Some tests on the effects of inflation targeting in New Zealand, Canada, and the UK

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Abstract

There is no empirical evidence that inflation targeting has changed macroeconomic variables in the unrestricted VAR context. There are two possible interpretations for this result. One is that inflation targeting may truly have no significant impacts on macroeconomic variables. The alternative scenario might be that the number of parameters in our model is so large relative to the number of observations that our tests do not have enough power to reject the null hypothesis of no structural changes. Further statistical investigations are desirable as more data become available and alternative models are devised. © 2000 Elsevier Science S.A. All rights reserved.

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JEL classification: C12; E52

1. Introduction

Many central bankers and economists have paid close attention to the so-called ‘inflation targeting’ in recent years (see, for example, Bernanke and Mishkin, 1997; Cecchetti, 1998; Bernanke et al., 1999; and a series of recent conference proceedings in Leiderman and Svensson (1995), Journal of Monetary Economics (1997) and Federal Reserve Bank of New York (1997)). Mishkin and Posen (1997) estimate a three-variable, unrestricted vector autoregression (VAR) model over the sample period prior to the adoption of inflation targeting, and simulate dynamically (in the sense that they use the model’s forecast values rather than actual data values for lagged variables) over the period after the adoption of targeting. Because the predicted values from the model tended to overestimate the actual values of the inflation rate and/or the nominal interest rate, they suggested that inflation
targeting has some favorable impacts on macroeconomic variables. Employing a similar three-variable\nVAR model, Bernanke et al. (1999) also report that the dynamic out-of-sample forecast values of\ninflation tend to exceed the corresponding actual data values after the adoption of targeting for New\nZealand, Canada, the UK, and Sweden.\n
Despite these favorable reports, the statistical evidence, supporting the effectiveness of inflation\ntargeting, is not necessarily strong as it stands now. In particular, there have been no formal statistical\ntests, at least to our knowledge, on the impacts of inflation targeting on macroeconomic variables in\nthe unrestricted VAR context. This paper seeks to fill this gap.

2. Tests for structural changes

2.1. Four-variable vector autoregression

To identify the possible effects of inflation targeting on macroeconomic variables, we consider the\nfollowing four-variable VAR model for country $j$ ($j = n, c, u$; $n, c, u$ denote New Zealand, Canada, and\nthe UK, respectively), where the four variables are inflation rate ($p$), real GDP growth rate ($y$),\nnominal short-term interest rate ($r$), and the rate of change in the nominal exchange rate ($e$).\n
$$\begin{align*}
z_t &= a_z + \sum_{i=1}^{4} b_{zi} p_{t-i} + \sum_{i=1}^{4} c_{zi} y_{t-i} + \sum_{i=1}^{4} d_{zi} r_{t-i} \\
+ \sum_{i=1}^{4} f_{zi} e_{t-i} + u_{zi}, & \quad t = 1, 2, \ldots, T
\end{align*}$$

where $z = p, y, r, e, a_z, b_{zi}, c_{zi}, d_{zi},$ and $f_{zi}$ denote coefficient parameters for variable $z$. $u_{zi}$ is the\ndisturbance term, which is assumed to be independently and normally distributed with mean zero and\nvariance $\sigma_{zzi}(z = p, y, r, e)$. $T$ denotes the number of the first set of observations under the policy\nregime prior to inflation targeting. Data are quarterly, and we take 1-year period lags a priori in the\nright-hand side variables. We basically follow Mishkin and Posen (1997) in the above specification,\nexcept for the inclusion of the nominal exchange rate.

All of the above three countries adopted the exchange rate targeting policy, at least to a certain\nextent, for some periods in the past. Under this regime, the exchange rate might become exogenous to\nthe private sector to that extent, while the inflation rate might be endogenously determined.

If, on the other hand, the central bank rigidly controls inflation by inflation targeting, then the

