A preliminary look at monetary policy in the basic new Keynesian model

This description follows (Gali, J. 2008). We first characterize the efficient allocation of resources in the model with monopolistic firms, in which a lump-sum subsidy is applied that guarantees the efficiency. The objective of the monetary authority is to try to attain this efficiency, which apparently is lacking in the event of sticky prices. This can be achieved by pursuing a policy that stabilizes the price level.

Flexible prices and efficiency

It is then assumed that a benevolent social planner tries to maximize the representative household's welfare, given technology and preferences, i.e. for each period maximize $U(C_t, N_t)$ subject to the constraint $C_t(i) = A_t N_t(i)^{1-\alpha}$ for all i where $C_t = \left(\int_0^1 C_t(i)^{1-\frac{1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}}$ and $N_t = \int_0^1 N_t(i)di$.

The optimality conditions are

$$C_t(i) = C_t$$
$$N_t(i) = N_t$$
$$-\frac{U_{n,t}}{U_{c,t}} = (1-\alpha)A_t N_t^{-\alpha}$$

where $(1-\alpha)A_t N_t^{-\alpha} = MPN_t$, which implies that the marginal rate of substitution between consumption goods and leisure should equal the marginal rate of transformation. The efficient allocation implied by these optimality conditions are then violated once we consider: (1) firms in monopolistic competition, with some market power and (2) sticky prices.

Monopolistic competition

The monopolistic firms, assuming for the moment flexible prices, will all charge the price

$$P_t = \mathrm{M}\frac{W_t}{MPN_t}$$

i.e. a uniform and constant markup on marginal cost, where $\mathrm{M} = \frac{\varepsilon}{\varepsilon - 1} > 1$. Therefore,

$$-\frac{U_{n,t}}{U_{c,t}} = \frac{W_t}{P_t} = \frac{MPN_t}{\mathrm{M}} < MPN_t$$

and the efficiency condition in the competitive economy is violated. The levels of employment and production will be too low. This inefficiency can be eliminated through a suitable employment subsidy which is assumed to be financed by lump-sum taxes. Prices will now be charged

$$P_t = \mathrm{M}\frac{(1-\tau)W_t}{MPN_t}$$

and τ chosen such that $M(1-\tau)$=1, which amounts to setting $\tau = \frac{1}{\varepsilon}$. The new Keynesian models assume that such a subsidy is in place and hence that the flexible price equilibrium is efficient.

Sticky prices

The introduction of sticky prices means that since firms do not adjust their prices continuously the economy's average markup will vary over time in response to shocks in the economy and differ from the average markup M in the flexible-price economy. The average markup with sticky prices will then be

$$\mathrm{M}_t = \frac{P_t}{(1-\tau)(W_t / MPN_t)} = \frac{P_t\mathrm{M}}{(W_t / MPN_t)}$$

where the second equality follows from the assumption that the chosen τ corrects the inefficiency created by monopolistic competition. It follows that

$$-\frac{U_{n,t}}{U_{c,t}} = \frac{W_t}{P_t} = MPN_t \frac{\mathrm{M}}{\mathrm{M}_t}$$

and we can see that the inefficiency appears to the extent that the markup actually set deviates from the desired markup in the flexible-price economy. The efficient allocation can only be restored in case the monetary authority manages to stabilize the economy's average markup M_t to the efficient level M. The presence of sticky prices creates two inefficiencies. The one above implies that the economy's aggregate level of employment and output may be too low or too high. The other inefficiency follows from the fact that relative prices are changed due to the unsynchronized prices which implies that the allocation of resources is affected and becomes inefficient. The monetary authority may restore both of these inefficiencies through stabilizing the price level, in which case there would be no incentive for firms to change prices (the markup is at its desired level).

Optimal monetary policy

The efficient allocation can be attained by a monetary policy that stabilizes marginal cost at a level consistent with firms' desired markups, given the predetermined prices. With that policy, no firm has an incentive to change its price. That implies $P_t^* = P_{t-1}$ and $P_t = P_{t-1}$. The aggregate price level then is stabilized and there are no relative price distortions. In addition, $\mathrm{M}_t = \mathrm{M}$.

The optimal policy then requires

$$y_t = y_t^n$$
$$\pi_t = 0$$

which through the dynamic IS equation implies

$$i_t = r_t^n$$

for all t.

This means that the policy maker has no incentive to stabilize output, since output moves optimally with natural output, which in turn could be volatile. Secondly, the price stability condition is not a primary goal in itself, but rather connected to the objective of restoring the efficient allocation of resources.

