E C O N O M I C S   B U L L E T I N

Macroeconomic Effects of Inflation Targeting Policy in New Zealand

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Abstract

In this paper we analyze macroeconomic effects of inflation targeting policy in New Zealand using Markov switching model with one time permanent break. Our results show that the inflation targeting policy has significantly changed the inflation dynamics in the New Zealand economy. The Markov switching model clearly detects a structural break date that is very close to the actual date of the policy change. The volatility in the inflation rate shows a considerable reduction after the structural break date. Our results also show that the inflation targeting policy led to a structural change in real GDP growth rate. The policy change significantly reduced the volatility of real GDP growth rate after the break date. We find that there is a lag of about one year and six months between the monetary policy change and its actual effect on output growth.

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1. Introduction

In the 1990s, several countries introduced a policy that concentrates on stabilizing inflation rates, which is labeled inflation targeting policy. Inflation targeting is a monetary policy framework in which central banks set an inflation rate target, for example, 2% annual inflation rates for 2 years, and make use of all available policy instruments to attain the goal.

Inflation targeting policy has been adopted by a number of industrialized countries such as New Zealand (1990), Canada (1991), Israel (1991), U.K. (1992), Sweden (1993), Finland (1993), and Australia (1994).[1] Among G7 countries, the U.S., France, Germany, Japan, and Italy do not commit to an explicit inflation targeting policy. Bernanke, Laubach, Mishkin and Posen (1999) show that all countries using inflation targeting significantly reduced both the rate of inflation and the volatility of key macroeconomic variables, and argue that inflation targeting would be a better choice for monetary policy in the U.S. In the literature, however, most research regarding inflation targeting utilizes a relatively less rigorous case-study approach rather than a rigorous econometric approach. It is the goal of this paper to analyze macroeconomic effects of inflation targeting policy in New Zealand using a more rigorous framework.

New Zealand is an inflation targeting pioneer and the first country to adopt inflation targeting policy. New Zealand, which had experienced high and volatile inflation in the past, has been successful in bringing inflation in line with other OECD countries by adopting inflation targeting. To account for the dramatic effects of the adoption of inflation targeting in New Zealand, we employ traditional parameter stability tests and introduce the more rigorous framework of Markov switching structural break model.

The paper proceeds as follows. Section 2 discusses the New Zealand economy before and after the adoption of the inflation targeting policy. Section 3 presents the traditional parameter stability testing results for the inflation rate using the Chow test, CUSUM and CUSUM square tests. Section 3 explains the Markov switching structural break model. Section 4 analyzes the empirical results from the Markov switching model, and section 5 summarizes our conclusions.

2. Background

New Zealand is a country with limited internal resources, thus a large appetite for international trade. However, it has a short list of exports and a small number of trading partners. This has led to a history of wide swings in the New Zealand economy with amplified responses to both internal and external shocks. For example, while the oil price shocks of the 1970s sent the US into a recession with about 2% decline in output and Australia's growth slowed to about 1%, New Zealand went into a 6% decline.

In addition to exaggerated real output cycles, New Zealand has also experienced high volatility in its overall price level. During the 1970s and early 1980s the country was subjected to inflation rates in the teens with peaks around 20%. The use of wage and price controls was attempted three times during that period, resulting in even higher inflation once the controls were eased. The failure of these policies resulted in political pressure for monetary reform, reforms

[1] The adoption of an inflation targeting policy in Australia was more gradual, and it is hard to determine the exact date of the adoption.

that materialized in the mid-1980s. By the first quarter of 1985 New Zealand had instituted financial liberalization, which included a free-floating NZ currency, disappearance of interest rate controls and reserve ratios, and the establishment of the independence of the Reserve Bank of New Zealand [RBNZ]. Subsequently, the RBNZ Act of 1989 mandated that the sole responsibility of the central bank was to establish and maintain price stability. Inflation targets are set via a Policy Targets Agreement [PTA] between the Reserve Bank and the government. The Governor of the Reserve Bank is personally responsible for achieving the inflation target and can be dismissed for target breaches. Although the targets have been violated several times since the signing of the first PTA in March 1990, the Governor[2] has been allowed to keep his job so far.

