CALTECH

Ec 11 Midterm Examination
Professor R. Preston McAfee
Winter 2006

Instructions: Open book, open notes, no collaboration.
Partial credit will be assigned. Please show your work.
You may take this test during any consecutive 4 hour period.
Due February 6, by 5:00 PM. Please deposit in Box outside Baxter 100.

1. (20 points) The short run elasticity of demand for gasoline is 0.25, and the long run demand elasticity is 0.8. The gasoline market is initially in equilibrium, and then a hurricane destroys 20% of US refinery capacity.
   a. Assuming a perfectly inelastic short run supply, how much does the price go up in percent?
   b. If the long run supply has elasticity of 1, what is the long run price change? Draw the long and short run adjustment diagram.

2. (20 points) An automated pin factory costs an amount with present value equal to $1M/year to build, and produces $\sqrt{x}$ million boxes of pins per year, where *x* is the input of metal in kg.
   a. If the price of metal is $1/kg, what is the long and short run industry supply of pins?
   b. Does the short run supply of pins have constant elasticity?
   c. Starting with the pin market in long run equilibrium, and a demand elasticity of one, compute the short run effect on pin price of an increase in the price of metal to $4/kg.

3. (20 points) Consider the production possibilities frontier for wheat *W* and corn *C*. One nation has a frontier of $2W^2 + C^2 = 3$ and another nation has a frontier of $W^2 + 2C^2 = 3$. Both nations consume equal amounts of corn and wheat.
   a. Under autarky, how much does each nation consume?
   b. What is marginal cost of each nation?
   c. How much extra can be obtained through trade? (Hint problem is symmetric)
   d. What relative price supports the outcome in c.?

4. (10 points) According to Ricardian theory, where should #2 pencils be manufactured? You should describe the characteristics of the location, rather than naming specific countries.

5. (20 points) A factory uses two inputs, with quantities denoted by *x* and *y*. The prices of these inputs are *p* and *r*, respectively Output is $\sqrt{x^2 + y^2}$. What is marginal cost? (Hint: suppose we are producing *z* units of output. What is minimum cost?)

6. (10 points) Oil is the major input to the manufacture of plastics. Should an increase in the price of oil reduce the use of plastics as automotive parts? Why or why not?

Answers

1. (20 points) The short run elasticity of demand for gasoline is 0.25, and the long run demand elasticity is 0.8. The gasoline market is initially in equilibrium, and then a hurricane destroys 20% of US refinery capacity.

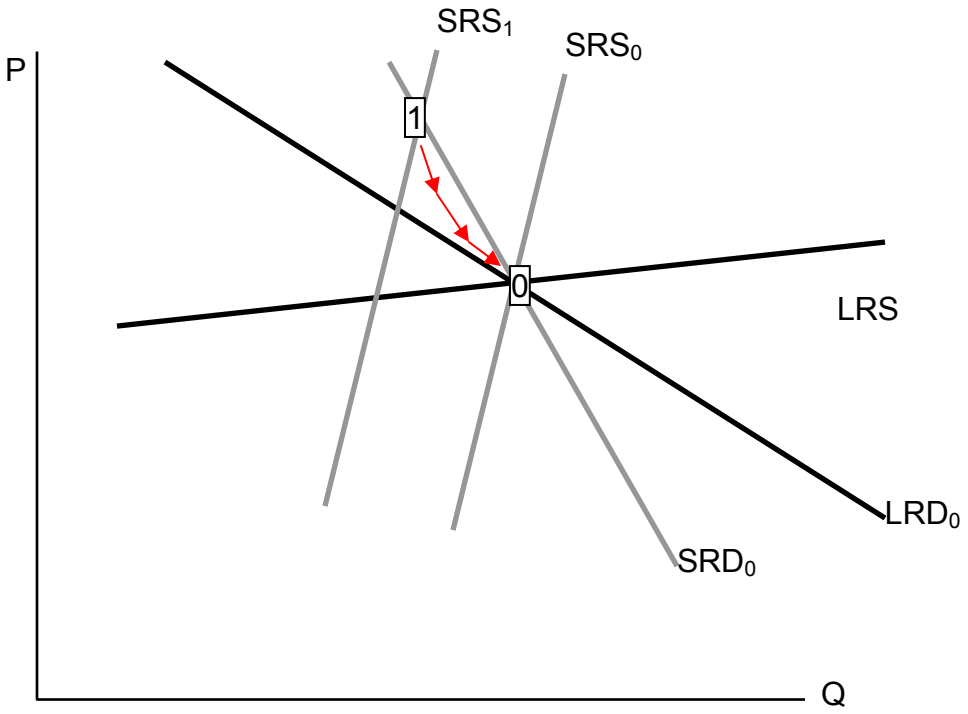
a. Assuming a perfectly inelastic short run supply, how much does the price go up in percent?

b. If the long run supply has elasticity of 1, what is the long run price change? Draw the long and short run adjustment diagram.

Constant elasticity means $q_d = ap^{-0.25}$. In order for q_d to fall by 20%,

$.8 = (p_{new} / p_{old})^{-0.25}$, or $2.44 = (.8)^{-4} = p_{new} / p_{old}$, which is 144% increase in price.

