Microeconomic Foundations of Incomplete Nominal Adjustment
A Baseline Model of Imperfect Competition and Price Setting (see Romer, Chapter 6.4)
Introduction

• Before turning to staggered adjustment, we first examine an economy of imperfectly competitive price setters with complete price flexibility.

• There are two reasons for analyzing this model:
  – As we will see later, imperfect competition alone has interesting macroeconomic consequences.
  – The following Caplin-Spulber model is concerned with the causes and effects of barriers to price adjustment. To address these issues, we will need a model that shows us what prices firms would choose in the absence of barriers to adjustment and what happens when prices depart from those levels.
Assumptions (1)

- The economy consists of a large number of individuals.
- Each one sets the price of some good and is the sole producer of that good.
- Labour is the only input into production. But individuals do not produce their own goods directly; instead there is a competitive labour market where they can both sell their labour and hire workers.
- The demand for each good is log-linear. Thus, the demand for good $i$ is

\[ q_i = y - \eta(p_i - p), \quad \eta > 1. \quad (1) \]

where $y$ is log aggregate real income, $z_i$ is a shock to the demand for good $i$, $\eta$ is the elasticity of demand for each good and $p$ is the (log) price level, constituting the average of the $p_i$'s.
Assumptions (2)

• To ensure that a profit-maximizing price exists, $\eta$ is assumed to be greater than 1.

• This implies that a, say, 1 percent rise in the price $p_i$ leads to a more than 1 percent drop in demand $q_i$:

$$dq_i = -\eta dp_i < -dp_i$$

• As a consequence, (the log of) nominal expenditure for good $i$, $p_i+q_i$, falls after a rise in the price:

$$d(p_i + q_i) = dq_i + dp_i = -\eta dp_i + dp_i = (1-\eta)dp_i < 0$$
Assumptions (3)

- Sellers with market power set price above marginal cost; thus, if they cannot adjust their prices, they are willing to produce to satisfy demand in the face of small fluctuations in demand. Sellers are therefore assumed not to ration customers.

- The utility of a typical individual is \( U_i = C_i - \frac{L_i}{\gamma} \), \( \gamma > 0 \), where \( C_i \) is real consumption and \( L_i \) is the amount that he or she works. The condition \( \gamma > 1 \) ensures that marginal disutility of labor is increasing.

- An individual consumes all goods. Hence, nominal consumption is \( PC_i \). This must equal nominal income (budget constraint), which is the sum of profit income, \( (P_i - W)Q_i \), and labour income, \( WL_i \), where \( Q_i \) is the output of good \( i \) and \( W \) is the nominal wage:

\[
PC_i = (P_i - W)Q_i + WL_i
\]
Assumptions (4)

- Real consumption is the individual’s income divided by the price index:
  \[ C_i = \frac{(P_i - W)Q_i + WL_i}{P} \]

- Thus, the utility function can be re-written as
  \[ U_i = \left( \frac{(P_i - W)Q_i + WL_i}{P} \right) - \frac{1}{\gamma} L_i^{\gamma}. \] (2)

- Finally, the aggregate demand side of the model is given by
  \[ Y = \frac{M}{P} \] or in logs \[ y = m - p \]
  where \( y \) is the average of the \( q_i \)‘s. The money supply \( m \) is publicly observed.
Individual Behaviour (1)

- Converting the demand equation, $q_i = y + \eta( p_i - p )$, from logs to levels yields $Q_i = Y(P_i / P)^{-\eta}$. Substituting this into the utility function leads to

$$U_i = \left( \left( \frac{P_i - W}{P} \right) Y_i \left( \frac{P_i}{P} \right)^{-\eta} + WL_i \right) - \frac{1}{\gamma} L_i^\gamma. \quad (3)$$

- The individual has two choice variables, the price of his or her good ($P_i$) and the amount he or she works ($L_i$). The first order condition for $P_i$ is

$$\frac{Y(P_i / P)^{-\eta} - (P_i - W)\eta Y(P_i / P)^{-\eta-1}(1/P)}{P} = 0. \quad (4)$$
Individual Behaviour (2)

• Multiplying this expression by \( (P_i / P)^{\eta+1} P \), dividing by Y, and rearranging yields \[
\frac{P_i}{P} = \frac{\eta}{\eta - 1} \frac{W}{P}.
\]

(5)

• That is, we get the standard result that a producer with market power sets price as markup over marginal cost, with the size of the markup determined by the elasticity of demand \((\eta/(\eta-1)>1 \text{ due to } \eta>1)\).

• Now consider labour supply. Using (3), the first order condition for \(L_i\) is \[
\frac{W}{P} - L_i^{\gamma-1} = 0,
\]
or \[
L_i = \left(\frac{W}{P}\right)^{1/(\gamma-1)}.
\]

(6)

• Thus labour supply is an increasing function of the real wage; the elasticity is \(1/(\gamma-1)>0\).
Equilibrium (1)

- Because of the symmetry of the model, in equilibrium each individual works the same amount and produces the same amount. Equilibrium output thus is equal to the common level of labour supply.
- We can therefore use the first order condition (6) for $L_i$ to express the real wage as a function of output:

\[ Y = \left( \frac{W}{P} \right)^{1/(\gamma-1)} \Rightarrow \frac{W}{P} = Y^{(\gamma-1)}. \]  \hspace{1cm} (7)