According to RBNZ (2001), in the post-liberalization / pre-RBNZ Act of 1989 period, the central bank embraced the monetarist approach to attacking inflation. They were concerned with controlling the monetary quantities and mostly ignored interest rates and exchange rates. Following a sharp drop in the exchange rate in late 1988, this focus gradually shifted from monetary aggregates to inflation targeting. Official inflation targets did not emerge, however, until the first PTA was signed in 1990.

The PTA inflation rate has been set as a range, usually about 0 to 3%. A fixed range is deemed more credible than a point or a floating range. Target transparency and operational transparency are also seen as helping monetary policy to be more credible and effective (see RBNZ (1999)). The inflation rate as measured by CPIX, consumer price index minus cost of credit, began subsiding in the late 1980s coinciding with the advent of reforms. The first PTA in 1990 was set at 3 to 5%. It was reduced to 0 to 2% in 1992. Actual inflation, for the most part, followed the targeted path and hovered around 2% during the late 1990s[3]. This has kept New Zealand's inflation in line with the average among OECD countries in recent years.

Former Governor Don Brash (RBNZ (1999)) credits the success of inflation targeting in stabilizing prices with reducing the volatility of New Zealand's business cycle as well. Although New Zealand is still highly sensitive to economic shocks, growth since 1990 does indeed appear to be more stable than in the past.

3. Parameter Stability Tests

In order to investigate if the adoption of the inflation targeting policy has effectively stabilized the inflation rate of New Zealand and brought a change in the structure of the New Zealand economy, we use some traditional parameter stability testing procedures, i.e. the Chow test, CUSUM and CUSUM squares tests. We collect the data of GDP deflator for New Zealand from 1997 OECD International Statistical Yearbook CD. The sample period is from the first quarter of 1982 to the last quarter of 1996. We estimate the following AR(2) model for the inflation rate of New Zealand because the Akaike's Information Criterion (AIC) and the Schwarz's Information Criterion (SIC) suggest the series follows an autocorrelated process with two lags. This process takes the following form:

$$\pi_{t+1} = \alpha_{\pi 1}\pi_t + \alpha_{\pi 2}\pi_{t-1} + \varepsilon_{t+1} \qquad (1)$$

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[2] Dr. Don Brash served as Governor until April 2002 when he left to run for political office. The current Governor is Dr. Alan Bollard.

[3] As of this writing the PTA is set at 1-3% with the last reported CPIX at 2.4%.

where π_t denotes quarterly inflation rate using GDP deflator.

We test for the existence of a structural change in the model before and after the first quarter of 1990 when the first PTA was signed. In Table 1, the Chow test results show that we should reject the null hypothesis of no structural change at the 1 % level.[4] The test statistic, 4.816, is distributed as $F_{2,56}$ and the p-value is 0.005.

The CUSUM testing results are shown in Figure 1.[5] Figure 1 shows that the model of the inflation rate of New Zealand becomes unstable in the middle of the 1980s, which coincides with the beginning of financial reform. In Figure 2, the CUSUM square testing results show that the model became unstable between 1987 and 1992. It is known that CUSUM and CUSUM square tests can detect systematic and haphazard movements in parameters respectively.[6] Combining CUSUM and CUSUM square testing results, we conclude that the model is unstable both systematically and haphazardly before and after the adoption of inflation targeting policy.

In sum, the Chow test and the CUSUM and CUSUM squares tests show that the parameters of the model are unstable over the sample period under consideration.

4. Markov Switching Model

Since traditional parameter stability tests do not provide enough information to analyze macroeconomic effects of the inflation targeting policy in New Zealand, we adopt a more sophisticated and general technique. In the previous section we performed the Chow test under the assumption that the structural break happened in the first quarter of 1990. In practice, however, we do not know when the structural break occurred. In addition, traditional parameter stability tests cannot provide any information on the volatility reduction of the inflation rate. We can solve these problems using Markov switching model with one time permanent break.

