output also fell quite dramatically.

3. Smooth transitions models

The use of smooth transition models as a means of representing deterministic structural change in a time series model was originally suggested by Bacon and Watts (1971) and, more recently, has been reconsidered by Lin and Terasvirta (1994) and Granger and Terasvirta (1993), Ch. 7. Rather than attempting to model any structural change in trend as an instantaneous trend break (as is common in empirical work), these models permit the possibility of a smooth transition between two different trend paths over time. In the context of economic time series this has considerable intuitive appeal. Generally, changes in economic aggregates are influenced by the changes in behavior of a very large number of agents. It is highly unlikely that all individual agents will react simultaneously to a given economic stimulus; while some may be able to (and want to) react instantaneously, others will be prone to different degrees of institutional inertia (dependent, for instance, on the efficiency of the markets in which they have to operate) and so will adjust with different time lags. Thus, when considering aggregate behavior, the time path of structural changes in economic series is likely to be better captured by a model whose deterministic component permits gradual rather than instantaneous adjustment.

Here, we consider the following logistic smooth transition regression model for a time series $y_t$:

$$y_t = \alpha_1 + \beta_1 t + \alpha_2 S_t(\gamma, \tau) + \beta_2 S_t(\gamma, \tau) + v_t, \quad (7)$$

where $v_t$ is a zero mean stationary $I(0)$ process and $S_t$ is the logistic smooth transition function, based on a sample of size $T$,

$$S_t(\gamma, \tau) = (1 + \exp(-\gamma(t - \tau T)))^{-1}, \gamma > 0. \quad (8)$$

This function controls the transition between trend paths. The parameter $\tau$ determines the timing of the transition midpoint since, for $\gamma > 0$, we have $S_{-\infty} = 0$, $S_{+\infty} = 1$ and $S_{T/2} = 0.5$. The speed of transition is then determined by $\gamma$. For small values of $\gamma$, $S_t$ traverses the interval $(0,1)$ very slowly; in the limiting case $\gamma = 0$ then $S_t = 0.5$ for all $t$. Alternately, for large $\gamma$, $S_t$ traverses this interval very rapidly, and as $\gamma$ approaches $\infty$ the function changes value from 0 to 1 instantaneously at time $t = \tau T$. Thus, if we assume that $v_t$ in Eq. (7) is stationary, $y_t$ is stationary around a trend function which changes from an initial value $\alpha_1 + \beta_1 t$ to final value $(\alpha_1 + \alpha_2) + (\beta_1 + \beta_2) t$ (if we allow $\gamma < 0$ then the initial and final model states are reversed but the interpretation of the parameters remains the same).

The function $S_t$ does impose certain restrictions on the transition path, in that it is monotonic and symmetric around the midpoint. Also, it constrains the transitions in intercept and slope to occur once only, simultaneously, and with the same speed. However, in the interests of parsimony we consider the current specification as being
quite reasonable. Moreover, it embeds the two standard paradigms of no change and instantaneous structural change as limiting cases.

Stationarity around a smooth transition in linear trend is an attractive and intuitively plausible specification for many economic time series. However, nonstationary autoregressive unit root \( I(1) \) models have also been found to represent well the evolution of these series. Graphical inspection of a series generated by an \( I(1) \) process (such as a random walk) will often spuriously suggest the possibility of a smooth transition in trend around an \( I(0) \) process and vice versa. It is therefore important to test between these specifications. Leybourne et al. (1997) consider the following hypotheses:

**Null hypothesis**: \( y_t = \mu_t, \mu_t = \kappa + \mu_{t-1} + \varepsilon_t, \mu_0 = \psi \);

**Alternative hypothesis**: Eqs. (7) and (8);

where \( \varepsilon_t \) and \( v_t \) are assumed to be stationary (zero mean) processes. They suggest a test statistic calculated via a two-step procedure:

**Step 1.** Using a nonlinear least squares (NLS) algorithm, estimate the deterministic component of Eqs. (7) and (8) and compute the NLS residuals

\[
\hat{v}_t = y_t - \hat{\alpha}_1 - \hat{\beta}_1 t - \hat{\alpha}_2 S_t(\hat{\gamma}, \hat{\xi}) - \hat{\beta}_2 t S_t(\hat{\gamma}, \hat{\xi}).
\]

**Step 2.** Compute the augmented Dickey–Fuller (ADF) statistic, the \( t \)-ratio associated with \( \hat{\rho} \) in the ordinary least squares (OLS) regression

\[
\Delta \hat{v}_t = \hat{\rho} \hat{v}_{t-1} + \sum_{i=1}^{k} \hat{\delta}_i \Delta \hat{v}_{t-i} + \hat{\eta}_t,
\]

where the lagged difference terms are included to account for any stationary dynamics in \( \varepsilon_t \). This ADF statistic is denoted \( s_{\alpha \beta} \).

