

A Classical Model

Producer Behavior

There are many different goods.

A representative producer of a typical good, good i , produces according to the production function:

$$Q_i = L_i \tag{6.1}$$

where L_i is the amount the individual works and Q_i is the amount he produces.

Real consumption, is nominal income divided by a price index:

$$C_i = \frac{P_i Q_i}{P}.$$

Utility depends positively on consumption and negatively on hours worked:

$$U_i = C_i - \frac{1}{\gamma} L_i^\gamma, \quad \gamma > 1 \tag{6.2}$$

Substituting the previous equations into (6.2) gives:

$$U_i = \frac{P_i L_i}{P} - \frac{1}{\gamma} L_i^\gamma. \tag{6.3}$$

Taking prices as given, an individual maximizes utility by selecting L_i to satisfy the first order condition:

$$\frac{P_i}{P} - L_i^{\gamma-1} = 0. \tag{6.4}$$

Rearranging, we get:

$$L_i = \left(\frac{P_i}{P} \right)^{\frac{1}{\gamma-1}} \tag{6.5}$$

Letting lowercase letters denote logs:

$$l_i = \frac{1}{\gamma-1} (p_i - p) \tag{6.6}$$

This is a labor supply function (and, indirectly, an output supply function) in which an individual's hours depend on the relative price of the individual's output price. Note that this supply function does not include inertial effects like those in the Lucas paper we read earlier.

Note that if $P_i = P$, then $L_i = 1$, $Q_i = 1$, $l_i = 0$, $q_i = 0$ (the utility function was designed so that this would be the result).

Demand

We assume that the demand for good i has the following form (note: this is NOT derived from a utility maximization problem):

$$q_i = y + z_i - \eta(p_i - p), \quad \eta > 0, \quad (6.7)$$

where y is the log of a measure of aggregate income, z_i is a shock to demand for good i (with mean zero across goods), and η is the demand elasticity. More specifically, y is defined to be the average of the q_i 's across goods, and p is defined to be the average of the p_i 's across goods:

$$y = \bar{q}_i \quad (6.8)$$

and

$$p = \bar{p}_i. \quad (6.9)$$

Aggregate demand is given by:

$$y = m - p \quad (6.10)$$

This is just a simple way of modeling aggregate demand; the essential property is that the price level and output are inversely related. While m can be literally interpreted as the log money supply, it might be thought of more generally as any aggregate demand shifter.

Equilibrium

We require that quantities demanded equal quantities supplied in each market i . From (6.6) and (6.7) we obtain:

$$\frac{1}{\gamma-1}(p_i) = y + z_i - \eta(p_i - p). \quad (6.11)$$

Solving for p_i yields:

$$p_i = \frac{\gamma - 1}{1 + \eta\gamma - \eta} (y + z_i) + p \quad (6.12)$$

Next, average the left- and right-hand sides of (6.12):

$$p = \frac{\gamma - 1}{1 + \eta\gamma - \eta} y + p \quad (6.13)$$

Solve for y :

$$y = 0. \quad (6.14)$$

Recall equation (6.10):

$$y = m - p \quad (6.10)$$

If $y = 0$, then (6.10) implies:

$$p = m \quad (6.15)$$

Thus money is neutral in this model. An increase in m leads to a proportional increase in p . Also, since p is observable and markets clear, the average level of log output is zero. An increase in aggregate demand does NOT lead to higher aggregate output in the perfect information version of the model.

A Model of Imperfect Competition and Price Setting

It turns out that modern New Keynesian models generally rely on the existence imperfect competition. This helps in explaining why prices might be rigid. Given that this is so, we will develop a model which incorporates imperfect competition.

Assumptions

The economy consists of a large number of individuals.

Each individual is the producer of a good and sets the price of that good.

Labor is the only input: the output of good i is equal to the amount of labor employed in its production.

Demand equations for each good are as:

$$q_i = y - \eta(p_i - p), \quad \eta > 1,$$

In this equation the lower case letters represent logs, p is the average of the p_i 's, and y is the average of the q_i 's. Converting from logs to levels, the demand equation can be written:

$$Q_i = Y \left(\frac{P_i}{P} \right)^{-\eta} .$$

Sellers with market power will sell at a price above marginal cost. If they cannot adjust price, they will be willing to satisfy small increases in demand.

