The Taylor Rule in Australia

Frank Elston

The Taylor rule is a rules based monetary policy whereby the policy maker reacts to inflation and output gaps in setting the policy instrument, usually a short term interest rate. It can be prescriptive or descriptive. This study examines whether the Taylor rule describes the behaviour of the Reserve Bank of Australia since 1996, a period encompassing the last two Governors of the RBA. Using the traditional gap coefficients of .5 we find the implied Taylor cash rate, which then can be compared with the actual cash rate. The Taylor rule describes well the policymaking during the era of Governor Glenn Stevens, but does not describe as well the policymaking during the era of his predecessor. The study also determines the least squares estimates of the coefficients and finds that both the inflation and output coefficients exceed .5. A supplementary finding is that lagging the output and inflation gaps did not make any material difference.

1. Introduction

The Taylor rule is a rules based monetary policy proposed by John Taylor (Taylor 1993) to evaluate monetary policy making. Accordingly it represents a further development of the rules based monetary lineage associated most especially with monetary macroeconomists such as Milton Friedman (Asso, Khan & Leeson 2007) and more recently by Bennett McCallum (1997). It may be viewed as either prescriptive or descriptive. A rules based approach provides more predictability and may avoid instability attendant to aggressive monetary policy. At the same time some may view rules as putting monetary policy into a strait jacket and losing flexibility, such flexibility needed in cases of shocks, the impact of which is not reflected in the current economic variables captured by the Taylor rule (de Brouwer & O’Regan 1997, p. 245). As the monetarist approach entails a steady or constant increase in the money supply, it is a very strict rules based approach. In contrast, the Taylor rule envisions a more activist approach and it targets interest rates instead of the monetary aggregates. Yet it shares the monetarist disdain for utter discretion and so therefore it advocates the central bank adopt a rule specified in terms of an instrument of monetary policy. Currently both the Federal Reserve Board (FRB) and the Reserve Bank of Australia (RBA) use a very short term interest rate as the policy rate. In the US this rate is the Federal funds rate, whilst in Australia the rate is the...
cash rate. While following the Taylor rule may improve the conduct of monetary policy, the rule “was certainly not meant to be used mechanically but rather as a guide embodying important principles” (Taylor 2009, p. 68).

The Taylor rule reflects a dual mandate for the central bank of output and inflation. The dual mandate for the Federal Reserve can be found in the Humphrey-Hawkins Act of 1978 whereby the government has the responsibility for pursuing full employment as well as price stability. Similar to the Federal Reserve in the US, the Reserve Bank of Australia follows a dual mandate (Stevens 2006). The central bank’s responsibility is to set policy in accordance with inflation and output (or unemployment). Indeed, the parameters of the Taylor rule are reaction functions to these inflation and output variables (de Brouwer & O’Regan 1997).

The Taylor rule has been a tremendously robust model shedding light on numerous questions. One study showed the similarity of Taylor implied rules in New Zealand and in Australia, suggesting compatibility of Australia and New Zealand monetary policies and hence the compatibility of these two countries for a currency union (Bjorksten et al 2004). Another paper examined whether the chosen policy interest rate was appropriate for the various states and territories of Australia (Hernandez & Layton 2002). The conclusion was that the policy rate matched the Taylor implied rate in Victoria and New South Wales more closely than the Taylor implied rate in the other states and territories of Australia.

In this paper we will look at the historical period in Australia from late 1996 to mid-2013. By focusing on a particular episode ‘one may get a better sense about how a policy rule might work in practice’ (Taylor 1999, p. 320). This episode marks the tenure of two Reserve Bank governors: Ian Macfarlane and (ongoing) Glenn Stevens. Examining this period with the Taylor rule should help us see how the economic changes impacted the conduct of monetary policy. The economic changes are encapsulated in both output and prices. In this study we will also see whether the RBA equally followed the Taylor rule under the two Governors. In this context we view adherence to the Taylor rule as not necessarily conscious.

