Dynamic Macroeconomics

Chapter 9: Imperfectly flexible prices

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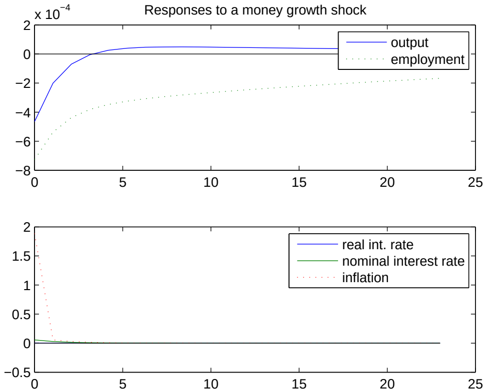
Overview

1. Introduction and motivation
2. Price-setting under imperfect competition

Introduction and motivation

- Effects of a monetary impulse in an economy with flexible prices:



$\Longrightarrow$ Monetary decisions have almost no real effects.

Introduction and motivation

- Evidence suggests that nominal prices are sticky in the short run:
  - Bils and Klenow (2004): Prices in the United States are changed on average every six months.
  - Alvarez et al. (2006): Prices in the euro area are changed on average every ten to twelve months.

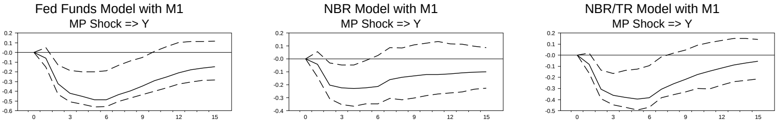
$\Longrightarrow$ Monetary policy has influence on real variables in the short run.

$\Longrightarrow$ Ben Bernanke (Interview, June 2004):

The second issue is that these models [RBC models] abstract from sticky wages and prices and hence from the possibility of short-run deviations of output from full employment. They don't have any substantial role for stabilization policies. I believe that we live in a world where stabilization policy - stabilization of inflation as well as output - is sometimes needed.

Introduction and motivation

- Effect of a monetary shock (Christiano, Eichenbaum and Evans, 1997)



$\Longrightarrow$ Monetary shocks have relatively sizeable and persistent real effects.

Introduction and motivation

- To model price-setting in macro models several approaches have been developed.
- Leading examples are:
  - Calvo pricing (Calvo, 1983)
  - Staggered wage setting (Taylor, 1979)
  - Quadratic adjustment costs (Rotemberg, 1982)
  - Menu-cost models (Akerlof and Yellen, 1985)

$\Longrightarrow$ Most popular: Calvo pricing (and - increasingly - menu-cost models).

Price-setting under imperfect competition

- We consider the supply side of the economy.
- There is one representative firm.
- This firm has monopolistic power.
- The firm produces good Q using input factors X_1, X_2, ..., X_n.
- To produce the good the firm has access to a production function:

$$Q = F\left(X_1, X_2, \ldots, X_n\right), \;\; F' > 0, \;\; F'' < 0 \tag{1}$$

- The cost of production, C, are given by:

$$C = \sum_{i=1}^{n} W_i X_i \tag{2}$$

where W_i denotes the price of input factor X_i.

Price-setting under imperfect competition

- The price of input factor X_i increases with X_i, i.e. we have:

$$W_i = W(X_i),\ W'(X_i) > 0 \tag{3}$$

- The firm faces a downward-sloping demand for its product:

$$P = P(Q),\ P'(Q) < 0 \tag{4}$$

- The firm's maximization problem is given by:

$$\max_{Q, X_1, X_2, \dots, X_n} PQ - C \tag{5}$$

s.t.

$$P = P(Q) \tag{6}$$

$$C = \sum_{i=1}^{n} W_i X_i \tag{7}$$

$$Q = F(X_1, X_2, \dots, X_n) \tag{8}$$

Price-setting under imperfect competition

- The associated Lagrange function is given by:

$$\mathcal{L} = P(Q)Q - \sum_{i=1}^{n} W(X_i)X_i + \lambda \left[F\left(X_1, X_2, \ldots, X_n\right) - Q \right] \quad (9)$$

- The first-order conditions are:

$$\frac{\partial \mathcal{L}}{\partial Q} = P + P'(Q)Q - \lambda = 0 \quad (10)$$

$$\frac{\partial \mathcal{L}}{\partial X_i} = -W_i - W'(X_i)X_i + \lambda F_i' = 0 \quad (11)$$

- Combining the two first-order conditions yields:

$$\lambda = P + P'(Q)Q = MR = \frac{W_i + W'(X_i)X_i}{F_i'} = \frac{MC_i}{MP_i} = MC \quad (12)$$

with MC total marginal cost, MR marginal revenue

Price-setting under imperfect competition

- MP_i is the marginal productivity and MC_i is the marginal cost of the i-th factor.
- So formally we have

$$MC = \frac{\partial C}{\partial Q} = \frac{\partial C}{\partial X_i}\frac{\partial X_i}{\partial Q} \tag{13}$$

$$MC_i = \frac{\partial C}{\partial X_i} = W(X_i) + W'(X_i)X_i \tag{14}$$

$$MP_i = \frac{\partial Q}{\partial X_i} = F_i' \tag{15}$$

Price-setting under imperfect competition

- For the price P we obtain:

$$P + P'(Q)Q = MC \iff P + \frac{\partial P}{\partial Q}\frac{Q}{P}P = MC \iff \tag{16}$$
$$P\left(1 + \frac{\partial P}{\partial Q}\frac{Q}{P}\right) = MC \iff P = \frac{1}{\left(1 - \frac{1}{\varepsilon_D}\right)}MC$$

- with

$$\varepsilon_D = -\frac{\partial Q}{\partial P}\frac{P}{Q} \tag{17}$$

$\implies$ Interpretation?

Price-setting under imperfect competition

- Substituting

$$\varepsilon_{X_i} = \frac{\partial X_i}{\partial W}\frac{W}{X_i} \tag{18}$$

- we get

$$P = \frac{\left(1 + \frac{1}{\varepsilon_{X_i}}\right) W_i}{\left(1 - \frac{1}{\varepsilon_D}\right) F_i'} \tag{19}$$

- So the price P depends upon the unit cost of the factors of production W_i, their marginal productivities MP_i, the elasticity of their supply ε_{X_i} and the elasticity of the demand for the good ε_D.