Monetary Policy Rules and the Persistence of Inflation and Output

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Abstract:

This paper argues that the parameters of monetary policy rules affect the persistence of inflation and output. Persistence is lower if monetary policy emphasises the price level or if there is an inflation target. A greater emphasis on output increases persistence. There is a simple New Keynesian interpretation of our findings: monetary policy rules affect persistence by affecting real rigidities.

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1) Introduction

Monetary policy rules have been widely used in recent years to describe the behaviour of policymakers (eg Taylor, 1993, Clarida et al, 1999) and to analyse optimal policy (Svennson, 1997). This paper develops that literature by arguing that monetary policy rules affect the persistence of inflation and output and that they do so by affecting real rigidities.

We consider a simple macroeconomic model in which policymakers manipulate aggregate demand using a monetary policy rule in which the nominal money supply responds to the deviations of output and the price level from their target or desired values. On the supply side, monopolistically competitive firms produce output using labour inputs. Price adjustment is staggered and modelled using the familiar Calvo (1983) framework.

We show that the parameters of the monetary policy rule affect the persistence of inflation and output. Persistence is lower if policymakers attach greater importance to the price level. If policymakers have a strict inflation target, there is no persistence. By contrast, persistence is high if policymakers give priority to attaining their target level of output. Our model has the New Keynesian property that persistence is higher when real rigidities are stronger (Ball and Romer, 1990). We argue that the parameters of monetary policy rules affect persistence by affecting the degree of real rigidity.

The remainder of the paper is structured as follows. Section 2 outlines our model. Section 3 describes how monetary policy rules affect persistence. Section 4 summarises and considers the wider implications of our work.

2) The model

There are a large number of identical monopolistically competitive firms Each firm has the simple production function

(1) $$y_{it} = l_{it}$$

where y_{it} is output in firm i at time t, l_{it} is employment in firm i at time t and all variables are expressed as natural logarithms. Each firm also faces the demand curve

(2) $$y_{it} = y_t - \eta(p_{it} - p_t)$$

where y_t is aggregate demand, p_{it} is the price set by firm i, p_t is the aggregate price level and η is the constant price elasticity of demand.

Firms hire labour on the labour market. We assume the labour market is imperfectly competitive and that the real wage is

(3) $$w_t - p_t = y_t / \rho$$

where w is the nominal wage. Equation (3) is a general expression for the real wage that can be derived from a number of models of imperfectly competitive wage determination such as efficiency wage theories or union-firms bargaining models. A larger value of ρ implies that real wages are less responsive to output.

The optimal price for each firm is simply a mark-up over the nominal wage. Using (3), the optimal price is therefore

(4) $$p^*_{it} = \mu + p_t + y_t / \rho$$

where p* is the optimal price and μ=(η/η-1) is the mark-up of price over marginal cost.

Aggregate demand is

(5) $$y_t = (m_t - p_t) + \varepsilon_t$$

where m is the nominal money supply and ε_t is an aggregate demand shock that is assumed for simplicity to be white noise and known at time t. Monetary policymakers manipulate aggregate demand using the monetary policy rule

(6) $$m_t = \bar{m} - \phi(p_t - p^T) - \psi(y_t - y^T)$$

where p^T is the target or desired price level and y^T is the target or desired level of output. The parameters ϕ and ψ reflect the importance policymakers attach to achieving their price and output targets. If $\phi \to \infty$ and $\psi \to 0$, the over-riding priority of policymakers is to achieve a price level of p^T. In this model, this is equivalent to a policy of strict inflation targeting (Bernanke et al, 1999). If $\psi \to \infty$ and $\phi \to 0$, the only objective of monetary policy is to achieve an output level of y^T. If $\phi = \psi$, policymakers pursue a target for nominal GDP, while if $\phi = \psi = 0$, policymakers target the money supply.

Combining (4), (5) and (6), we can express the optimal price as

$$p^*_{it} = \mu + \beta \hat{m} + (1-\beta) p_t + \frac{\beta}{1+\phi} \varepsilon_t \tag{7}$$

where $\hat{m} = \dfrac{\bar{m} + \phi p^T + \psi y^T}{1+\phi}$ and $\beta = \dfrac{1+\phi}{\rho(1+\psi)}$.

We assume that price adjustment is sluggish and use a version of the Calvo (1983) model of staggered price adjustment. For each firm, prices are adjusted with fixed probability λ and remain constant with probability $(1-\lambda)$. Then the price level is given by

$$p_{it} = \lambda \sum_{i=0}^{\infty} (1-\lambda)^i x_{it-j} = \lambda x_{it} + (1-\lambda) p_{it-1} \tag{8}$$

where p is the aggregate price level, x is the price chosen by firms, The price chosen when firms adjust is forward-looking:

$$x_{it} = \lambda \sum_{i=0}^{\infty} (1-\lambda)^i E_t p^*_{it+j} = \lambda p^*_{it} + (1-\lambda) E_t x_{it+1} \tag{9}$$

where we assume there is no discounting for simplicity.