2. Review of Taylor Rule Equation

The Taylor rule has been stated in a number of similar versions. Here is a form that is true to Taylor’s model (Taylor 1993) using contemporaneous variables:

\[ R_t = \Pi_t + A_t + B_t (\Pi_t - \Pi_{p,t}) + C_t (Y_t - Y_{f,t}) \]  

where \( R_t \) equals the Taylor implied policy interest rate at time \( t \), \( \Pi_t \) equals the inflation rate at time \( t \), \( A_t \) equals the real equilibrium (natural non-inflationary) interest rate at time \( t \), \( B \) equals the coefficient for the inflation gap, \( \Pi_{p,t} \) is the targeted or
policy inflation rate at time t, C equals the coefficient for the output gap, $Y_t$ equals the real output level at time t and $Y_{f,t}$ is the full employment output level at time t.

Although the Taylor rule is known for its simplicity there are a myriad of specification choices to be made. First, we must input the real rate of interest. For developed economies this is usually set at 2%. Second, the policy coefficients of the two gaps, B and C, would be treated as a constant. Taylor used .5 for each. While these might be considered weights, they are not weights in the customary sense as they need not sum to 1 or any other particular number.

A third key specification is the inflation rate target, which is normally treated as a constant. For the US it customarily is considered to be 2%, although the US has never explicitly adopted inflation targeting. Like some other central banks the RBA adopted an inflation target in 1993. Currently the RBA on its website states: ‘The Governor and the Treasurer have agreed that the appropriate target for monetary policy in Australia is to achieve an inflation rate of 2–3 per cent, on average, over the cycle. This is a rate of inflation sufficiently low that it does not materially distort economic decisions in the community’ (Reserve Bank of Australia, Inflation Target 2013). With the 2-3 per cent stated goal it is natural to choose the midpoint, 2.5%, as the inflation target for purposes of the Taylor rule.

A fourth key variable is the potential output of the economy, also known as the full employment level of output or the non-accelerating inflation rate of unemployment (NAIRU). Because of growth in the economy the full employment level of output would normally rise and therefore $Y_{f,t}$ would not be a constant. As a proxy for full employment output the analyst might choose a trend output level. “However, calculating the NAIRU [nonaccelerating inflation rate of unemployment] is a complex exercise. Furthermore, even if one accepts the concept of the NAIRU there is the question of it changing over time. There are others who even question the very existence of a NAIRU. Assuming that one accepts that the NAIRU exists, there are quite a number of different approaches to calculate ‘output potential’ and each may yield substantively different estimates.” (Hernandez & Layton 2002, pp. 4-5).

An alternative formulation is possible for the output gap. $Y_t$ could measure the real growth rate of the economy and $Y_{f,t}$ would measure the long term sustainable rate of growth of the economy. One advantage of this approach is that we could then treat $Y_{f,t}$ as a constant. Another advantage is that we do not have to be concerned with estimating theoretical non-observable amounts: the level of output that would have occurred if the economy had been at full employment and the level of employment that constitutes full employment. In a developed country such as Australia the Reserve Bank considers 3% as the appropriate goal. Therefore for our study we could consider the following as prescribed or constant: A, B, C, $\Pi_p$ and $Y_t$. 
Another issue concerns lags. Policymakers might react one period to the information known from the previous period. In this case the right hand side variables would be t-1 instead of t. As the periods are quarterly this formulation makes sense. Alternatively we could consider the model as fully contemporaneous. Policymakers react to what they think is true even if published figures are not immediately available. Furthermore, policy makers might have some memory, namely the performance of critical variables over a year. The inflation gap and output gaps would be constructed using the last four quarters. This smoothing of the data probably would yield a better fit between predicted (implied) Taylor rule cash rate and the actual targeted cash rate. However, the improvement from smoothing might be rather slight (Huston & Spencer 2007).