To arrive at an optimal interest rate rule we investigate rules that obtains the objectives $y_t - y_t^n = \pi = 0$ applied to the two basic equations, the dynamic IS curve and the Phillips curve

$$y_t - y_t^n = E_t\left\{y_{t+1} - y_{t+1}^n\right\} - \frac{1}{\sigma}\left(i_t - E_t\left\{\pi_{t+1}\right\} - r_t^n\right)$$
$$\pi_t = \beta E_t\left\{\pi_{t+1}\right\} + \kappa\left(y_t - y_t^n\right)$$

Three policy rules are considered:

(a) $i_t = r_t^n$
(b) $i_t = r_t^n + \phi_\pi \pi_t + \phi_y (y_t - y_t^n)$
(c) $i_t = r_t^n + \phi_\pi E_t\left\{\pi_{t+1}\right\} + \phi_y E_t\left\{y_{t+1} - y_{t+1}^n\right\}$

The first rule (a) implies that the second term on the RHS of the dynamic IS equation is zero and hence that $y_t - y_t^n = E_t\left\{y_{t+1} - y_{t+1}^n\right\}$ and is a natural candidate. The second and third rules also implies that the central bank sets the interest as soon as the economy deviates from the targets for the efficient allocation.

All rules can generate the efficient equilibrium. However, in the first rule (a) the equilibrium is not unique, which means that another, inefficient equilibrium, might be realized when using this policy rule. For the other two rules a unique equilibrium can be guaranteed under certain conditions regarding the parameters ϕ_π and ϕ_y. For the rule (b) the condition is $\kappa\left(\phi_\pi - 1\right) + (1-\beta)\phi_y > 0$ which implies that the central bank should adjust the interest rate aggressively. The condition implies that the parameters should be sufficiently large so that it ensures that the real interest rate is increased in the event of a rise in the inflation rate. In particular, $\phi_\pi > 1$ and $\phi_y \geq 0$. Similar conditions can be derived for the forward-looking rule (c), but results in parameter regions that are unrealistically high.

Problems with the optimal rules

The most attractive rule of the three considered seems to be (b). However, this rule requires the knowledge of r_t^n and y_t^n which are both unobservable variables. The most problematic variable is the natural interest rate, since the knowledge of the natural rate of output is not required if the central bank chooses a strict inflation target with $\phi_y = 0$.

The problems with these optimal rules instead have led researchers to try out simple rules that are functions of observables only. The possible success of rules are evaluated in loss functions which estimate the utility loss experienced by the representative consumer (measured as the loss from a fraction of permanent consumption). The loss function would be

$$L = \frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t \left[\left(\sigma + \frac{\varphi + \alpha}{1-\alpha} \right) \left(y_t - y_t^n \right)^2 + \frac{\varepsilon}{\lambda} \pi_t^2 \right]$$

where loss is increasing in σ, φ, α which reflects the fact that larger values of these parameters amplify any output gap's effect on the difference between the marginal rate of substitution between consumption and leisure and the marginal product of labor, which is the measure of inefficiency gap in the model. The loss is increasing in ε, which reflects the increasing loss experienced from a given price dispersion ($\varepsilon = 0$ would give no such loss, i.e. no relative price effects). The loss is increasing in θ (θ is inversely related to λ) which reflects that increased stickiness increases price dispersion. By choosing a simple policy rule it is then possible to calibrate/estimate the model and calculate the welfare losses.

Loss with Taylor rules

It is now possible to evaluate the welfare effects from so called Taylor rules, as originally done in (Rotemberg, J. J., M. Woodford and J. B. Taylor 1999) and in (Clarida, R., J. Gali and M. Gertler 1999, Woodford, M. 2003). (Gali, J. 2008) uses the Taylor rule

$$i_t = \rho + \phi_\pi \pi + \phi_y (y_t - y)$$

where *y* is the steady state output and computes the welfare losses.

	Taylor Rule			
ϕ_π	1.5	1.5	5	1.5
ϕ_y	0.125	0	0	1
$(\sigma_\zeta, \rho_\zeta)$	—	—	—	—
$\sigma(\tilde{y})$	0.55	0.28	0.04	1.40
$\sigma(\pi)$	2.60	1.33	0.21	6.55
welfare loss	0.30	0.08	0.002	1.92

Table 1. Welfare losses and deviations from targets with different parameterizations of Taylor rule.

As can be seen in the table the highest welfare is obtained when the weight on output gaps is set to zero. A Taylor rule with an aggressive response to deviations from the inflation target (zero in this case) is optimal.

References

CLARIDA, R., J. GALI, and M. GERTLER (1999): "The Science of Monetary Policy: A New Keynesian Perspective," *Journal of Economic Literature*, 37, 1661-1707.

GALI, J. (2008): *Monetary Policy, Inflation, and the Business Cycle*. Princeton: Princeton University Press.

ROTEMBERG, J. J., M. WOODFORD, and J. B. TAYLOR (1999): "Interest Rate Rules in an Estimated Sticky Price Model," in *Monetary Policy Rules*. NBER Conference Report series. Chicago and London: University of Chicago Press, 57-119.

WOODFORD, M. (2003): *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton, NJ: Princeton University Press.