Since Eq. (7) is linear in the parameters \( \alpha_1, \beta_1, \alpha_2 \) and \( \beta_2 \), Leybourne et al. (1997) show that it is possible to obtain substantial economy in the NLS estimation. The NLS sum of squares function can be “concentrated” with respect to \( \alpha_1, \beta_1, \alpha_2 \) and \( \beta_2 \) as

\[
SS = \sum_{t=1}^{T} (y_t - \hat{\alpha} x_t)^2,
\]

where

\[
\hat{\alpha} = \left( \hat{\alpha}_1, \hat{\beta}_1, \hat{\alpha}_2, \hat{\beta}_2 \right)' = \left( \sum_{t=1}^{T} x_t x'_t \right)^{-1} \sum_{t=1}^{T} x_t y_t,
\]

and

\[
x_t = x_t(\hat{\gamma}, \hat{\xi}) = \{1, t, S_t(\hat{\gamma}, \hat{\xi}), t S_t(\hat{\gamma}, \hat{\xi}) \}'.
\]

Hence, the NLS estimation problem reduces to minimizing the sum of squares func-
tion with respect to just the two parameters \( \hat{\gamma} \) and \( \hat{\tau} \). Also, this partial linearity ensures that \( s_{0\beta} \) is invariant to the starting value \( \mu_0 = \psi \) and drift term \( \kappa \).

Leybourne et al. (1997) provide null critical values for \( s_{0\beta} \), calculated using Monte Carlo simulation methods. In common with standard ADF tests, in small samples the critical values of \( s_{0\beta} \) depend not only on the sample size, \( T \), but also the number of lagged difference terms in the ADF regression, \( k \).

4. Results

The results reported in this section are calculated for Australian, Canadian and New Zealand data on headline and underlying consumer price indices (CPI). There are six series, taken from Datastream, which cover the CPI including all items for all three countries, the Treasury underlying CPI for Australia and New Zealand, and the CPI excluding food and energy prices for Canada. Where a distinction needs to be drawn these will be referred to as CPI (all items) and CPI (underlying) in the rest of the paper. We restrict our sample to 1987:1–1996:4 to avoid including data which may potentially record transitions in the CPI series associated with other economic events such as changes to exchange rate regimes and large aggregate supply shocks such as the oil price increases.\(^9\) All the series are converted to natural logarithms. The series are shown as the solid lines in Figs. 1–6.

![Fig. 1. Australia: CPI (all items) \((y_t)\) and fitted smooth transition.](image-url)

\(^9\) The data for the New Zealand underlying CPI series exists only from 1988:1.
Fig. 2. Canada: CPI (all items) ($y_t$).

Fig. 3. New Zealand: CPI (all items) ($y_t$) and fitted smooth transition.
Fig. 4. Australia: CPI (underlying) \( (y_t) \) and fitted smooth transition.

Fig. 5. Canada: CPI (underlying) \( (y_t) \) and fitted smooth transition.
The time series properties of the six CPI measures are investigated firstly using a standard ADF unit root test to detect whether the series is $I(1)$ against the alternative of stationarity around a fixed trend. This is calculated as the $t$-ratio on $\hat{\rho}$ in OLS regression

$$
\Delta \hat{y}_t = \hat{\alpha} + \hat{\beta} t + \hat{\rho} \hat{y}_{t-1} + \sum_{i=1}^{p} \hat{\delta} \Delta \hat{y}_{t-i} + \hat{\nu}_t
$$

and is denoted $t_{ADF}$. Also, we use the smooth transition test $s_{ADF}$ outlined in the previous section in to detect whether the CPI series are $I(1)$ or, alternatively, are stationary around a trend function undergoing a smooth transition between regimes. For this second test, the NLS estimation step is conducted using the Berndt–Hall–Hall–Hausman optimization algorithm in GAUSS 3.2.