As needed the Taylor rule can be further modified to fit the institutional environment. A Taylor rule for Ghana would adjust the inflation target to a more realistic 5% and the equilibrium real rate to 6% (Boamah 2012). In other words the constants would reflect the greater rate of inflation and hence interest rates. The constants are really only constants for a given institutional setting.

An important part of the Taylor equation as a prescription for monetary policy making is that the policy rate (cash rate in the case of Australia) should rise more than the increase of the inflation rate. Indeed this is called the Taylor principle. An inspection of the Taylor equation indicates that a 1% increase in the inflation rate should raise the target policy rate by (1+B). If B equals .5 then the cash rate in Australia would increase 1.5% for a 1% increase in the inflation rate. John Taylor sets out one version of his rule (Taylor 2009, p. 67) as follows:

\[ \text{Interest rate} = 1.5 \times \text{inflation rate} + \frac{1}{2} \times \text{GDP gap} + 1 \]  

It is apparent that this equation is equivalent to equation 1 when both B and C equal .5, the real cash rate is 2%, the inflation target is 2% and real target growth of output equals 3%. The key is that by raising the nominal interest rate more than the increase of the inflation rate the real rate of interest increases. This principle is essential for any monetary policy that seeks to stabilize the economy:

Failure of monetary policy to satisfy the principle can produce undesirable outcomes in two ways. First, the effects of fundamental shocks are amplified and can cause fluctuations in output and inflation that are arbitrarily large. Second, there exist a multiplicity of bounded equilibria in which output and inflation respond to nonfundamental—sunspot—disturbances. If the objective of a central bank is to stabilize output and inflation, these outcomes are clearly undesirable (Davig & Leeper 2007, pp. 607-08).
3. Method of Empirical Model

The model we will consider will set the parameters for the Australian monetary sector as follows:

\[ \Pi_t = \text{inflation rate at time } t \text{ based upon the last four quarters} \]
\[ A = \text{the real equilibrium cash rate, set at 2\%} \]
\[ B = \text{coefficient for the inflation gap, set to .5} \]
\[ \Pi_p,t = \text{the inflation target, set to 2.5\%} \]
\[ C = \text{the coefficient for the output gap, set to .5} \]
\[ Y_t = \text{the rate of GDP expansion at time } t \text{, based upon the last four quarters} \]
\[ Y_{f,t} = \text{the long run annual potential for growth in the economy, set to 3\%} \]

Thus, we can restate equation (1) as

\[ R_t = \Pi_t + 2\% + .5 (\Pi_t - 2.5\%) + .5 (Y_t - 3\%) \]  \hspace{1cm} (3)

The period of time chosen is the tenure of Ian Macfarlane and Glenn Stevens as Governor of the Reserve Bank of Australia. This means we will observe the RBA’s setting of the cash rate from the fourth quarter of 1996 through the second quarter of 2013. As inflation targeting began in 1993 in Australia, this period may reflect a fairly consistent approach to monetary policy. Yet with two Governors we may find differences in the two parts spanning the entire period: from 1996 to 2006 and from 2006 to 2013. Ideally we would like to see how the inflation gap and the output gap impact policy and minimize the operation of other factors that could distort the relationship of the two gaps and the cash rate.

This basic model we will label model 1:

\[ R_t = \Pi_t + A + B (\Pi_t - \Pi_p) + C (Y_t - Y_f) \]  \hspace{1cm} (4)

where \( A = 2 \), \( B = .5 \), \( C = .5 \), \( \Pi_p = 2.5 \), and \( Y_f = 3 \)

The actual cash rate can change within a quarter. In those cases we will average the cash rate to determine a quarterly cash rate. The actual cash rate and the cash rate targeted by the RBA are almost always identical and we will treat them as the same. The CPI inflation rate will be our measure of the inflation rate. Model 1 will be run with three sets of periods: 1996 Q4 – 2006 Q3 representing the tenure of Ian McFarlane; 2006 Q4 – 2013 Q2 representing the tenure of Glenn Stevens; and 1996 Q4 – 2013 Q2 representing the whole period with the two Governors. Both inflation and output rates will be measured over 4 quarters so that the output and inflation rates for periods t-3 through t will circumscribe the output and inflation measures for period t.