We employ this utility function:

$$U_i = C_i - \frac{1}{\gamma} L_i^\gamma, \quad \gamma > 1$$

C_i is consumption by individual i and L_i is the amount that i works. Income now profit as well as wage income, so utility can be written as:

$$U_i = \frac{(P_i - W)Q_i + WL_i}{P} - \frac{1}{\gamma} L_i^\gamma . \tag{6.37}$$

Aggregate demand is given by:

$$y = m - p .$$

Unlike the Lucas model, here we assume that the money supply is observed.

Individual Behavior

Substituting the demand equation, $Q_i = Y \left(\frac{P_i}{P} \right)^{-\eta}$, into the utility function, yields:

$$U_i = \frac{(P_i - W)Y \left(\frac{P_i}{P} \right)^{-\eta} + WL_i}{P} - \frac{1}{\gamma} L_i^\gamma \tag{6.38}$$

The individual chooses his price, P_i , and his work effort, L_i . The first order conditions for the utility maximization problem lead to the following results (after some manipulation):

$$\frac{P_i}{P} = \frac{\eta}{\eta-1} \frac{W}{P} \quad (6.40)$$

$$L_i = \left(\frac{W}{P} \right)^{\frac{1}{\gamma-1}} \quad (6.42)$$

The first of these is a price mark-up equation; the second is an individual's labor supply function.

Equilibrium

By symmetry, in equilibrium, each individual works the same amount and produces the same amount of output. From (6.42) the real wage is:

$$\frac{W}{P} = Y^{\gamma-1} .$$

Substituting into (6.40) yields an expression for each producer's desired relative price as a function of aggregate output:

$$\frac{P_i^*}{P} = \frac{\eta}{\eta-1} Y^{\gamma-1} . \quad (6.44)$$

In logs:

$$p_i^* - p = \ln \left(\frac{\eta}{\eta-1} \right) + (\gamma-1)y$$

or

$$p_i^* - p = c + \phi y . \quad (6.45)$$

Since producers are symmetric, all prices are the same, and each price is equal to the average price. We can then use (6.44) to solve for the equilibrium level of output:

$$Y = \left(\frac{\eta-1}{\eta} \right)^{\frac{1}{\gamma-1}} . \quad (6.46)$$

From the aggregate demand equation, $Y = M / P$, we find the equilibrium price:

$$P = \frac{M}{\left(\frac{\eta-1}{\eta}\right)^{\frac{1}{\gamma-1}}} . \quad (6.47)$$

Implications

Output is less than one, which was the competitive market level of output (in our first model with perfect competition, y was equal to zero, so Y was equal to one). This reflects the suboptimality of the monopoly outcome. This implies:

Recessions and booms have asymmetric welfare effects. Booms are good, recessions are bad.

Pricing decisions have external effects. Suppose that starting from an equilibrium point, each producer cuts price by a small amount. The average price declines, and aggregate output rises, shifting out the demand curve for each product. The demand shift makes everyone better off (even though each individual is privately better off not cutting price).

The existence of imperfect competition is consistent with monetary neutrality. The solution for output in (6.46) does not depend on M .

Nominal Imperfections

Agents are presumably interested in real magnitudes. Nominal magnitudes matter only in minor ways to them. If nominal “imperfections” are macroeconomically important, one must show that small frictions at a microeconomic level have large impacts at a macroeconomic level.

We will assume the existence of menu costs, small costs associated with changing prices. We investigate whether such costs might have important macroeconomic consequences.

Market power, Menu Costs, and Price Adjustments

Consider a firm with market power, which currently sets a price at the profit maximizing level.

Now suppose that there is a reduction in the demand facing this firm.

Momentarily suppose that the firm does **not** lower its price to the new lower optimal level.

Fig. 6.3 in Romer shows that:

The profit consequence of a reduction in demand is “large.”

The profit consequence of failing to cut price is “small.”

We can illustrate the same point with an alternative diagram (show π as a function of P), or with a Taylor’s series expansion of the profit function.

If the menu cost (the cost incurred when one changes a price) is larger than the gain from changing price, then the firm will leave its price unchanged.

How Aggregate Demand Externalities Arise

For simplicity suppose that AD is given by:

$$Y = M/P.$$

If prices are rigid, then a reduction in M reduces real demand for all firms in proportion.

But for each of many small firms (each imperfectly competitive), the losses from failing to adjust prices are very small (as shown above).