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1. At the same time, however, Bernanke et al. (1999) observe the same pattern of inflation behavior for the US and\n   Australia (prior to its target adoption).
2. Bernanke et al. (1999) also empirically investigate whether the adoption of inflation targeting reduces inflation\n   expectations and/or the sacrifice ratio (the ratio of the loss of output or employment that an economy must sustain in order to\n   achieve a reduction in inflation). Bernanke et al. (1999) test the stability of parameters of Phillips curves or of regressions\n   of quarterly inflation on its own lags, changes in the nominal effective exchange rate and in commodity prices for nine\n   industrialized countries. They find the parameter instability at the margin only for the case of a parsimonious specification in\n   Canada. Together with other evidence, they suggest that the adoption of inflation targeting does not reduce the sacrifice ratio.
3. The first differences in the logarithms of production, prices, and the exchange rate are used.
4. Friedman and Kuttner (1992) also took 1-year lags a priori.
inflation rate might be exogenous and the exchange rate endogenous. The adjustment, made by inflation under the exchange-rate targeting regime, might now have to be made by other variables such as real GDP growth or the exchange rate under inflation targeting. How does the exchange rate react to exogenous shocks under inflation targeting? If the purchasing power parity holds, then lower domestic prices should lead to the appreciation of the nominal exchange rate, given overseas prices. Because of these considerations, we include the nominal exchange rate in our model.

Since the second set of observations is short, we test structural changes, using prediction errors. We ask whether or not the newly obtained samples under inflation targeting belong to the older samples obtained under the prior policy regime.

We consider two sorts of tests. The first type empirically tests whether or not there is a structural break in a single variable equation in a single country. This is a simple Chow test. Since there are three countries with four variables, we report the results of possible structural changes in 12 equations in Section 2.2. The second type empirically tests whether or not there is a structural break in the system of four equations, as a whole, in a single country. We report the test results of the three countries in Section 2.3.

2.2. A possible structural change in each equation in each country

We first estimate Eq. (1) for each variable for each country, and calculate the sum of squared residuals, using only the data under the prior policy regime (from 1978:3 to 1989:4 for New Zealand, from 1978:3 to 1990:4 for Canada, from 1978:3 to 1992:3 for the UK). Then we get the corresponding sum of squared residuals, using the data covering the entire sample period from 1978:3 to 1997:1, and calculate the standard Chow test statistics. The results in Table 1 show that we cannot reject the null hypothesis of no structural change in all equations in all countries at the significance level of 5%.

2.3. A possible structural change in a country as a whole

In this section, we pool the four equations in each country, and test for the possible structural break in the system of four equations, as a whole. Stack the four equations (1) in a single country \( j \), and we get

\[
Z = \{I_4 \otimes X\} \beta + U
\]  

Table 1

<table>
<thead>
<tr>
<th>Country</th>
<th>New Zealand</th>
<th>Canada</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees of freedom</td>
<td>(29,29)</td>
<td>(25,33)</td>
<td>(18,40)</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>0.294</td>
<td>0.650</td>
<td>0.578</td>
</tr>
<tr>
<td>Real GDP</td>
<td>0.478</td>
<td>0.409</td>
<td>0.297</td>
</tr>
<tr>
<td>Interest rate</td>
<td>0.320</td>
<td>0.300</td>
<td>0.626</td>
</tr>
<tr>
<td>Exchange rate</td>
<td>0.787</td>
<td>0.808</td>
<td>0.570</td>
</tr>
</tbody>
</table>
where
\[ Z = [p'y' r'e']', \quad U = [u_p', u_y', u_r', u_e']'. \]
\[ X = [l p_p - p_p p_p - p_p y_p - y_p y_p - y_p r_p - r_p r_p - r_p e_p - e_p]. \]
\[ \beta = [\beta_p', \beta_y', \beta_r', \beta_e'], \quad \text{and} \]
\[ \beta_z = [a b c d e f g h i j k l m n o p q r s t u v w x y z]. \]
\[ z \text{ and } z_i(z = p, y, r, e) \text{ are all } (T \times 1) \text{ column vectors, whose } \]tth elements are \( z_t \) and \( z_i \), respectively. \( u_z \) and \( l \) are also \( (T \times 1) \) column vectors. Each element in \( l \) is one. \( \otimes \) and \( I_4 \) denote the Kronecker product and an identity matrix of order 4, respectively.

Making use of only those samples prior to inflation targeting, we first apply ordinary least-squares (OLS) to Eq. (2), and get the OLS estimator
\[ \beta^* = [I_4 \otimes (X'X)^{-1}X']Z, \]
which is identical to the OLS estimator obtained from the four separate regressions on (1) in a single country.