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[4] The Chow test statistic is given as follows:

$$F = \frac{(\tilde{u}'\tilde{u} - u'_1 u_1 - u'_2 u_2)/k}{(u'_1 u_1 + u'_2 u_2)/(N-2k)}$$

where $\tilde{u}'\tilde{u}$ is the restricted sum of squared residuals and $u_i' u_i$ is the sum of squared residuals from sub-sample i , N is the total number of observations and k is the number of parameters in the equation.

[5] We examine parameter stability using the CUSUM test. This test is based on the cumulative sum of the recursive residuals and calculates the following statistic.

$$W_t = \frac{\sum_{\tau=k+1}^{t} w_\tau}{s}, t = k+1, \ldots, T$$

where w is the recursive residual defined above and s is the standard error of the regression fitted to all T sample points. We can find the parameter instability when the cumulative sum goes outside the area between the two critical lines.

[6] See Brown, Durbin, and Evans (1975) for details.

Assuming an AR(2) process as in section 3, we adopt two-state Markov switching break model using Hamilton filter (1989) as follows[7]:

$$\pi_t = \mu_{D_t} + \phi_{1D_t}\pi_{t-1} + \phi_{2D_t}\pi_{t-2} + e_t,\, e_t \mid D_t \sim iid\ N(0, \sigma^2_{D_t}) \quad (2)$$

$$\mu_{D_t} = \mu_0(1-D_t) + \mu_1 D_t \quad (3)$$

$$\phi_{1D_t} = \phi_{10}(1-D_t) + \phi_{11} D_t \quad (4)$$

$$\phi_{2D_t} = \phi_{20}(1-D_t) + \phi_{21} D_t \quad (5)$$

$$\sigma^2_t = \sigma^2_0(1-D_t) + \sigma^2_1 D_t \quad (6)$$

where π_t is the inflation rate and D_t is a latent variable and modeled as a first order Markov process (two regimes) with transition probabilities given by:

$$P[D_t = i \mid D_{t-1} = i] = q_{ii},\, P[D_t = j \mid D_{t-1} = i] = 1 - q_{ii},\, 0 < q_{00} < 1,\, q_{11} = 1,\, i, j = 0,1 \quad (7)$$

where D_t equals 0 before the structural break at time $t = \tau$ and D_t equals 1 after the structural break.

$$D_t = \begin{Bmatrix} 0 \text{ for } 1 \le t \le \tau \\ 1 \text{ for } \tau \le t \le T \end{Bmatrix} \quad (8)$$

The expected duration of a regime before a structural break occurs is given by $E(\tau) = \frac{1}{1-q_{00}}$.

To estimate this model we derive the joint density of π_t, D_t and D_{t-1} conditional on the past information I_{t-1}:

$$\begin{aligned} f(\pi_t, D_t, D_{t-1} \mid \mathrm{I}_{t-1}) &= f(\pi_t \mid D_t, D_{t-1}, \mathrm{I}_{t-1}) \Pr\left[D_t, D_{t-1} \mid I_{t-1}\right] \\ &= \frac{1}{\sqrt{2\pi\sigma^2_{D_t}}} \exp\left(-\frac{\left(\pi_t - \mu_{D_t} - \phi_{1D_t}\pi_{t-1} - \phi_{2D_t}\pi_{t-2}\right)^2}{2\sigma^2_{D_t}} \right) \Pr\left[D_t, D_{t-1} \mid I_{t-1}\right]. \end{aligned} \quad (9)$$

Next we use equation (9) to get $f(\pi_t \mid I_{t-1})$ as follows:

[7] The model we use in this paper is similar to the one used by Kim, Nelson and Piger (2003). They use Bayesian Markov Switching model to tests a structural break at an unknown break date. They find that the structural break date of the U.S. real GDP volatility is 1984:1 and that it is shared by its cyclical component but not by its trend component. They also find that the volatility reduction occurs over broad sectors of real GDP. We, however, apply the classical model instead of Bayesian model.