If all firms did adjust prices, they would all be better off (because their demand curves would be shifted back out to the right). *But no firm can make its demand curve shift back out by unilaterally being flexible on price.*

Thus one can view a recession as a result of market failure -- the failure to overcome externalities because of free-rider problems.

Some Welfare Implications

In some models (Lucas, Fischer, McCallum) booms as well as recessions are associated with welfare losses.

In this model monopoly equilibrium is suboptimal (with output too low) so booms increase welfare (by causing higher output). Recessions result in welfare losses, consistent with everyday views.

It is not obvious, but in such models fluctuations (i.e. demand induced business cycles) are inefficient. There can be a role for stabilization policy.

Some Problems for the Market Power/Price Rigidity Model

The analysis of price rigidity for an individual firm was conducted in a partial equilibrium environment.

It turns out that a general equilibrium analysis reveals some problems with the preceding analysis.

Previous Model Revisited

First, recall that in our last model, the first order condition for utility maximization describing labor supply behavior was given by:

$$L_i = \left(\frac{W}{P}\right)^{\frac{1}{\gamma-1}} \quad (6.42)$$

Because of symmetry, in equilibrium each individual works and produces the same amount, so $L_i = Y$ and:

$$\frac{W}{P} = Y^{\frac{1}{\nu}} \quad (6.42a)$$

where $\nu = \frac{1}{\gamma-1}$. This is the elasticity of labor supply with respect to the real wage.

Recall that each producer faces a demand function (See 6.7):

$$Q_i = Y \left(\frac{P_i}{P}\right)^{-\eta} \quad (6.7a)$$

Each firm's (real) profit is given by (again recall that one unit of output requires the use of one unit of labor input):

$$\pi = \frac{(P_i - W)Q_i}{P}$$

or

$$\pi = \left(\frac{P_i}{P} - \frac{W}{P}\right)Q_i$$

Substituting (6.7a) for Q_i and (6.42a) for W into the equation above we get:

$$\pi_i = Y \left(\frac{P_i}{P}\right)^{-\eta} \left(\frac{P_i}{P} - Y^{\frac{1}{\nu}}\right)$$

or, since $Y = \frac{M}{P}$

$$\pi_i = \frac{M}{P} \left(\frac{P_i}{P} \right)^{1-\eta} - \frac{M}{P} \left(\frac{P_i}{P} \right)^{-\eta} \left(\frac{M}{P} \right)^{\frac{1}{\nu}}$$

$$\pi_i = \frac{M}{P} \left(\frac{P_i}{P} \right)^{1-\eta} - \left(\frac{M}{P} \right)^{\frac{1+\nu}{\nu}} \left(\frac{P_i}{P} \right)^{-\eta} \quad (6.84)$$

Remember that each firm regards M and P as exogenous, so 6.84 expresses profits as a function of P_i .

Price Adjustments

We earlier used this model to solve for an equilibrium under the assumption that all firms adjusted prices to optimal levels.

We will now consider the profit consequences of failing to adjust prices when demand (M) changes.

Profits when Price is not Adjusted

By assumption, in the original flexible price equilibrium other firms are charging P and firm i is charging $P_i = P$. Now, when M changes, if firm i does not change price and all other firms do not change price, then we still have $P_i = P$ and by equation (6.84) profits for firm i are:

$$\pi_{FIXED} = \frac{M}{P} - \left(\frac{M}{P} \right)^{\frac{1+\nu}{\nu}} \quad (6.85)$$

Profits when Price is Adjusted:

When firm i adjusts its price, holding P fixed, it sets it to the profit maximizing value.

We also recall that the utility maximization problem for this model also involved choosing price, P_i . The first order condition implied this mark-up pricing result:

$$\frac{P_i}{P} = \frac{\eta}{\eta-1} \frac{W}{P} \quad (6.40)$$

Successively substituting (6.42a), $\frac{W}{P} = Y^{\frac{1}{\nu}}$, and $Y = \frac{M}{P}$ into this equation yields:

$$\frac{P_i}{P} = \frac{\eta}{\eta-1} \left(\frac{M}{P} \right)^{\frac{1}{\nu}} \quad (6.40a)$$

Recall (6.84):

$$\pi_i = \frac{M}{P} \left(\frac{P_i}{P} \right)^{1-\eta} - \left(\frac{M}{P} \right)^{\frac{1+\nu}{\nu}} \left(\frac{P_i}{P} \right)^{-\eta} \quad (6.84)$$

