Monetary Economics

Lecture 8: monetary policy in the new Keynesian model, part one

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2nd Semester 2014

This class

- Monetary policy in the new Keynesian model, part one
  - efficient allocations, sources of distortion
- Reading: Gali, chapter 4 section 4.1–4.2

This class

1- Efficient allocations

2- Sources of suboptimality in the new Keynesian model

- digression on profits and taxes

3- Optimal policy

Efficient allocations

- Social planner maximizes utility

$$U(C, N), \qquad C \equiv \left(\int_0^1 C(j)^{\frac{\varepsilon-1}{\varepsilon}} \, dj \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

subject to the physical resource constraints

$$C(j) = Y(j) = A \, N(j)^{1-\alpha}, \qquad \text{for all } j \in [0, 1]$$

and

$$N = \int_0^1 N(j) \, dj$$

- Once again, this is an entirely *static* problem

Efficient allocations

- Lagrangian for this problem

$$
\begin{aligned}
L &= U\left[\left(\int_0^1 C(j)^{\frac{\varepsilon-1}{\varepsilon}}\,dj\right)^{\frac{\varepsilon}{\varepsilon-1}}, \int_0^1 N(j)\,dj\right] \\
&\quad + \int_0^1 \lambda(j)[A\,N(j)^{1-\alpha} - C(j)]\,dj
\end{aligned}
$$

- First order conditions

$$
C(j) \quad : \quad U_c(C,N)\left(\frac{C(j)}{C}\right)^{-\frac{1}{\varepsilon}} = \lambda(j)
$$

and

$$
N(j) \quad : \quad -U_n(C,N) = (1-\alpha)\,A\,N(j)^{-\alpha}\lambda(j)
$$

Efficient allocations

- The first order conditions imply that for all j

$$\begin{aligned} C(j) &= C \\ N(j) &= N \end{aligned}$$

(because utility is concave and the goods are perfectly symmetric)

- The aggregates C, N satisfy the marginal rate of substitution equal marginal rate of transformation condition

$$-\frac{U_n(C,N)}{U_c(C,N)} = (1-\alpha)AN^{-\alpha}$$

and the aggregate resource constraint

$$C = AN^{1-\alpha}$$

Suboptimality in the new Keynesian model

- Two sources of suboptimality

  1- imperfect competition
  (firms set markup over marginal cost, lower output)

  2- nominal rigidity
  (time variation in markups, distorts cross-sectional relative prices)

Decentralized equilibrium with flexible prices

- Imperfect competition but flexible prices
- Gives "natural" output etc underlying the new Keynesian equilibrium
- Reminder

$$-\frac{U_n(C,N)}{U_c(C,N)} = \frac{W}{P}, \qquad P = \frac{\varepsilon}{\varepsilon - 1}\left(\frac{1}{1-\alpha}\right)\frac{W}{A}\left(\frac{C}{A}\right)^{\frac{\alpha}{1-\alpha}}$$

Since $C = AN^{1-\alpha}$, markup implies real wage

$$\frac{W}{P} = \frac{\varepsilon - 1}{\varepsilon}(1-\alpha)AN^{-\alpha}$$

Labor not paid its social marginal product

Decentralized equilibrium with flexible prices

- Can correct markup distortion with tax/subsidy scheme

- Let price received by firm be scaled by tax τ

$$(1-\tau)P = \frac{\varepsilon}{\varepsilon - 1}\left(\frac{1}{1-\alpha}\right)\frac{W}{A}\left(\frac{C}{A}\right)^{\frac{\alpha}{1-\alpha}}$$

- Implement marginal cost pricing by

$$1-\tau = \frac{\varepsilon}{\varepsilon - 1} \Leftrightarrow \tau = -\frac{1}{\varepsilon - 1} < 0$$

(a subsidy, makes sense since otherwise output too low)

Digression on profits in the decentralized model

- For simplicity, suppose constant marginal costs ($\alpha = 0$)

- Profits to producer of variety j are

$$\Pi(j) \equiv \left[P(j) - \frac{W}{A}\right] Y(j)$$

where

$$Y(j) = \left(\frac{P(j)}{P}\right)^{-\varepsilon} Y$$

- With constant optimal markup, simplifies to

$$\Pi = \frac{1}{\varepsilon - 1} \frac{W}{A} Y$$

Digression on profits in the decentralized model

- Budget constraint of household

$$PC = WN + \Pi$$

- In equilibrium, pricing behavior of firms implies

$$PC = \frac{\varepsilon}{\varepsilon - 1}\frac{W}{A}C = \frac{\varepsilon}{\varepsilon - 1}WN$$

- And equilibrium profits are

$$\Pi = \frac{1}{\varepsilon - 1}\frac{W}{A}Y = \frac{1}{\varepsilon - 1}WN$$

- So this all adds up (yay)!