$$f(\pi_t \mid I_{t-1}) = \sum_{D_t=0}^{1} \sum_{D_{t-1}=0}^{1} f(\pi_t, D_t, D_{t-1} \mid I_{t-1})$$
$$= \sum_{D_t=0}^{1} \sum_{D_{t-1}=0}^{1} f(\pi_t \mid D_t, D_{t-1}, I_{t-1}) \Pr\left[D_t, D_{t-1} \mid I_{t-1}\right], \quad (10)$$

From equation (10), we can find the following log likelihood:

$$\ln L = \sum_{t=1}^{T} \ln\left[\sum_{D_t=0}^{1} \sum_{D_{t-1}=0}^{1} f(\pi_t \mid D_t, D_{t-1}) \Pr\left[D_t, D_{t-1} \mid I_{t-1}\right] \right] \quad (11)$$

where $\Pr\left[D_t = j, D_{t-1} = i \mid I_{t-1}\right] = \Pr\left[D_t = j \mid D_{t-1} = i\right] \Pr\left[D_{t-1} = i \mid I_{t-1}\right]$, for $i, j = 0,1$. We can compute the weight term, $\Pr[D_t, D_{t-1} \mid I_{t-1}]$, in equation (11) by updating it, once π_t is observed at time *t*, as follows:

$$\Pr\left[D_t = j, D_{t-1} = i \mid I_t\right] = \frac{f(\pi_t \mid D_t = j, D_{t-1} = i, I_{t-1}) \Pr\left[D_t = j, D_{t-1} = i \mid I_{t-1}\right]}{\sum_{D_t=0}^{1} \sum_{D_{t-1}=0}^{1} f(\pi_t \mid D_t = j, D_{t-1} = i, I_{t-1}) \Pr\left[D_t = j, D_{t-1} = i \mid I_{t-1}\right]} \quad (12)$$

with $\Pr[D_t = j \mid I_t] = \sum_{D_{t-1}=1}^{1} \Pr\left[D_t = j, D_{t-1} = i \mid I_t\right]$ and iterate equation (11) and (12) for $t = 1, 2, \ldots, T$, we will have appropriate weighting terms in $f(\pi_t \mid I_{t-1})$. (For more details, see Hamilton (1989) and Kim and Nelson (1999).)

5. Empirical Results

Table 2 summarizes the results. The estimated structural break date is the 4th quarter of 1989, which is very close to when New Zealand officially adopted the inflation targeting policy in the first quarter of 1990, but even closer to the point where actual inflation targeting most likely began. Note that q = 0.965 and it is statistically significant at the 1% level. Therefore, we conclude that the inflation targeting policy has significantly changed the inflation dynamics in the New Zealand economy. Next, the volatility in the inflation rate shows considerable reduction after the structural break date. Before adopting the inflation targeting policy, the volatility, for which we use the standard deviation, is almost three times larger than afterwards. Those two estimated standard deviations, σ_{D_0} and σ_{D_1}, are statistically significant at the 1% level. The constant term also has undergone a large drop that affects the unconditional mean of the inflation rate. The unconditional mean decreased from 7.5 to 0.41.[8] The estimated AR parameters, however, are not statistically significant. Figure 3 plots the estimated probability of a structural

[8] We can calculate the unconditional mean as $c_{D_t} = \dfrac{\mu_{D_t}}{1 - \phi_{1D_t} - \phi_{2D_t}}$.

break at each point in time. It is easy to see that the unknown break date is very close to the date when New Zealand adopted the inflation targeting policy.

Figure 4 shows the effect of the inflation targeting policy on real GDP growth rate. In Figure 4 the volatility reduction can be clearly detected after the break date compared to before the break date. In Table 2 the structural break date of real GDP growth rate is found to be the third quarter of 1991, which means that there is a lag of about one year and six months between the monetary policy change and its actual effect on output growth.[9]

6. Conclusion

We find from section 5 that the inflation targeting policy has significantly changed the inflation dynamics in the New Zealand economy. The Markov switching model clearly detects a structural break date that is very close to the actual date of the policy change. The volatility in the inflation rate shows a considerable reduction after the structural break date. Before adopting the inflation targeting policy, the volatility of inflation rates is almost three times larger than afterwards. The constant term also decreases significantly after the break date.