Model 2 is the same as model 1 except for lagged output growth. In model 2 we will lag output one quarter as output numbers notoriously are late. This means that the output for periods t-4 through t-1 will define the output and therefore shape the output gap for determining the policy cash rate for period t. We will also look at a one period lag for inflation. For both output and inflation one quarter lag,
\[ R_t = \Pi_{t-1} + A + B (\Pi_{t-1} - \Pi_p) + C (Y_{t-1} - Y_l) \]  
(5)

where \( A = 2, \) \( B = 0.5, \) \( C = 0.5, \) \( \Pi_p = 2.5, \) and \( Y_l = 3 \)

In model 3 we will run regression equations with the quarterly cash rate as the dependent variables. The explanatory variables will be the inflation gap, the output gap and a Governor dummy variable for the whole period. Least squares will determine the reaction coefficients and the Governor coefficient. Judd and Rudebusch (1998) found that parameters varied over their subperiods which featured different chairs of the Fed, viz. Arthur Burns, Paul Volcker and Alan Greenspan. In contrast, Duffy and Engle-Warnick (2006) found that only Volcker represented a break in monetary regime. We might also find a difference in Australia between our two subperiods because of the differences of Governors. It should be noted that Australia has had inflation targeting while the Federal Reserve so far has eschewed explicit inflation targeting. Thus we might expect only a rather modest difference in monetary policy between the regimes of Glenn Stevens and Ian Macfarlane. While Taylor’s model set each of these coefficients at .5, we might expect that least squares will provide somewhat different results.

\[ R_t = \Pi_t + A + B (\Pi_t - \Pi_p) + C (Y_t - Y_l) + D \times G_t \]  
(6)

where \( A = 2, \) \( \Pi_p = 2.5, \) and \( Y_l = 3 \)

We set the null hypothesis that the coefficients are zero and the alternative hypothesis that the coefficients are not zero.

\[ H_0: B = 0 \text{ and } H_0: C = 0 \]  
(7)

\[ H_A: B \neq 0 \text{ and } H_A: C \neq 0 \]  
(8)

In model 4 we will change the target inflation rate and long run output potential to the average parameters achieved over the period examined. The basic idea is that the stated targets, 2.5% and 3%, are one thing and actual performance another. We might expect that targets are under achieved, that is there is a bias of having inflation higher and output lower than the targets. We will then re-estimate the coefficients using the actual rates of inflation and output growth during the period of study. In model 4:

\[ R_t = \Pi_t + A + B (\Pi_t - \Pi_p) + C (Y_t - Y_l) + D \times G_t \]  
(9)

where \( A = 2 \) and \( \Pi_p \) and \( Y_l \) are to be determined.

4. Results

In model 1 we used the traditional values for the coefficients for the two gaps of the Taylor rule. The Taylor rule cash rate implied by the model differed from the actual cash rate on average by twenty basis points for the whole period (Macfarlane through Stevens). However, the period by period discrepancy averaged in absolute value terms 114 basis points. The correlation between the cash rate and the Taylor implied rate was .45.
A substantial dichotomy emerged between the Macfarlane and Stevens eras. The economy in the Macfarlane era outperformed with a 3.3% rate of real growth compared to 2.89% real growth rate in the Stevens era. The conduct of monetary policy appeared to follow the Taylor rule more closely under Governor Stevens. The cash rate and Taylor rule implied cash rate on average differed by 39 basis points under Governor Macfarlane and 8 basis points under Governor Stevens. The absolute difference averaged 143 basis points under the former and 71 basis points under the latter. Remarkably, the correlation of the Taylor implied cash rate and the cash rate was .22 under Governor Macfarlane, but .81 under Governor Stevens. This is fairly good when you consider the institutional practice of changing the cash rate in increments of 25 basis points.