We denote the corresponding model to (2) for the second set of observations under inflation targeting by
\[ W = [I_4 \otimes R]y + V, \]
where \( W, R, \gamma, V \) are matrices of \((4N \times 1), (N \times 17), (68 \times 1), \) and \((4N \times 1), \) respectively, and \( N \) is the number of second set of observations. Assuming that disturbances are normally distributed with mean zero and variance–covariance matrix
\[ \text{Cov}(U) = \begin{bmatrix} \sum \otimes I_T & 0 \\ 0 & \sum \otimes I_N \end{bmatrix}, \quad \text{where} \quad \sum = \begin{bmatrix} \sigma_{pp} & \sigma_{py} & \sigma_{pr} & \sigma_{pe} \\ \sigma_{py} & \sigma_{yy} & \sigma_{yr} & \sigma_{ye} \\ \sigma_{pr} & \sigma_{yr} & \sigma_{rr} & \sigma_{re} \\ \sigma_{pe} & \sigma_{ye} & \sigma_{re} & \sigma_{ee} \end{bmatrix}, \]
\[ \sigma_{zz} = E[u_z^2], \quad \text{and} \quad \sigma_{zs} = E[u_z u_s] \quad \text{for} \quad z, s = p, y, r, e, \]
the prediction errors, \( W - [I_4 \otimes R]\beta^* \), have asymptotic variance–covariance matrix, \( \Sigma \otimes [I_N + R(X'X)^{-1}R'] \). Therefore, the test statistic
\[ (W - [I_4 \otimes R]\beta^*)' \left( \sum \otimes [I_N + R(X'X)^{-1}R'] \right)^{-1} (W - [I_4 \otimes R]\beta^*) \]
has an asymptotic \( \chi^2 \) distribution with \( 4N \) degrees of freedom under the null hypothesis of no structural change. The test statistic tends to be large under the alternative hypothesis. Each element of \( \Sigma^* \) in (5) is defined by \( \sigma_{zs}^* = \Sigma_{i=1}^{T} u_{z_i}^2 u_{s_i}/(T - 17), \) where \( u_{z_i}^2 \) are the OLS residuals obtained from separate regressions on (1).

Making use of statistic (5), and noting that \( N \) is equal to 29, 25 and 18, for New Zealand, Canada, and the UK, respectively, we have Table 2. This table clearly shows that we cannot reject the null hypothesis of no structural change in all countries.
Table 2
Approximate $\chi^2$-test statistics in a country as a whole

<table>
<thead>
<tr>
<th>Country</th>
<th>New Zealand</th>
<th>Canada</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees of freedom</td>
<td>116</td>
<td>100</td>
<td>72</td>
</tr>
<tr>
<td>Critical value at 5%</td>
<td>142.68</td>
<td>125.00</td>
<td>93.60</td>
</tr>
<tr>
<td>Test statistic</td>
<td>62.25</td>
<td>58.29</td>
<td>37.21</td>
</tr>
</tbody>
</table>

3. Conclusion

There is no empirical evidence that inflation targeting has changed macroeconomic variables in the unrestricted VAR context. There are two possible interpretations for this result. One is that inflation targeting may truly have no significant impacts on macroeconomic variables.

The alternative scenario might be that the number of parameters in our model is so large relative to the number of observations that our tests do not have enough power to reject the null hypothesis of no structural changes. In fact, Bernanke and Mihov (1998, p. 889) use a similar Chow test and also fail to reject the no-change null hypothesis in the different context of a VAR model. If this is indeed the case, it might perhaps be worth trying to devise alternative stability tests in the VAR context, which have better power than Chow tests.

Finally, the effectiveness of inflation targeting is at least questionable, on the basis of current evidence. Further investigations are desirable as more data become available and alternative models are devised.

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Appendix A. Data

All data are from `Main Economic Indicators' in Organization for Economic Cooperation and Development(OECD) Statistical Compendium 1997#2. The sample period is from the second quarter of 1977 to the first quarter of 1997, but the actual estimation period is from the third quarter of 1978 to the first quarter of 1997.

The variables used for the different countries were: (1) New Zealand: ‘Real Domestic Product’, ‘Consumer Prices, All Items’, ‘Bank Bills Rate (90 days)’, and ‘US$ Spot Exchange Rate’ for production, prices, the short-term interest rate, and the exchange rate, respectively. (2) Canada: ‘Real Gross Domestic Product (1990 Prices), Seasonally Adjusted’ in National Accounts, ‘Implicit Price

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3 Mishkin and Posen (1997, footnote 2 in Part VII in p. 103) assert this scenario.

References

Journal of Monetary Economics (1997), Special Issue: Rules and Discretion in Monetary Policy, Journal of Monetary Economics, 39 (June issue).