Our results also show that the inflation targeting policy led to a structural change in real GDP growth rate. In fact the policy change significantly reduced the volatility of real GDP growth rate after the break date. The results also show that there is a lag of about one year and six months between the monetary policy change and its actual effect on output growth.

Overall, we can conclude that the inflation targeting policy adopted by New Zealand was successful in stabilizing the inflation and output growth rates of the New Zealand economy. However, we need to further investigate the cases of other countries to draw a general conclusion on the effect of the inflation targeting policy.

[9] We employ the same Markov switching model and estimation method for real GDP growth rate. We collect the data from 1997 OECD International Statistical Yearbook CD.

Figure 1 CUSUM test: Inflation Rate

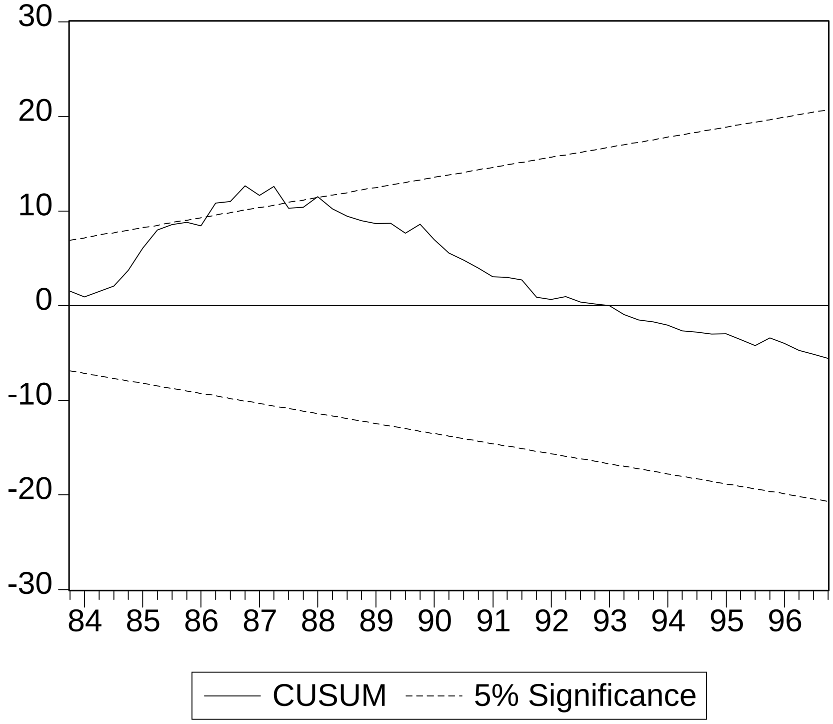

Figure 2 CUSUM square test: Inflation Rate

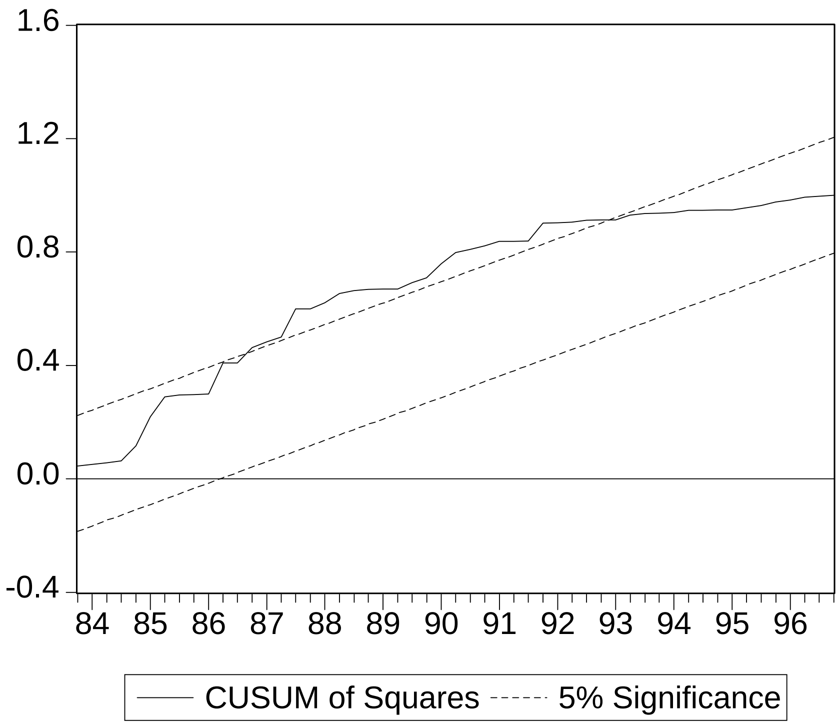

Figure 3 Probability of Structural Break: New Zealand Inflation Rate

