Monetary Theory II

The earlier monetary theory framework in Monetary Theory I assumed the followings:

1. Static model / one-period interaction in the conduct of monetary policy. There are no time dimensions or concerns over future periods in making monetary policy decisions.
2. Flexible prices. The authority can also directly influence π without transmission mechanism
3. Inflationary bias can only arise if the authority sets an output target (ky^*) above its natural level, i.e. $k > 1$. If $k = 1$, there will be no inflationary bias and no gains from commitment to rules compared to discretion.

In practice, however, the monetary authority is unlikely to be as myopic as the static models assume. With a time span in office greater than one-period, it will have continuous interaction with private agents, and the temptation to cheat to have one-period gain will be tempered by any resultant inflationary bias in subsequent periods. Two important strands have emerged in the literature which considers monetary policy in a dynamic setting: models which emphasize the reputation of the policy maker[1] and models which employs a timeless perspective[2]. Moreover, price adjustments are subject to some degree of frictions, therefore prices are not completely flexible. The recent developments in the theory of monetary policy addressed the weaknesses of earlier models within a New-Keynesian framework. It is possible to show that:

'…in the presence of a trade-off between output and inflation, society will generally gain from having a central bank that can (credibly) commit to a state-contingent plan, even in the absence of a classic inflationary bias, i.e. even if the central bank has no desire to push output above its natural level. That result overturns an implication of the classic Barro-Gordon analysis, where the gains from commitment arise only if the central bank sets a target for output that does not correspond to its natural level…' (Gali (2001) pp.3).

---

1 Barro, R. J. and Gordon, D.B. (1983), 'Rules, Discretion and Reputation in a Model of Monetary Policy', Journal of Monetary Economics, 12, pp. 101-121

Backus, D. and Driffill, J. (1985), 'Inflation and Reputation', American Economic Review, 75, pp. 530-538

2 Woodford, M. (1999), 'Commentary: How Should Monetary Policy be Conducted in an Era of Price Stability?', Prepared for New Challenges for Monetary Policy, a symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming, August 26-28, 1999.

This result occurs because, where prices are sticky, current price setting depends upon expectations of the future: a credible commitment to fight inflation in the future can improve the current output/inflation trade-off faced by a central bank. Specifically, it can reduce the effective cost in terms of current output loss that is required to lower current inflation.

Dynamic framework with sticky prices: New-Keynesian monetary policy[3]

I. The sticky price New-Keynesian model of inflation (Aggregate Supply)

$$\pi_t = \lambda y_t^g + \beta E_t \pi_{t+1} + u_t \qquad \text{A.}$$

y^g_t : output gap (= $y - y^*$ in the static model)

λ and β: positive parameters with β, the discount factor, less than one.

u_t : supply shock that takes the autoregressive form of order 1 (AR(1)) $u_t = \rho u_{t-1} + \hat{u}_t$, where $\rho < 1$ and $\hat{u}_t \sim i.i.d.(0, \rho^2_u)$

The derivation of (A) was based on price-setting model by Calvo (1983).[4] The gist of the model was profit maximisation by setting prices as mark-ups over marginal costs subject to limited probability of re-setting prices in each period. Once able to reset prices, firms need to form expectations on what will happen to prices in the following periods, hence the term: $E_t\pi_{t+1}$.

Marginal costs are assumed to be directly related to output gap owing to a linear form of production function with a single input, which is labour. Therefore, marginal costs, i.e. wages are closely related to labour supply, which in turns determines the level of output, hence the term y^g_t .

II. Aggregate demand (dynamic IS curve)

$$y_t^g = -\frac{1}{\sigma}[r_t - E_t \pi_{t+1} - rr] + E_t y_{t+1}^g + g_t \qquad \text{B.}$$

r: nominal interest rate

rr: rate of time preference

g: government expenditure

---

[3] Clarida, R., Gali, J. and Gertler, M. (1999), 'The Science of Monetary Policy: A New Keynesian Perspective', Journal of Economic Literature, 37, pp. 1661-1707

[4] Calvo G (1983), 'Staggered prices in a utility-maximising framework', Journal of Monetary Economics, 12, pp. 383-98

σ: positive parameter

The intuition behind IS relation, was household optimisation by maximising discounted stream of utility (consumption and labour supply) subjected to budget constraints (consumption expenditure and wages). Interest rate (policy instrument) is incorporated into the calculation of the present value of spending and wages.

III. Government's objective function

$$\text{Maximise } -\frac{1}{2}E_t\left[\sum_{i=0}^{\infty}\beta^i\left(ay_t^{g\,2}+\pi_{t+i}^2\right)\right] \qquad \text{C.}$$

where a indicates the weight attached to output in the loss function. Note that in this loss function there is no presumption that the central bank is aiming to achieve a higher level of output than the natural level.