The return to equilibrium – short run capacity is rebuilt over the long run – is illustrated in the next diagram in red.



2. (20 points) Each automated pin factory costs an amount with present value equal to \$1M/year to build, and produces $\sqrt{x}$ million boxes of pins per year, where x is the input of metal in kg.

a. If the price of metal is \$1/kg, find is the long and short run industry supply of pins.

b. Does the short run supply of pins have constant elasticity?

c. Starting with the pin market in long run equilibrium, and a demand elasticity of one, compute the short run effect on price of an increase in the price of metal to \$4/kg.

a. The total cost of producing y per year pins is, in \$M, $1+y^2$. Average total cost is $\frac{1+y^2}{y}$.

Average variable cost is minimized at y=1, with a cost of 2, so LRAC is constant at \$2/box. The marginal cost is $2y$, where y is the number of million boxes per factory. The short run supply, then, is given by *price* = $2Q/N$, where Q is the total quantity and N is the number of factories.

b. Yes.

c.In long run equilibrium, the price is \$2, the number of factories is *N*, and the short run marginal cost is 2Q/*N*, so *N*=*Q*. With an elasticity of 1, demand is in the form $q_d = Ap^{-1} = ½ A$. Thus *A* = 2*N*. Increase the price of metal, and the total cost rises to $1+4y^2$ and average total cost to $\frac{1+4y^2}{y}$. Average total cost is minimized at *y*= ½, with an average total cost of \$4. The long run supply is constant at this price. The short run industry marginal cost rises to 8*Q*/*N*. Thus, in the short run, $p = 8Q/N = 8(Ap^{-1})/N = 8(2Np^{-1})/N = 16p^{-1}$, so *p*=\$4. Thus the short run price equals the long run price.

3. (20 points) Consider the production possibilities frontier for wheat *W* and corn *C*. One nation has a frontier of $2W^2 + C^2 = 3$ and another nation has a frontier of $W^2 + 2C^2 = 3$. Both nations consume equal amounts of corn and wheat.

a. Under autarky, how much does each nation consume?
b. What is marginal cost of each nation?
c. How much extra can be obtained through trade? (Hint problem is symmetric)
d. What relative price supports the outcome in c.?

a. Under autarky, you can readily check that each nation consumes 1 unit of corn and 1 unit of wheat.

b. For the first nation, $W = ½\sqrt{3 - C^2}$, so $\frac{dW}{dC} = -½(2 - C^2)^{-½}C = -½\frac{C}{W}$. Thus, the marginal cost of corn (in terms of wheat) is $½\frac{C}{W}$. Similarly, for nation 2, the marginal cost of corn in terms of wheat is $2\frac{C}{W}$.

c. There are various ways to solve this problem. The easiest is to note that the solution to part d. is 1 because of symmetry . That is, the prices supporting trade must be equal. Thus, nation 1 maximizes w + c subject to $2W^2 + C^2 = 3$, which solves for $w = ½\sqrt{2}$ and $c = \sqrt{2}$. Thus each nation with trade consumes $\frac{3}{4}\sqrt{2}$ of each good, a 6% increase over autarky.

4. (10 points) According to Ricardian theory, where should #2 pencils be manufactured? You should describe the characteristics of the location, rather than naming specific countries.

The major inputs are labor, wood, graphite, erasers and some capital equipment. The labor is low to medium skilled. Pencils should be manufactured where these inputs are abundant. Moreover, graphite and erasers are pretty easily transported. My pencils were made in Indonesia, which is sensible under Ricardian theory.

5. (20 points) A factory uses two inputs, with quantities denoted by *x* and *y*. The prices of these inputs are *p* and *r*, respectively Output is $\sqrt{x^2 + y^2}$. What is marginal cost? (Hint: suppose we are producing *z* units of output. What is minimum cost?)

Cost is $px + ry = px + r\sqrt{z^2 - x^2}$. Cost is minimized when $x = z\sqrt{\frac{p^2}{p^2 + r^2}}$ and thus total cost is $px + ry = p\sqrt{\frac{p^2}{p^2 + r^2}}z + r\sqrt{\frac{r^2}{p^2 + r^2}}z = \left(p\sqrt{\frac{p^2}{p^2 + r^2}} + r\sqrt{\frac{r^2}{p^2 + r^2}}\right)z$. The marginal cost is the derivative with respect to output and hence is $p\sqrt{\frac{p^2}{p^2 + r^2}} + r\sqrt{\frac{r^2}{p^2 + r^2}} = \frac{p^2 + r^2}{\sqrt{p^2 + r^2}} = \sqrt{p^2 + r^2}$.

6. (10 points) Oil is the major input to the manufacture of plastics. Should an increase in the price of oil reduce the use of plastics as automotive parts? Why or why not?

Plastic is used to reduce the weight of automobiles, which increases their fuel efficiency. Oil is also the major input into the manufacture of gasoline. Thus an increase in the price of oil increases the demand for plastic in automobiles, simultaneously while decreasing the supply of plastics. The overall quantity is ambiguous. Historically, however, increased oil prices increased the use of plastics in cars, although the plastics are also improving technologically.