The test results are reported in Table 1. The respective degrees of lag augmentation of the tests, denoted $p$ and $k$, are calculated using a general-to-specific selection procedure starting with a maximum value of 8 and are based on two tailed $t$-tests (performed at the 10% level of the $t$-distribution). Finite sample null critical values for the tests $t_{ADF}$ and $s_{ADF}$ are shown which are corrected for the lag augmentations $p$ and $k$. For $t_{ADF}$ these are obtained from the response surface regressions given in Cheung and Lai (1995) and for $s_{ADF}$ we simulated the null critical values directly.

The standard ADF test $t_{ADF}$ rejects the $I(1)$ null for none of the six series. However, by modifying the ADF test to take into account dynamic deterministics, represented by the smooth transition from a first to a second regime, we find that the test $s_{ADF}$
rejects the \( I(1) \) null for five out of six series. Only the CPI (all items) series for Canada fails to reject this null at the 10% level.

It might be argued that the failure of \( t_{ab} \) to reject \( I(1) \) is simply a consequence of its relatively low power to detect a true alternative of stationarity around fixed deterministics when the sample size is small \((T=36, 40\) here). However, as is shown by simulation in Leybourne et al. (1997), under this alternative, \( t_{ab} \) more frequently rejects \( I(1) \) than does \( s_{ab} \). Thus, if our series were actually generated by this alternative, when \( t_{ab} \) fails to reject, then the same ought to be true of \( s_{ab} \). Leybourne et al. (1997) also show that under a true alternative of stationarity around smooth transition deterministics, whilst \( s_{ab} \) will reject the false \( I(1) \) null frequently, \( t_{ab} \) virtually never rejects \( I(1) \).

Thus, for our data, the rejections of the \( I(1) \) null by \( s_{ab} \), not simultaneously accompanied by rejections by \( t_{ab} \), point quite clearly to these CPI series being better characterized as stationary processes that undergo transitional deterministics rather than stationary processes with fixed deterministic components. Hence, we can, with some confidence, consider that smooth transition deterministics was an important feature in the evolution of five out of the six CPI series. For the five series which reject the \( I(1) \) null in favor of the stationarity about a smooth transition alternative, we estimate the model Eqs. (7) and (8) by NLS again, but now treat \( v_t \) explicitly as an AR\((k+1)\) process whose parameters are estimated jointly with those of the deterministic smooth transition component.

Table 2 reports the parameter estimates with \( t \)-ratios given in brackets. For brevity, rather than report all the intermediate estimated AR coefficients, we simply report the coefficients of the AR\((k+1)\)th estimation.

The estimates of the initial intercept and slope parameters \( \alpha_1 \) and \( \beta_1 \) are augmented by the parameters \( \alpha_2 \) and \( \beta_2 \) which identify the change to the intercept and slope as a result of the smooth transition. The intercept is positive and significant. The change to the intercept is small and typically less than 0.2% of the original intercept value, however, the slope parameter exhibits a proportionally much larger change as a result of the smooth transition.

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Table 1
Standard ADF \((t_{ab})\) and smooth transition ADF \((s_{ab})\) test results for CPI (all items) and CPI (underlying)

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<thead>
<tr>
<th></th>
<th>Statistic</th>
<th>( p )</th>
<th>10% critical value</th>
<th>Statistic</th>
<th>( k )</th>
<th>10% critical value</th>
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<td>-2.130</td>
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<td>-5.839</td>
<td>3</td>
<td>-4.58</td>
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Table 2
Smooth transition estimates for headline and underlying CPI

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<th>$\beta_1$</th>
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<th>$\gamma$</th>
<th>$\tau$</th>
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<td>Australia</td>
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<td>(19.77)</td>
<td>(73.46)</td>
<td>(-2.62)</td>
<td></td>
</tr>
<tr>
<td>New Zealand</td>
<td>6.750</td>
<td>-0.013</td>
<td>0.010</td>
<td>-0.004</td>
<td>0.227</td>
<td>0.467</td>
<td>-0.451</td>
<td>0.999</td>
</tr>
<tr>
<td></td>
<td>(5976)</td>
<td>(-0.573)</td>
<td>(19.53)</td>
<td>(-10.85)</td>
<td>(14.17)</td>
<td>(45.83)</td>
<td>(-2.81)</td>
<td></td>
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</table>

Except in the case of CPI (all items) for Canada, the fitted smooth transition deterministic component, $\hat{\alpha}_1 + \hat{\beta}_1 t + \hat{\alpha}_2 S_t(\hat{\gamma}, \hat{\tau}) + \hat{\beta}_2 t S_t(\hat{\gamma}, \hat{\tau})$ is shown in the figures as a dotted line.

