Ph.D. Macroeconomics Fall 2015

Homework Assignment #5 Due: 9:00, Thursday 19 November

1. Multiple equilibria with menu costs. (Based on Romer's 6.10) Consider an economy consisting of many imperfectly competitive firms, such as the one analyzed in detail in Chapter 6. Let p^* be the log of the price that the firm would set if it had no adjustment costs. If it sets a log-price other than p^*, then it receives lower operating profit. We assume that the reduction in operating profit is $K\left(p_i - p^*\right)^2$, where p_i is the price the firm sets and K is a positive constant. Note that the reduction is zero if $p_i = p^*$ and is positive if p_i is either above or below p^*.

As in the textbook model, $p^* = (1-\phi)p + \phi m$, and aggregate demand is given by $y = m - p$, so $p^* = p + \phi y$ with all lower-case letters referring to logs. Initially, the economy is in equilibrium with all prices at their optimal level and (in log terms) $m = y = p = 0$.

Now suppose that m changes unexpectedly to a positive value m_1. We want to consider one firm's ("our" firm's) optimal pricing decision and how it depends on what other firms do.

a. Suppose that we believe that some fraction f of all firms are going to change their price to p^* and that the remainder will keep their price at 0. Then the average log-price is fp^*. Use this equation and the equations above to find the equilibrium values of p, y, and p^* as functions of m_1 and f.
b. Assume that $\phi < 1$. If our firm keeps its log-price at zero, it loses $K\left(0 - p^*\right)^2 = Kp^{*2}$. Plot our firm's losses as a function of f. Do we lose more or less from keeping our log-price at zero if more other firms adjust their prices? Why? Does this imply strategic complementarity or strategic substitutability in price setting? Explain.
c. Suppose that our firm incurs a fixed menu cost Z if it changes its log-price from zero to p^*. How big does m_1 have to be for us to decide to change price if we believe that no other firms adjust ($f = 0$)? (This will be a function of Z, K, and ϕ.) How big does m_1 have to be for us to change price if we believe that all firms will adjust ($f = 1$)?
d. Find the ranges of values for the aggregate-demand shock m_1 for which we will (1) adjust our price even if no other firms adjust ($f = 0$), (2) adjust our price if we think everyone else will adjust ($f = 1$), but not adjust our price if we think everyone else will not adjust ($f = 0$), and (3) not adjust our price even if all other firms adjust ($f = 1$).
e. Assuming that all firms have the same values of Z and K, find the range of values for m_1 for which price flexibility is the only possible equilibrium, the range for which either price flexibility or price stickiness can be equilibria, and the range for which only price stickiness can occur. Explain why multiple equilibria are possible in this model.
f. We often measure the degree of real rigidity in prices inversely by ϕ. There is no real rigidity if $\phi = 0$ and great real rigidity as $\phi \to 1$. What happens to the range of shocks that lead to multiple equilibria if ϕ get larger?

2. Expected and unexpected demand shocks with fix-price and flex-price firms. (Based on Romer's 6.16) Firms often differ across industries in the ease with which they can change prices. Suppose that there are two categories of firms in an economy. Flex-price firms can change price instantly at any time without cost. Fix-price firms set price at the beginning of the year and cannot change once the price is set.

Let p^f be the log-price set by each flex-price firm and p^r be the log-price set by fix-price (or rigid-price) firms. A fraction q of all firms have fixed prices, so the aggregate log-price level is

$$p = qp^r + (1-q)p^f.$$

At the beginning of the year, people expect the log-level of aggregate demand to be Em, the expected value of m. Fix-price firms set their price based on Em, so they set

$$p^r = Ep^* = (1-\phi)Ep + \phi Em,$$

where Ep is their expectation of the average price level.

Flex-price firms do not set their prices until the actual value of m is known. They also know what price the fix-price firms set, so they know p and set their price at

$$p^f = (1-\phi)p + \phi m.$$

a. Find the price that the flex-price firms will set as a function of the price set by fix-price firms and the level of aggregate demand. In other words, find p^f in terms of p^r, m, and the parameters ϕ and q.
b. Find the price that the fix-price firms set as a function of the expected level of aggregate demand. In other words, find p^r in terms of Em and the parameters.
c. Based on these results, find equations for p and y in terms of m, Em, and the parameters.
d. Do changes in m that are known before fix-price firms set prices (in other words, if both m and Em change by the same amount) have any effect on y? Explain why or why not.
e. Do changes in m that are not known when fix-price firms set prices (so m changes but Em does not) have any effect on y? Explain why or why not.