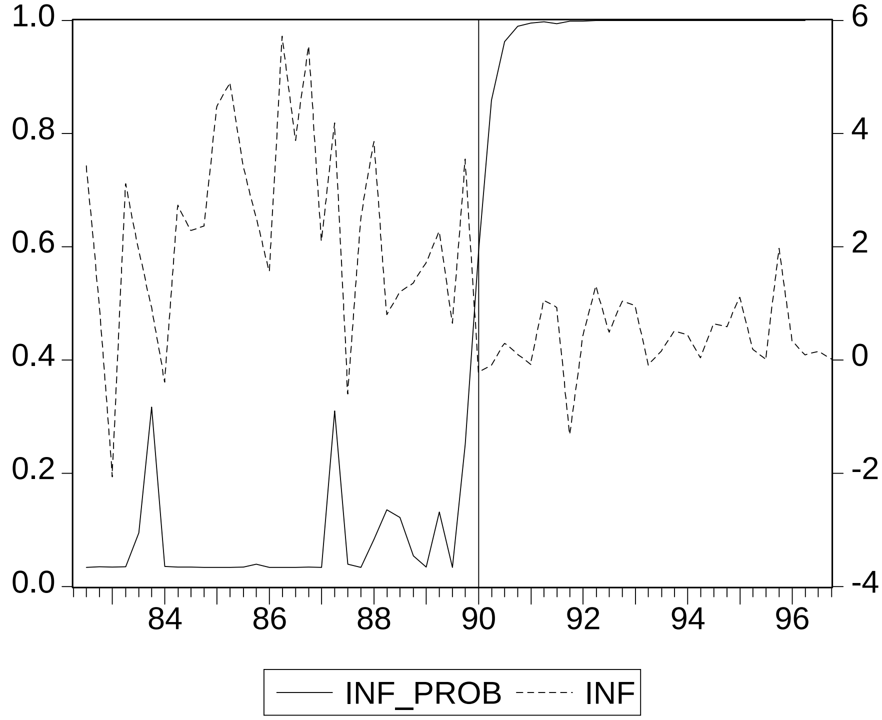

Figure 4 Probability of Structural Break: New Zealand Real GDP Growth Rate

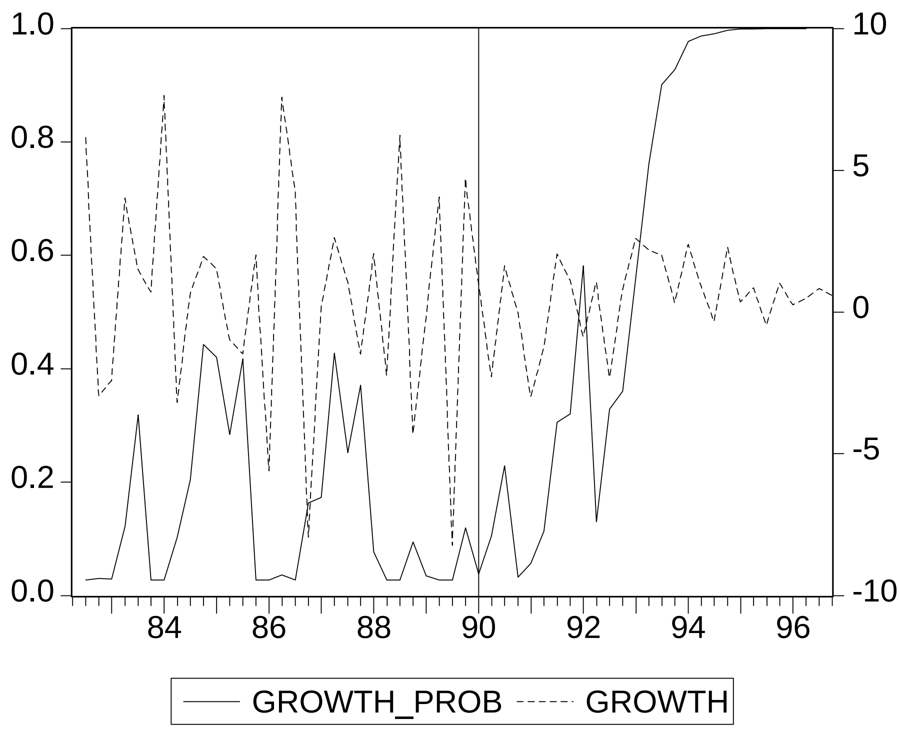

Table 1 Chow Break and Forecast Results

Variables	F-statistic	P-value
Inflation Rate	4.816	0.005

Table 2 Markov Switching Estimation Results

Parameters	μ_{D_0}	μ_{D_1}	$\phi_{1_{D_0}}$	$\phi_{1_{D_1}}$	$\phi_{2_{D_0}}$	$\phi_{2_{D_1}}$	σ_{D_0}	σ_{D_1}	q	SB* date
Inflation	1.801[a] (0.666)	0.477[a] (0.140)	0.134 (0.1888)	-0.146 (0.152)	0.106 (0.190)	-0.005 (0.011)	1.772[a] (0.236)	0.593[a] (0.079)	0.965[a] (0.033)	89.IV
Real GDP Growth Rate	0.540 (0.561)	0.812[b] (0.356)	-0.535[a] (0.186)	-0.001 (0.149)	-0.07 [a] (0.049)	-0.000 (0.000)	3.266[a] (0.422)	1.133[a] (0.290)	0.972[a] (0.027)	91.III

* SB denotes Structural Break.

Note that a and b denotes rejection of the hypothesis at the 1% and 5% levels respectively.

References

Bernanke, B.S., T. Laubach, F.S. Mishkin, and A. Posen (1999) *Inflation Targeting*, Princeton University Press: Princeton.

Brown, R.L., J. Durbin, and J.M. Evans (1975) "Techniques for Testing the Constancy of Regression Relationships over Time" *Journal of the Royal Statistical Society, Series B* **37**, 149-192.

Hamilton, J. (1989) "A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle" *Econometrica* **57**, 357-384.

Kim, C. J., and C. R. Nelson (1999) "*A State Space Models with Regime-Switching: Classical and Gibbs-Sampling Approach with Applications*," The MIT Press: Cambridge, Massachusetts.

Kim, C. J., C. R. Nelson, and J. Piger (2003) "A Bayesian Investigation of Time, Breadth, and Potential Explanations" forthcoming in *Journal of Business and Economic Statistics*.

RBNZ (1999) *Monetary Policy over the Business Cycle*, Reserve Bank of New Zealand.

RBNZ (2001) "The Evolution of Monetary Policy Implementation," *Monetary Policy Review*, Reserve Bank of New Zealand (http://www.rbnz.govt.nz/monpol/review/index.html).

Rudebusch, G.D., and L.E. Svensson (1999) "Policy Rules for Inflation Targeting" in *Monetary Policy Rues*, edited by J. Taylor, The University of Chicago Press: Chicago, 203-246.