The trend growth rates of the CPI series under the former regime can be calculated from the estimates of $\hat{\beta}_1$. The annualized rates for the CPI (all items) indices are 7.2% and 4.0% in Australia and New Zealand and 6.8%, 4.8% and 4.0% for the underlying rates of Australia, Canada and New Zealand. Adding the $\hat{\beta}_2$ parameter estimates to $\hat{\beta}_1$ gives the trend growth of the CPI series under the latter regime, since all the $\hat{\beta}_2$ parameter estimates are negative and significant, this represents a reduction in the growth of the price series. The new trend growth rates are 3.2% and 2.4% for the CPI (all items) index in Australia and New Zealand and 3.6%, 1.6% and 2.4% for the underlying rates of Australia, Canada and New Zealand. The reductions are all significant and represent reductions in excess of 50% of the original trend growth rate for all but the CPI (underlying) series for New Zealand. Canada appears to have the lowest CPI trend growth rate and is the only country to have a trend growth rate within the specified target range set by the Minister of Finance and the Governor of the Bank of Canada. The trend growth of CPI is higher than Canada for New Zealand and Australia and in both cases the trend growth is higher than the target ranges set by the respective Treasury Ministers and Governors.

The smooth transition process itself is characterized by the parameters $\gamma$ and $\tau$, which give the speed of transition and the midpoint of the transition respectively. The speed of transition indicates how quickly the series has moved from the former regime to the latter. Ranking the speeds shows that CPI (all items) has exhibited the fastest transition whilst the transition in the underlying rate is slower, as we might expect. The transition paths are plotted in Figs. 1–6 demonstrating the relative speeds of adjustment; CPI (all items) for Australia and New Zealand, and Canadian underlying CPI exhibit fast transitions whilst the other series show slower transitions.
Table 3 gives an alternative indicator of the relative speed of transition by recording the number of quarters required to traverse 90%, 80% and 70% of the transition path. When these are centered on the midpoints of the transitions, \( \tau \), the ranges over which the transitions in the CPI series take place within the sample period can be calculated. These can then be compared with the timing of the institutional developments, such as central bank reforms, to determine whether the transitions in CPI series coincide with these events.

In each of the countries the timing of the midpoint of the reforms and the range of the transition are determined endogenously by the smooth transition analysis. Given that the transition is symmetric, the start of the range over which 90% of the transition took place began in the quarter of the reforms for New Zealand and Canada. Hence, the ranges of transition are consistent with the hypothesis that the central bank reforms and the adoption of an inflation target were responsible for the transition in the CPI series. With the exception of Australia, all the other series experienced the midpoint (i.e. 50% of the transition completed) some seven to nine quarters after central bank reforms were enacted by parliament legislation. The length of time from the start of the reforms to the midpoints for New Zealand and Canada are consistent with the optimal inflation forecast horizons predicted by Batini and Haldane (1998) and the time usually allowed for monetary policy to work through to prices. In all of the cases there was a transition in the CPI (all items) series before the CPI (underlying) rate, as would be expected, and the range of the reform period was longer for the CPI (underlying) series. For Australia the midpoints of the transition process occur before the implementation of institutional reforms to the central bank and the inflation target and are therefore not caused by them. This indicates that at least fifty percent of the transition had taken place before the RBA was given greater independence and before inflation targets were set. One interpretation of these results is that the RBA acquired considerable reputation before the central bank reforms took place due to anticipation effects and credibility of announcements. Yet Almeida and Goodhart (1996) and Mizen (1997) show that anticipation effects had little effect on inflation performance prior to the establishment of an independent central bank and price target agreements. Significant changes to inflation expectations only resulted after the declaration of an independent central bank and these may well be the result of other reforms which we discuss below.