Now substituting $\frac{P_i}{P} = \frac{\eta}{\eta-1} \left(\frac{M}{P} \right)^{\frac{1}{\nu}}$ into (6.84) yields:

$$\pi_{ADJ} = \frac{M}{P} \left(\frac{\eta}{\eta-1} \left(\frac{M}{P} \right)^{\frac{1}{\nu}} \right)^{1-\eta} - \left(\frac{M}{P} \right)^{\frac{1+\nu}{\nu}} \left(\frac{\eta}{\eta-1} \left(\frac{M}{P} \right)^{\frac{1}{\nu}} \right)^{-\eta}$$

which simplifies to:

$$\pi_{ADJ} = \frac{1}{\eta-1} \left(\frac{\eta}{\eta-1} \right)^{-\eta} \left(\frac{M}{P} \right)^{\frac{1+\nu-\eta}{\nu}} \quad (6.86)$$

We can now compare profits gained by the firm when it does and does not adjust price when M changes.

A Numerical Example

Set the labor supply elasticity at $\nu = 0.1$.

This implies that labor supply is not very elastic, in conformity with most micro evidence.

Set the demand elasticity at $\eta = 5$.

This implies that the price markup factor, $\frac{\eta}{\eta-1}$, is 1.25. See equation (6.40) on the markup.

For the original equilibrium level of output, recall that $Y = \frac{M}{P}$, impose the condition

$P_i = P$, and use (6.40a):

$$\frac{P_i}{P} = \frac{\eta}{\eta-1} \left(\frac{M}{P} \right)^{\frac{1}{\nu}}$$

$$1 = \frac{\eta}{\eta-1} Y^{\frac{1}{\nu}}$$

$$Y = \left(\frac{\eta-1}{\eta} \right)^{\nu}$$

For these parameters, $Y = 0.978$.

Now suppose that there is a 3% fall in M . A comparison of (6.85) and (6.86) implies that:

$$\pi_{ADJ} - \pi_{FIXED} \cong 0.253.$$

This implies that when a firm fails to change its price in response to a 3% decrease in M , it loses profit that amounts to about one-fourth of its revenue! Menu costs will not be this large, so the model seems to imply that prices will always be adjusted. What happened?

The problem is that when M rises and P is held fixed, output must rise. However, to produce more output more labor must be supplied. To induce more work effort, the real wage must rise. How much must the real wage rise? A 1.0% change in the real wage induces a 0.10% change in labor supplied (and output produced). To get a 3.0% change in labor supply (i.e., a 30 times bigger change), we therefore need a 30.0% change in the real wage. Obviously it would be very costly to ignore a 30.0% change in the real wage when setting prices – so firms should not do it.

So how do we explain observed price inflexibility and business cycle effects which might result from them?

More Model Alterations

The model we have employed above suggests that we are unlikely to observe price stickiness as a consequence of imperfect competition when there are menu costs. The key problem is that in this model real wages were flexible, and demand shifts have impacts on wages that will not be ignored by firms considering price adjustments.

If we are to rationalize sticky prices, the determination of wages in our model will require some modification. One possibility is simply that labor supply elasticities are much larger than assumed in the quantitative example. In fact, short-run elasticities might be rather large because of intertemporal substitution effects.

A second possibility is that workers are off of their labor supply curves at various times over the business cycle. Romer Chapter 10 takes up models of the labor market that imply that wages are acyclical over the business cycle.

A Quantitative Example with Real Wage Stickiness

Suppose that firms pay workers a wage that is above the market clearing level. This assumption will imply that workers are willing to work more hours when asked to do so by firms.

Furthermore, suppose that the real wage is now determined by:

$$\frac{W}{P} = AY^\beta \quad (6.52)$$

Note that this looks a lot like (6.43), but the parameters are now different. Using (6.52) instead of (6.43) throughout the model, we can again derive an expression for profit, and for the difference between profit when prices are allowed to adjust or are held fixed, given a change in demand.

Set $\beta = 0.1$, implying that real wages are not sensitive to the quantity of labor employed.

Set $A = 0.806$, so that the flexible price equilibrium output is 0.928 (this is 95% of output in our previous calculation; output should be lower here because of the supracompetitive wage assumption).

Now, if we assume a decline in M of 3%, and if other firms do not adjust its price, the gain to firm i from adjusting price is 0.000168, a tiny fraction of its revenue.

So the combination of imperfect competition and real wage rigidity is sufficient to explain nominal price rigidity even when menu costs are small.