In model 2 (inflation and output lagged) there were no notable differences from model 1.

Next in model 3 we look at the regression, based on model 1, in order to determine the reaction coefficients that would minimize the sum of the least squares. It is reasonable to suppose that the central bank might behave roughly along the lines of minimizing least squares. In other words its utility function might be quadratic, which is to say the RBA may be willing to settle for lower average performance in order to avoid the worst outcomes. Yet the calculation of deviations is not according to semi-variance so that strictly speaking it is large deviations, even if supportive of a good outcome, that are “penalized” by squaring the deviations.

The story of the regression equations can be summarised very simply: the adjusted R square was .25 for the whole period, .06 for the Macfarlane period and .55 for the Stevens period. The regressors explain the majority of the variation of the cash rate for the Stevens era and almost none of the variation of the cash rate for the Macfarlane era. In fact for the whole period and the Macfarlane period the signs of the coefficients were not always as predicted. In regard to the regression for the whole period the coefficients for the inflation gap and the output gap were highly significant, but oddly the coefficient for the output gap was negative. In using the t test the dummy variable representing the identity of the Governor was not statistically significant (p value of .11).

In contrast to the whole period and the Macfarlane period, the regression equation for the Stevens tenure as Governor produced coefficients with the predicted signs and with very high statistical significance. The p values were .00023 and .00022 for the inflation gap and output gap coefficients. Thus, we can reject the null hypothesis that the estimated coefficients differ from zero by chance. The coefficients turned out higher than the .5, .5 values of the classic Taylor equation. For the Glenn Stevens era the results of the regression indicate that the cash rate

\[ R_t = 4.59 + .82 (\Pi_t - \Pi_p) + .74 (Y_t - Y_f) + e_t \]  

where \( \Pi_t \) is the inflation rate, \( Y_t \) is the real growth rate of output, and \( e_t \) is the error of the regression equation.
The inflation gap had a coefficient of .82 and the output gap coefficient was .74. This means that when the inflation rate goes up by 1%, the RBA would raise the cash rate by 1% x (1+.82) or about 182 basis points. An increase of the output gap by 1% should lead to an increase in the cash rate of 1% x .74 or about 74 basis points.

The F test was highly significant for the Stevens era and the whole era indicating that we could reject the hypothesis that neither the inflation gap nor the output gap could explain the cash rate. However, for the Macfarlane era the F statistic had a p = .12 indicating that we could not reject the hypothesis that these two gaps are not statistically significant at the 95% or higher level of confidence.

Although of lesser importance than the coefficients we might examine, in light of the Taylor equation, the intercept term, which is 4.59 during the Stevens era. The equation has two terms that are not part of the explanatory gap variables. They are the real long run equilibrium interest rate and the inflation rate. The former is generally not observable. The latter had a value of 2.74 over the regression period. The regression implies a real rate of 4.59-2.77 = 1.82 over the regression period, an amount close to the assumed value of 2.00.

In model 4 we use the actual performance of Australian inflation and output as the targets in the Taylor equation; we re-run model 1 substituting the average inflation rates and output growth for the targets. On the whole the results worsened.

5. Summary and Conclusions

In this paper we compared the Taylor rule implied cash rate in Australia to the cash rate. We found no significant difference or improvement when we lagged output and inflation by an extra quarter. The data were already smoothed by taking 4 quarters of output growth and price increases. Regressions were run for the whole period and separately for the periods associated with Governors Macfarlane and Stevens. The results for the Stevens tenure produced statistically significant coefficients for the inflation gap and the output gap with the predicted signs. These coefficients exceeded the .5 coefficient value in the classic Taylor equation. This indicates somewhat greater central bank response in Australia to each of the two gaps.

References


Hernandez, J & Layton, A 2002, Regional appropriateness of monetary policy: an application of Taylor’s rule to Australian states and territories, Discussion paper no. 115, Queensland University of Technology, Brisbane QLD.