- Substituting this expression into the price equation yields an expression for each producer’s desired relative price as a function of aggregate output:

\[ \frac{P_i^*}{P} = \frac{\eta}{\eta - 1} Y^{(\gamma-1)}. \]  \hspace{1cm} (8)
Equilibrium (2)

- For future reference, it is useful to write this expression in logarithms:

\[ p_i^* - p = \ln \frac{\eta}{\eta - 1} + (\gamma - 1)y \equiv c + \phi y. \quad (9) \]

- Since producers are symmetric, each charges the same price. The price index, \( P \), therefore equals this common price. Equilibrium therefore requires that each producer, taking \( P \) as given, sets his or her own price equal to \( P \); that is, each producer’s desired relative price must equal 1.
Equilibrium (3)

• From the producers' desired relative price equation (8), this condition is

\[
\frac{P^*_i}{P} = \frac{\eta}{\eta - 1} Y^{(\gamma - 1)} = 1 \quad \text{or} \quad Y = \left(\frac{\eta - 1}{\eta}\right)^{(\gamma - 1)} < 1. \quad (10)
\]

This is the equilibrium level of output.

• Finally, we can use the aggregate demand equation, \(Y = M/P\), to find the equilibrium price level:

\[
P = \frac{M}{Y} = \frac{M}{\left(\frac{\eta - 1}{\eta}\right)^{1/(\gamma - 1)}}. \quad (11)
\]
Main Result (1)

- When producers have market power, they produce less than the socially optimal amount.
- To see this, note that in a symmetric allocation each individual supplies some amount $\bar{L}$ of labour, and production of each good and each individual's consumption are equal to that $\bar{L}$.
- Thus, the problem of finding the best symmetric allocation reduces to choosing $\bar{L}$ to maximize $\bar{L} - (1/\gamma)\bar{L}^\gamma$. The solution simply is $\bar{L} = 1$ and therefore $\bar{Y} = 1$.
- As equation (10) shows, equilibrium output is less than this.
- Intuitively, the fact that producers face downward-sloping demand curves means that the marginal revenue product of labour is less than its marginal product.
Main Result (2)

- As a result, the real wage is less than the marginal product of labour. Substituting (10) into (7) shows that the real wage is \( (\eta - 1)/\eta \); the marginal product of labour, in contrast, is 1.

- This reduces the quantity of labour supplied, and thus causes equilibrium output to be less than optimal.

- From (10), equilibrium output is \( \l([\eta - 1]/\eta \r]^{1/(\gamma-1)} \). Thus the gap between the equilibrium and optimal levels of output is greater
  - when producers have more market power (that is, when \( \eta \) is lower) and
  - when labour supply is more responsive to the real wage (that is, when \( \gamma \) is lower).
Implications (1)

• This result has important implications for fluctuations.

• First, it implies that recessions and booms have asymmetric effects on welfare (Mankiw, 1985):
  – In practice, periods when output is unusually high are viewed as good times, and periods when output is unusually low are viewed as bad times.
  – Now consider a model where fluctuations arise from incomplete nominal adjustments in the face of monetary shocks.
  – If the equilibrium in the absence of shocks is optimal, both times of high output and times of low output are departures from the optimum, and thus both are undesirable.
  – But if equilibrium output is less than optimal, a boom brings output closer to the social optimum, whereas a recession pushes it farther away.
Implications (2)

- Second, it implies that pricing decisions have externalities:
  - Suppose that an economy is initially in equilibrium, and consider the effects of a marginal reduction in all prices. M/P thus aggregated output rise.
  - This affects the representative individual through two channels:
    - First, the prevailing real wage rises (see equation (7)). But since initially the individual is neither a net purchaser nor a net supplier of labour, at the margin the increase does not affect his welfare.
    - Second, because aggregate output increases, the demand curve for the individual's good shifts out.
  - Since the individual is selling at a price that exceeds marginal cost, this change raises his or her welfare.
  - Thus, under imperfect competition, pricing decisions have externalities, and those externalities operate through the overall demand for goods (aggregate demand externality).
Implications (3)

• Furthermore, it implies that imperfect competition alone does not imply monetary nonneutrality. A change in the money stock leads to proportional changes in the nominal wage and all nominal prices; output and the real wage are unchanged (see equations (10) and (11)).
Add-On (1)

• Finally, since a pricing equation of the form of equation (9) is important in later sections, it is worth noting that the basic idea captured by the equation is much more general than the specific model of price setters' desired prices we are considering here.

• Equation (9) states that \( p_i^* - p = c + \phi y \); that is, a price setters' optimal relative price is increasing in aggregate output.

• In the particular model we are considering, this arises from increases in the prevailing real wage when output rises. But in a more general setting, it can also arise from costs of adjusting output.

• The fact that price setters' desired real prices are increasing in aggregate output is necessary for the flexible price equilibrium to be stable.
Add-On (2)

• To see this, note that we can use the fact that $y = m - p$ to rewrite equation (9) as

$$p_i^* = c + (1 - \phi)p + \phi m.$$  

• If $\Phi$ is negative, an increase in the price level raises each price setter’s desired price more than one-for-one. This means that if $p$ is above the level that causes individuals to charge a relative price of 1, each individual wants to charge more than the prevailing price level; and if $p$ is below its equilibrium value, each individual wants to charge less than the prevailing price level.

• Thus, $\Phi$ must be positive for the flexible price equilibrium to be stable.