3) Persistence

Combining equations (8) and (9) and aggregating, the aggregate price level is

(10) $$p_t = \frac{(1-\lambda)}{2(1-\lambda)+\lambda^2}(p_{t-1} + E_t p_{t+1}) + \frac{\lambda^2}{2(1-\lambda)+\lambda^2} p^*_t$$

Aggregating (7) and substituting into (10)

(11) $$p_t = A(p_{t-1} + E_t p_{t+1}) + (1-2A)(\frac{\mu}{\beta} + \hat{m} + \frac{\varepsilon_t}{1+\phi})$$

where $A = \frac{1-\lambda}{2(1-\lambda)+\beta\lambda^2}$. Solving this difference equation, prices can be expressed as

(12) $$p_t = \theta p_{t-1} + (1-\theta)(\frac{\mu}{\beta} + \hat{m} + \frac{\varepsilon_t}{1+\phi})$$

where

(13) $$\theta = B - \sqrt{B^2 - 1}; \qquad B = 1 + \frac{\beta\lambda^2}{2(1-\lambda)}.$$

From equation (13) and the definition of β we obtain

(14) $$\frac{d\theta}{d\lambda} < 0; \quad \frac{d\theta}{d\beta} < 0; \quad \frac{d^2\theta}{d\lambda d\beta} < 0; \quad \frac{d\beta}{d\phi} > 0 \text{ and } \quad \frac{d\beta}{d\psi} < 0.$$

Based on equation (12) inflation is then simply

(15) $$\pi_t = \theta\pi_{t-1} + \frac{1-\theta}{1+\phi}(\varepsilon_t - \varepsilon_{t-1})$$

where $\pi_t = p_t - p_{t-1}$ is the inflation rate. Substituting (12) and (6) into (5), we can also express output as

(16) $$y_t = \theta y_{t-1} - (1-\theta)\rho\mu + \frac{\theta}{1+\psi}(\varepsilon_t - \varepsilon_{t-1})$$

Equations (15) and (16) establish our main result, which is that the parameters of the monetary policy rule affect the persistence of inflation and output. If policymakers place greater emphasis on the price level, then ϕ is large and ψ is small. From (7) (13), and (14) this implies that β will be higher and so inflation and output will be less persistent. A similar argument shows that a greater emphasis on output creates more persistence. If policymakers have a strict inflation target there is no persistence ($\theta \to 0$) and prices are at their target level ($p \to p^T$).

We can give our findings a simple New-Keynesian interpretation. Nominal rigidity is measured by $(1-\lambda)$, the proportion of firms who do not adjust price, and real rigidity is measured by $(1-\beta)$, the impact of the aggregate price level on each firms' optimal price (Romer, 2001). From (14), we note that persistence is greater when nominal rigidity is stronger, $\frac{d\theta}{d(1-\lambda)} > 0$, and this effect is stronger with stronger rigidities, $\frac{d^2\theta}{d(1-\lambda)d(1-\beta)} > 0$. Our model therefore has the New Keynesian property that persistence is due to nominal rigidity and that the impact of nominal rigidity is greater where real rigidity is stronger (Ball and Romer, 1990).

From (7), we note that real rigidity is lower when real wages are more responsive to output. Therefore persistence is stronger when real wages are less responsive to output (Ball and Romer, 1990). But real rigidity is also affected by the parameters of the monetary policy rule. If policymakers emphasize the price level, or adopt an inflation target, then, from (7), ϕ is large relative to ψ, so β is large. This means that real rigidity is low and, from (13), there is less persistence in inflation and output. Intuitively, policymakers will respond to shocks that tend to move prices away from their target value by offsetting changes in the nominal money supply. Desired relative prices in (7)

are therefore less responsive to the aggregate price level. By contrast, if policymakers place greater emphasis on output, then β is small. Real rigidity is stronger, leading to greater persistence. In this case, monetary policy will tend to accommodate movements in the price level and so desired relative prices are more responsive to the aggregate price level.

4) Conclusions

This paper has argued that the parameters of monetary policy rules affect the persistence of output and inflation and that a greater emphasis on stabilising prices (for example, through an inflation target) reduces the persistence of inflation and output. We also argue that monetary policy rules affect persistence by affecting the degree of real rigidity.

Our analysis can be extended in a number of ways. We could consider a more complete model where aggregate demand depended on the real interest rate and where policymakers control the nominal interest rate, in which case we could model monetary policy using a Taylor rule (Taylor, 1993). We could consider a more detailed model of nominal rigidity, such as the staggered adjustment model of Taylor (1979), in which case the frequency of price adjustment may also be affected by the monetary policy rule. We could also analyse a more detailed model of the labour market, allowing wage setting to be influenced by the monetary policy rule. We would expect to find a similar link between monetary policy rules and persistence in these more sophisticated models.

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