A Staggered Price-Setting Model

There are two groups of firms (1 and 2). Every two periods, one group sets a price that then stays in effect for two periods (the current period and the next one). Groups 1 and 2 alternate in setting prices; i.e., group one may set prices in periods 1, 3, 5 etc., while group 2 sets prices in periods 2, 4, 6, etc. Firms in the two groups are in other respects similar, but they are not perfect competitors -- different groups may charge different prices without having sales go to zero. Rather, firms are imperfectly competitive.

There are five basic equations:

$$p_{it}^* - p_t = \phi y_t \quad i = 1,2 \quad (6.45)$$

The equation above is the supply relation. The variable p_{it}^* is **the log price that a firm in group i would ideally like to charge** in period t (if it could change prices in every period, which it can't). The variable p_t is the **log aggregate price level** in period t . The variable y_t is the **log of aggregate output**. This is equation (6.45) in the text, with the normalization requiring that $c = 0$. (This simply redefines “normal” or long-run equilibrium output to be equal to 1, so that its log is zero).

The equation says that a firm would desire a higher price for its output when the general price level is high. One can think of firms as imperfect competitors who are sensitive to rivals' prices. When rivals are charging high prices, I can also charge high prices; when rivals charge low prices, I must also keep prices low. In other words, my price should not be too far out of line with other's prices. The equation also says that I am willing to see my relative price be higher when aggregate output is high. I.e., if demand is strong overall, then I would be willing to charge a somewhat higher price than my rivals, because sales will remain strong anyway.

Romer's book provides a slightly different justification for this equation. Essentially, in an imperfectly competitive market, firms charge prices that are a markup over costs (with the markup depending upon the elasticity of demand). In this model, firms must set prices and then satisfy demand. But if aggregate demand turns out to be unusually high, firms must then produce more output in the aggregate. But to produce more output, they must hire more labor. In this model, the supply of labor depends on the real wage, so wages (and costs) must rise with output. Because of the markup in pricing, with higher costs firms would wish to be charging a higher price for their product. So, other things equal, firms prefer to be charging a higher relative price when aggregate output is high.

$$x_t = \frac{1}{2}(p_{it}^* + E_t p_{it+1}^*) \tag{6.60}$$

The variable x_t is the **actual price** set by firms in the group that sets a price at time t . This price must prevail for two periods (i.e. periods t and $t+1$). It is equal to an average of this period's optimal price and next period's expected optimal price.

$$p_t = \frac{1}{2}(x_t + x_{t-1}) \tag{p. 266}$$

As noted, p_t is the aggregate price level in period t . In the equation above, it is shown as an average of the price set last period (by one group) and the price set this period (by the other group).

$$y_t = m_t - p_t \tag{6.10}$$

Equation (6.10) is a conventional, simple aggregate demand relation with m_t representing the money supply.

$$m_t = m_{t-1} + u_t \quad (6.59)$$

Equation (6.59) is a policy rule. It says that the money supply is a random walk.

Analysis

Our strategy will be to obtain a solution for x_t , the price set by firms who choose a price at time t . Clearly, once we have a solution for x_t , we will also be able to solve for p_t .

Substitute (6.10) into (6.45):

$$p_{it}^* = p_t + \phi(m_t - p_t)$$

$$p_{it}^* = \phi m_t + (1 - \phi)p_t$$

Now substitute the equation above into (6.60):

$$x_t = \frac{1}{2} \{ [\phi m_t + (1 - \phi)p_t] + [\phi E_t m_{t+1} + (1 - \phi)E_t p_{t+1}] \}$$

$$x_t = \frac{1}{2} \phi m_t + \frac{1}{2} (1 - \phi) \left(\frac{x_t + x_{t-1}}{2} \right) + \frac{1}{2} \phi m_t + \frac{1}{2} (1 - \phi) \frac{1}{2} (E_t x_{t+1} + x_t)$$

$$x_t = \phi m_t + \frac{1}{4} (1 - \phi) (2x_t + x_{t-1} + E_t x_{t+1})$$

Notice that if we regard m_t as exogenous, then the preceding equation includes only one endogenous variable, x_t , and also the expectational term $E_t x_{t+1}$. We now have the model in a form we know how to handle. Following Romer, I will isolate x_t on the LHS of this equation before following our usual procedures. After some algebra we obtain:

$$x_t = A(x_{t-1} + E_t x_{t+1}) + (1 - 2A)m_t \quad (6.62)$$

where

$$A = \frac{1(1 - \phi)}{2(1 + \phi)}$$

Now conjecture a solution:

$$x_t = \mu + \lambda x_{t-1} + \nu m_t$$

Update one period:

$$x_{t+1} = \mu + \lambda x_t + \nu m_{t+1}$$

Take expectations:

$$E_t x_{t+1} = \mu + \lambda x_t + \nu m_t$$

Substituting our conjectured solution for x_t into the equation above gives:

$$E_t x_{t+1} = \mu + \lambda(\mu + \lambda x_{t-1} + \nu m_t) + \nu m_t.$$

Now substitute for x_t and $E_t x_{t+1}$ in equation (6.62):

$$\mu + \lambda x_{t-1} + \nu m_t = A x_{t-1} + A[\mu + \lambda(\mu + \lambda x_{t-1} + \nu m_t) + \nu m_t] + (1 - 2A)m_t.$$

Now equate coefficients on the two sides of the equation. This yields the following three equations:

$$(1)' \quad \mu = A\mu + A\lambda \mu$$

$$(2)' \quad \lambda = A + A\lambda^2$$

$$(3)' \quad \nu = A\lambda\nu + A\nu + (1 - 2A)$$

The second equation is quadratic and can be solved for λ . The solution is:

$$\lambda = \frac{1 \pm \sqrt{(1 - 2A)(1 + 2A)}}{2A}$$

After substituting for A and doing lots of algebra, we obtain:

$$\lambda = \frac{1 - \sqrt{\phi}}{1 + \sqrt{\phi}} \quad \text{or} \quad \lambda = \frac{1 + \sqrt{\phi}}{1 - \sqrt{\phi}}$$

Only the first solution is reasonable (because the second solution would give an unstable solution for x_t).

Now that we have a solution for λ getting solutions for μ and ν should be straightforward. However, in this case there is a complication. In equation (1)' it appears that any value of μ will satisfy the equation.¹

To find μ we will take a short-cut. We can pin that parameter down using an analysis of the steady state of this model when there are no shocks. In such a steady state, we will have a stable price and a stable level of output. I.e., the sequence of chosen prices will have identical values in each period. Moreover, the chosen prices will also be the same as the desired prices in each period. But if desired price equals actual price in each period, then $y_t = 0$ by equation (6.45). And if $y_t = 0$, then equation (6.10) implies that $p_t = m_t$ in each period. But if actual and desired prices are equal in each period, then equation (6.60) implies that $x_t = p_t = m_t = x_{t-1} = p_{t-1} = m_{t-1}$, etc. Now recall that our conjectured solution was:

$$x_t = \mu + \lambda x_{t-1} + \nu m_t$$

The preceding analysis implies that

$$m_t = \mu + \lambda m_t + \nu m_t.$$

But this is generally true only if $\mu = 0$ and $\lambda + \nu = 1$. We now have a solution for μ . Moreover, the solution for ν will be given by $\nu = 1 - \lambda$.

¹ For any non-zero value of μ , the first equation implies that :

$$1 = A + A\lambda$$

or

$$\lambda = \frac{1-A}{A} = 2 \frac{(1+\phi)}{(1-\phi)}$$

However, this value of λ is not compatible with the value we solved for earlier:

$$2 \frac{(1+\phi)}{(1-\phi)} \neq \frac{1-\sqrt{\phi}}{1+\sqrt{\phi}}.$$

This implies that if we are to satisfy both (1)' and (2)', then $\mu = 0$. (Any non-zero value leads to the contradiction noted). The text gives an alternative route for finding this value for μ .

Given this solution for p_t , and given that $y_t = m_t - p_t$, a solution for output can be found:

$$y_t = \lambda y_{t-1} + \frac{1+\lambda}{2} u_t$$

Implications

The aggregate price level adjusts gradually to a shock. Because price adjusts gradually, the shock to output is persistent. The intuition is that when there is a demand shock, one group of firms has preset its price. The group which gets to choose price does not want a price “too different” from the other group, for competitive reasons. So price does not fully and immediately move to the new long-run price level. In the next period the next group chooses price, but they are similarly constrained by the need to keep their relative price in line. So prices adjust slowly. With prices adjusting slowly, the demand shock affects output instead (firms with market power are willing to produce the additional units demanded because price is in excess of marginal cost). When price adjusts slowly, output effects will last a long time.