<u>Policy setting in each period:</u>

1. Optimal conditions of output and inflation are found from minimisation of the loss function subject to the aggregate supply.
2. From the aggregate demand function, interest rate, consistent with optimal conditions of output and inflation, is chosen.
3. Once interest rate is changed, output is affected through aggregate demand function, then via aggregate supply, inflation is altered.

$$\Delta r \longrightarrow \Delta y \text{ in } AD \longrightarrow \Delta\pi \text{ in } AS$$

<u>Discretion:</u>

- In each period, the authority chooses y^g_t and π_t to maximize

$$-\frac{1}{2}\left[ay_t^{g\,2}+\pi_t^2\right]-\frac{1}{2}E_t\left[\sum_{i=1}^{\infty}\beta^i[ay_{t+i}^{g\;2}+\pi_{t+i}^2]\right]$$

subject to A.

- From the optimization, we obtain the First Order Condition (F.O.C.)

$$y_t^g = -\frac{\lambda}{a}\pi_t$$

and from A. :

$$\pi_t = \frac{a}{a+\lambda^2}\left[\beta E_t\pi_{t+1}+u_t\right]$$

- Combining F.O.C. with A, equilibrium output gap and inflation are:

(Hint: in solving this, assume the solution takes a linear form: $\pi_t = X + Yu_t$):

$$y_t^g = -\lambda q u_t \text{ and } \pi_t = aqu_t \text{ where } q = \frac{1}{\lambda^2 + a(1-\beta\rho)}$$

In the presence of supply shock, there is some policy-trade-off. Even if the central bank targets the natural rate of output, with aggregate supply shock, the central bank will allow higher *current* inflation and lower *current* output. In an absence of further shocks, the central bank will then allow inflation to gradually drift towards the target (zero):

$$E_t \pi_{t+1} = aq\rho u_t$$

$$\ldots.$$

$$E_t \pi_{t+i} = aq\rho^i u_t \to 0 \text{ as } i \to \infty$$

This may be described as inflation targeting regime, under which the central bank does not explicitly attempt to control the current level of inflation but aim to keep inflation rate *going forward* as close as possible to the target. Targeting current inflation is only feasible if there is no supply shock or $\lambda = 0$.

<u>Rule:</u>

- If the authority credibly commits to a rule of the form[5]:

$$y_t^{gc} = -\omega u_t$$

for all *t*, where $\omega > 0$ is the coefficient of the feedback rule, and where y^{gc}_t denotes the value of y^g_t conditional on commitment to the policy.

To find an optimal solution under this rule, first we iterate the Phillips curve forward:

$$\pi_t^c = \lambda y_t^{gc} + \beta E_t \pi_{t+1}^c + u_t$$

$$= E_t \sum_{i=0}^{\infty} \beta^i \left[\lambda y_{t+i}^{gc} + u_{t+i} \right]$$

and given commitment to rule above A. is transformed to:

$$\pi_t^c = \frac{1-\lambda\omega}{1-\beta\rho} u_t = \frac{\lambda}{1-\beta\rho} y_t^{gc} + \frac{1}{1-\beta\rho} u_t$$

From this new Phillips curve, if the authority would like to disinflate, contraction in output of 1% leads to a reduction in inflation of $\frac{\lambda}{1-\beta\rho}$, which is greater than the case of discretion (λ).

5 Of course, the central bank need not commit to this particular form of a rule. The point here is just to show that discretion can be improved upon by some form of rule.

Improvements in output/inflation trade-off are consequences of commitment to policy rule on expectations of output gap now and periods thereafter ($E_t^c y_{t+i}^{gc} = -\omega u_t$), which then affect inflation.

The action plan under rule can be derived by optimizing a similar loss function as in the case of discretion, but subject to the new Phillips curve. The optimal rule is:

$$y_t^{gc} = -\frac{\lambda}{a(1-\beta\rho)}\pi_t^c$$

which shows a commitment to engineer greater contraction in output in response to inflationary pressure than the case of discretion ($y_t^g = -\frac{\lambda}{a}\pi_t$). Under rule, output responds more aggressively to inflation (as the cost of disinflation is now lower, the central bank can afford to be more aggressive). From this result, ω can also be found. Under rule:

$$\pi_t^c = \frac{a(1-\beta\rho)}{a(1-\beta\rho)^2 + \lambda^2}u_t$$

$$y_t^{gc} = -\frac{\lambda}{a(1-\beta\rho)^2 + \lambda^2}u_t$$

Compared to discretion, output is more volatile than inflation under rule (similar to attaching greater weight to inflation relative to output).

Therefore, even without an output target greater than the natural level of output, commitment to rule improves the trade-off between inflation and output leading to an overall improvement in social welfare. Rule is, thus, superior to discretion.