Digression on profits in the decentralized model

- With tax/subsidy

$$\Pi(j) \equiv \left[(1-\tau)P(j) - \frac{W}{A}\right] Y(j)$$

- When subsidy is $1-\tau = \varepsilon/(\varepsilon-1)$, this simplifies to

$$\Pi = \frac{1}{\varepsilon - 1}\frac{W}{A}Y$$

(same as without tax/subsidy, since *net* price unchanged)

Digression on profits in the decentralized model

- Budget constraint of household, now with lump sum taxes

$$PC = WN + \Pi - T$$

- In equilibrium, pricing behavior of firms implies

$$PC = \frac{1}{1-\tau}\left(\frac{\varepsilon}{\varepsilon - 1}\right)\frac{W}{A}C = WN$$

- Thus

$$T = +\Pi$$

- With this subsidy, equilibrium is same as planner's allocation

Distortions due to nominal rigidity

- Calvo pricing implies time-varying *average markup* $\mathcal{M}_t$

- Write this as

$$(1-\tau)P_t = \mathcal{M}_t MC_t$$

where P_t is price level, MC_t is average marginal cost

- When we eliminate the static imperfect competition distortion with the subsidy $1-\tau = \mathcal{M}$ we can say

$$\frac{P_t}{MC_t} = \frac{\mathcal{M}_t}{\mathcal{M}}$$

- Define average marginal product of labor

$$MC_t = \frac{W_t}{MPN_t}$$

Distortions due to nominal rigidity

- Putting these together we can say

$$\frac{W_t}{P_t} = \frac{\mathcal{M}}{\mathcal{M}_t} MPN_t$$

and since the household is on its labor supply curve

$$-\frac{U_n(C_t, N_t)}{U_c(C_t, N_t)} = \frac{\mathcal{M}}{\mathcal{M}_t} MPN_t$$

- To extent $\mathcal{M}_t \neq \mathcal{M}$, we have *wedge* between marginal rate of substitution and marginal rate of transformation between C and N

  – implies aggregate output, employment generally too high or too low

Relative price dispersion & agg. productivity

- Aggregation. Start with

$$N = \int_0^1 N(j)\, dj$$

- From production function for each j

$$Y(j) = AN(j)^{1-\alpha} \qquad \Leftrightarrow \qquad N(j) = \left(\frac{Y(j)}{A}\right)^{\frac{1}{1-\alpha}}$$

- Demand curve for each product

$$Y(j) = \left(\frac{P(j)}{P}\right)^{-\varepsilon} Y$$

- Therefore

$$N = \int_0^1 \left[\left(\frac{P(j)}{P}\right)^{-\varepsilon} \frac{Y}{A}\right]^{\frac{1}{1-\alpha}} dj$$

Relative price dispersion & agg. productivity

- Gives aggregate production function

$$Y = ADN^{1-\alpha}$$

- Aggregate productivity (Solow residual) is AD where D is a measure of *inefficient relative price dispersion*

$$D \equiv \left[\int_0^1 \left(\frac{P(j)}{P} \right)^{\frac{\varepsilon}{\alpha-1}} dj \right]^{\alpha-1} \leq 1$$

- D is decreasing in amount of cross-sectional price dispersion

  – in this example, efficient allocation features *no* price dispersion
  – economy is inside production possibility frontier if $D < 1$

- **Important:** Dispersion term drops out if log-linearize around zero inflation (2nd order in that case), *but not generally*

Optimal policy in the new Keynesian model

- Simple calculation. Suppose initial condition $P_{-1}(j) = P_{-1}$ for all j (no cross-sectional relative price dispersion, $D_{-1} = 1$)

- Suppose $P_t^* = P_{t-1}$ for all that get opportunity for $t = 0, 1, 2, ...$ then no relative price dispersion going forward $D_t = 1$

- If so, optimal markup $\mathcal{M}_t = \mathcal{M} = \epsilon/(\epsilon - 1)$. Efficient allocations can be implemented with subsidy

Optimal policy in the new Keynesian model

- In short, for all $t = 0, 1, 2....$

$$\begin{aligned} \pi_t &= 0 \\ \tilde{y}_t &= 0 \\ i_t &= r_t^n \end{aligned}$$

- Output fluctuates, $y_t = y_t^n$. Output *gap* fluctuations eliminated

- Price stability, but not because valued for own sake, rather to mitigate distortions caused by nominal rigidity

Next class

- Monetary policy in the new Keynesian model, part two

  – equilibrium stability and uniqueness
  – implementation of optimal policy

- Reading: Gali, chapter 4 section 4.3–4.4