Dynamic Macroeconomics
Chapter 9: Imperfectly flexible prices

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Overview

1. Introduction and motivation

2. Price-setting under imperfect competition
• Effects of a monetary impulse in an economy with flexible prices:

\[ \Rightarrow \text{Monetary decisions have almost no real effects.} \]
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.

\[\Rightarrow\] Monetary policy has influence on real variables in the short run.

\[\Rightarrow\] 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.*
• Effect of a monetary shock (Christiano, Eichenbaum and Evans, 1997)

⇒ Monetary shocks have relatively sizeable and persistent real effects.
• 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)

⇒ Most popular: Calvo pricing (and - increasingly - menu-cost models).
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 $X_1, X_2, \ldots, X_n$. 

To produce the good the firm has access to a production function:

$$Q = F(X_1, X_2, \ldots, X_n), \quad F' > 0, \quad F'' < 0$$  \hspace{1cm} (1)

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

$$C = \sum_{i=1}^{n} W_i X_i$$  \hspace{1cm} (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:

$$W_i = W(X_i), \quad W'(X_i) > 0$$ (3)

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

$$P = P(Q), \quad P'(Q) < 0$$ (4)

- The firm’s maximization problem is given by:

$$\max_{Q, X_1, X_2, \ldots, X_n} PQ - C$$ (5)

s.t.

$$P = P(Q)$$ (6)

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

$$Q = F(X_1, X_2, \ldots, X_n)$$ (8)
Price-setting under imperfect competition

• The associated Lagrange function is given by:

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

• The first-order conditions are:

\[ \frac{\partial \mathcal{L}}{\partial Q} = P + P'(Q)Q - \lambda = 0 \]  \hspace{1cm} (10)

\[ \frac{\partial \mathcal{L}}{\partial X_i} = -W_i - W'(X_i)X_i + \lambda F'_i = 0 \]  \hspace{1cm} (11)

• Combining the two first-order conditions yields:

\[ \lambda = P + P'(Q)Q = MR = \frac{W_i + W'(X_i)X_i}{F'_i} = \frac{MC_i}{MP_i} = MC \]  \hspace{1cm} (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

$$MC = \frac{\partial C}{\partial Q} = \frac{\partial C}{\partial X_i} \frac{\partial X_i}{\partial Q} \quad (13)$$

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

$$MP_i = \frac{\partial Q}{\partial X_i} = F'_i \quad (15)$$
Price-setting under imperfect competition

- For the price $P$ we obtain:

$$P + P'(Q) Q = MC \iff P + \frac{\partial P}{\partial Q} \frac{Q}{P} = MC \iff$$

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

- with

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

$\implies$ Interpretation?
Price-setting under imperfect competition

• Substituting

\[ \varepsilon X_i = \frac{\partial X_i}{\partial W} W X_i \]  

(18)

• we get

\[ P = \frac{\left(1 + \frac{1}{\varepsilon X_i}\right) W_i}{\left(1 - \frac{1}{\varepsilon_D}\right) F'_i} \]  

(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 \( \varepsilon X_i \), and the elasticity of the demand for the good \( \varepsilon_D \).