Considering the possibility that those other reforms were responsible for the transition ranges, one obvious candidate is fiscal policy reforms. While the reforms did result in a turnaround of the government budget position in all three countries, they can be ruled out as the main or initiating cause of the transition in the trend of price series. The timing of the transition identified by the smooth transition analysis and the timing of the fiscal reforms do not coincide. In New Zealand (the earliest reformer), the defining budget statement came in 1991 but the achievements were not realized in the form of budget surpluses until 1994. In Canada and Australia the deficit and debt reforms occurred in 1993 with four-year horizons for the achievement of their objectives. The improvements to the deficit came in 1995 in Australia (to the surprise of the private sector) and improvements to the debt position occurred.
Table 3
Speed and range of transition

<table>
<thead>
<tr>
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<th>Speed of transition (quarters)</th>
<th>Range of transition (centered on midpoint)</th>
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<tbody>
<tr>
<td></td>
<td>90% transition</td>
<td>80% transition</td>
</tr>
<tr>
<td>CPI (all items)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>CPI (underlying)</td>
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in 1997 in Canada. Neither of these time periods corresponds with the periods of transition in Table 3, which occurred much earlier than 1993.

A more plausible explanation for the decline in the trend in prices is the dramatic slowdown in economic activity, resulting in negative GDP growth that, in the case of Canada, was not recovered for five years. Again our reasoning is based on the timing of the transition derived endogenously from the smooth transition analysis as compared to the information on the economic slowdown. For CPI series for Australia and New Zealand and for the CPI (underlying) series for Canada the transition ranges recorded in Table 3 coincide with periods when GDP was below the 1978–87 period average. The output level was below the previous decade average from 1989–1993 in Canada, 1990–93 in Australia and 1989–92 in New Zealand and these time periods correspond to the ranges over which the transition in prices took place.

It is worth noting that an approach that relied upon using institutional knowledge to specify dummy variables for transition dates, a priori, would have found it hard to reject the hypothesis that the impact of central bank independence was not entirely responsible for the observed disinflation. For the dates that correspond to the period of independence the downward transition in the trend of prices (disinflation) was already underway. Coefficients on dummy variables for the independence/inflation target period would have been estimated with negative signs and would be strongly significant even though the independence/inflation targets were not responsible for the decline. This may explain why cross-sectional evidence presented by Grilli et al. (1991) and Cukierman (1992) demonstrates a negative relationship between a central bank independence index and average inflation for industrialized countries. This has been supported by preliminary time-series work by Alesina and Summers (1993), Debelle (1996) and Mizen (1997). Many of these studies have analyzed the inflation performance of a small set of countries following the creation of independent central banks using period-average comparisons of inflation rates, or the relative performance of similar countries, some of which have and others do not have, independent central banks. Where period averages of inflation are used these are unlikely to identify gains to credibility which take place over time. Since inflation credibility will take some time to acquire, as the general public observe the behavior of inflation under the new regime and learn to accept that the independent central bank is indeed believable, a methodology that allows for gradual accumulation of credibility is important. Others investigate credibility gains over time in this context using a model with institutional dummies that are ramped to allow for gradual change to inflation expectations but these are subject to the critique that we identified in the introduction (see Mizen, 1997). The methodology relies on the investigator correctly specifying the institutional changes and the period over which they can be expected to have an effect. This is a difficult task since in many cases policy changes were “signaled” long before quantified targets were established, policies were implemented or their effects were felt.

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10 Note that the paper also uses time-varying parameters following a technique reported in Drazen and Masson (1994), Masson (1995) and Bleaney (1996).
Using price data to endogenously choose the transition duration and speed avoids these problems since the institutionally determined duration period, which is difficult enough to determine accurately anyway, is referred to only after the path of the transition is mapped.

5. Conclusions

The paper has provided three examples of countries that have adopted far reaching reforms as part of a package of disinflationary measures. Smooth transition analysis was used to endogenously determine the transition path in the trend of price series, specifying a speed of transition and the midpoint of the dynamic process, between two monetary policy regimes. The correspondence between the dates of the institutional changes to the monetary policy objective of the central banks in Canada and New Zealand and the data-determined smooth transition is very close, which suggests that the reforms made a large contribution to the transition in consumer price indices. They were not the only cause, however, since there was a marked and in some cases prolonged decline in GDP, which remained below the previous decade average over a time span corresponding to the transition ranges for each of the countries concerned. Other reforms to the labor market and fiscal policy were less influential. The transitions had begun before these institutional changes had been implemented and the reduction to inflation is likely to have been influenced more heavily by other factors.

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References