Comparing the effects of three alternative monetary policies in the New Keynesian model

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1 The model

The basic New Keynesian (NK) model consists of a dynamic IS, an NK Phillips curve (NKPC) and an equation describing monetary policy. The latter can be assumed in an ad hoc manner, motivated by the empirical evidence or derived as the outcome of a policy maker aiming to achieve certain objectives.

This note provides a simple comparison of three versions of the model. They all share the same first two equations, the IS and the NKPC, which are given by

$$x_t E_t x_{t+1} - \frac{1}{\sigma}\left(i_t - E_t \pi_{t+1}\right) \tag{1}$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t + u_t \tag{2}$$

where x_t is the output gap, π_t is inflation, i_t the nominal interest rate and r_t^n is the natural rate of interest. The NKPC includes a shock u_t. For simplicity, we assume that both r_t^n and u_t are white noise processes with a variance of one.

2 Monetary policy

We consider three alternative monetary policies. For the first two, assume that the policy maker's objective is to minimise

$$E_0 \sum_{t=0}^{\infty} \left[\pi_t^2 + \vartheta x_t^2\right]$$

Under discretion, the resulting policy is given by

$$x_t = -\frac{\kappa}{\vartheta}\pi_t \tag{3}$$

whereas under commitment we have

$$\begin{aligned} x_t &= -\frac{\kappa}{\vartheta}\pi_t \quad t = 0 \\ x_t - x_{t-1} &= -\frac{\kappa}{\vartheta}\pi_t \quad t > 0 \end{aligned} \tag{4}$$

Note that in either case, as the model is linear quadratic (linear constraints and quadratic objective), we have certainty equivalence: the variances of the shocks have no effects on the policy. Thus, the policy maker behaves in exactly the same manner when shocks are very large as when their variances are zero (hence the name certainty). This would not be the case if we solved the model under an optimal simple rule where, for example, we set policy to equal

$$i_t = \phi\pi_t$$

and the ϕ is chosen to minimise the policy objective. In this case, the optimal ϕ would be a function of the volatilities of the shocks.[1]

Lastly, we can consider the effects of monetary policy following a Taylor rule

$$i_t = mu_1\pi_t + \mu_2 x_t \tag{5}$$

We assume that monetary policy responds to the output gap, rather than output so that we do not need to include an additional variable as this will not alter the key results we want to study.

3 Parameter values

For the comparison we wish to undertake, we shall assume that $\beta = 0.995$, $\kappa = 0.5$, $\sigma = 1$, $\mu_1 = 1.5$, $\mu_2 = 0.125$, $\vartheta = 0.5$ and the variances of the two shocks equal one. The main conclusions of the comparison are unaffected by these specific values.

4 Results

4.1 Shocks to the Phillips curve

Figure 2 shows the responses of infation and the output gap to a shock ut. As expected, te shock causes a contraction in the output gap and an increase in inflation. Focusing on the effects across the different policies we note that

[1] To solve this version of the model, combine the equations to obtain the msv solution for inflation and output, which will contain ϕ. Substitute this into the policy objective and the differentiate with respect to ϕ. For a more complex model you would need to use the computer.

- Commitment produces the smallest responses of both inflation and the output gap. Moreover, the effects of a purely transitory shock are persistent under commitment only.

- The responses under discretion are larger than those under commitment for both variables. The reason is that under commitment, the policy maker promises to deliver π_{t+1} so that the increase in the current inflation rate (due to u_t) is partly offset. How does it do this? By implementing contractionary monetary policy not only in the current period, but also in the following periods, even though the shock will by then have already expired.

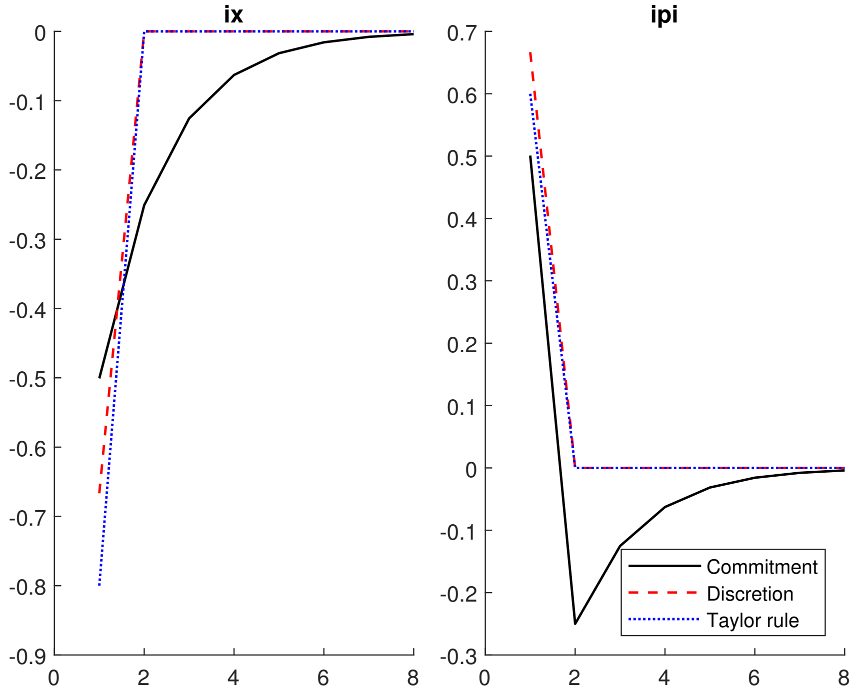
- Under the Taylor rule the inflation rate responds less to u_t and the output gap more, than under discretion. Recall that there is no reason for the Taylor rule to be anywhere close to optimal in this model as we have just imposed it.

4.2 Shocks to the natural rate of interest

Figure 2 plots the responses of inflation and the output gap to a shock r_t^n. In case it is not clear, the effects under either optimal policy are zero. Why? For the same reason that the IS can be ignored when obtaining the optimal policy. Consider the IS equation: a shock r_t^n affects the right hand side; i_t can be altered by a magnitude that fully offsets this and therefore the right hand side does not change at all, only its components. In other words, under the optimal policy, the central bank fully offsets any shocks arising from the IS.

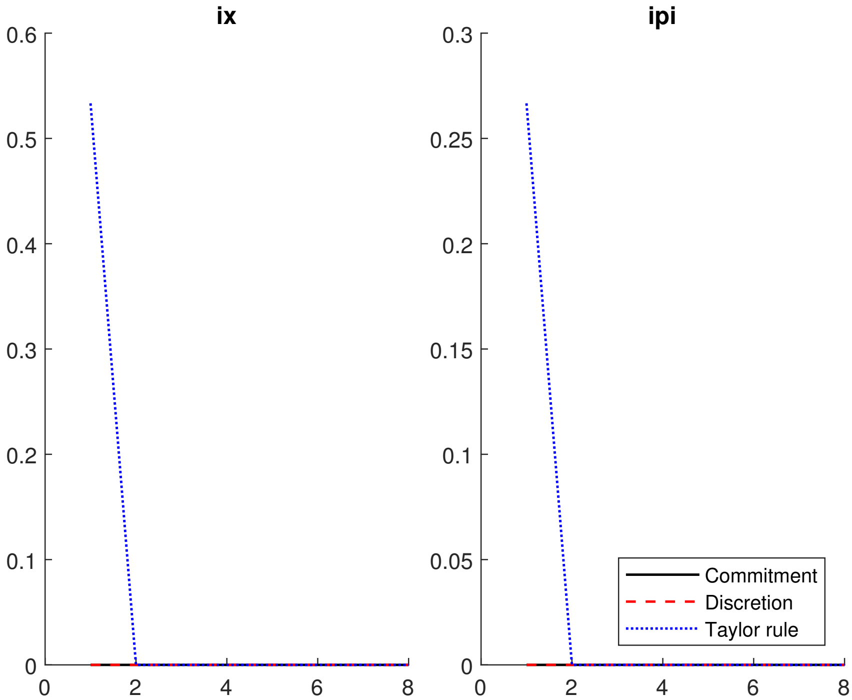
However, this is not the case under the Taylor rule (it would be if the μ_1 were sufficiently large but then this would have implications for the effects of the shock u_t). In this case, the shock is expansionary: both the output gap and the inflation rate increase. The reason? In the IS the real interest rate $r_t = i_t - E_t\pi_{t+1}$ does not rise as much as the natural rate of interest and it is this gap that affects x_t. Thus, the shock reduces $r_t - r_t^n$ and this causes x_t to rise.

Figure 1: Effects of a shock to the Phillips curve



The left panel shows the effects on the output gap and the one of the right represents inflation.

Figure 2: Effects of a shock to the natural rate of interest.



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