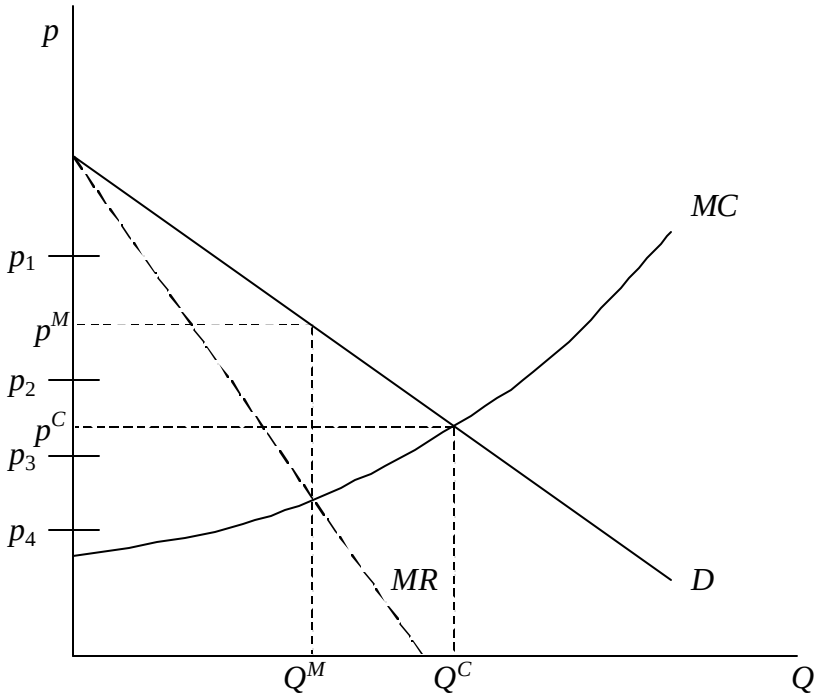
Problem Set 5 - *Answers*
Imperfect Competition

1. The graph below shows the marginal cost curve for producing a good in a country, together with the domestic demand curve for that good.



   a. If this were a competitive industry in a closed economy, what would be the price of the good and the quantity produced?

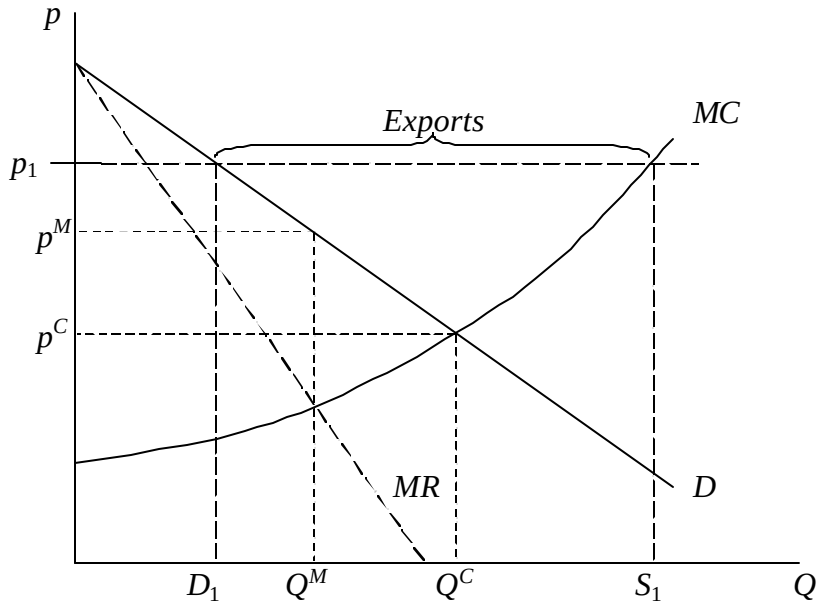
      With perfect competition, the marginal cost curve is the supply curve, and market equilibrium is at the intersection of this with the demand curve. Price and quantity are p^C and Q^C as shown.

   b. If instead there is only a single firm in the country able to produce this good, and this is that firm's marginal cost curve, what will be the price and quantity of the good produced in autarky?

      With only a single firm and no trade, the firm is a monopolist. Its profit-maximizing output can be found by constructing its marginal revenue curve, MR, half the horizontal distance between the demand curve and the vertical axis. Output is where MR=MC, or Q^M. The market clearing price of this output is p^M.

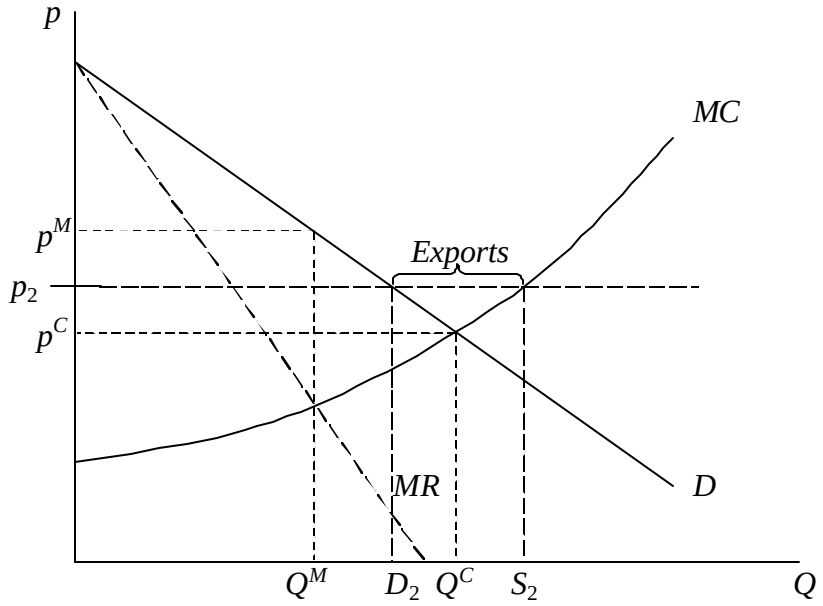
   c. Suppose now that the country becomes open to free international trade at a fixed world price equal to p_1 in the figure, at which the firm can sell all it wants to and at which buyers can also buy all they want to. How much will the firm produce and sell, both domestically and internationally? How much will buyers buy, and from whom? How much of the good will the country export and/or import?

The demand curve facing the firm is now, in effect, the horizontal line at price p_1, since it can sell all it wants at this price, and domestic demanders, with the option to import at that price, will not pay more. The firm becomes a perfect competitor, pricing where MC equals price, the quantity S_1. Domestic demanders buy D_1, and although they could just as well buy it from abroad, they may as well buy it from the domestic firm. The firm (and country) will therefore export the difference: $S_1–D_1$.

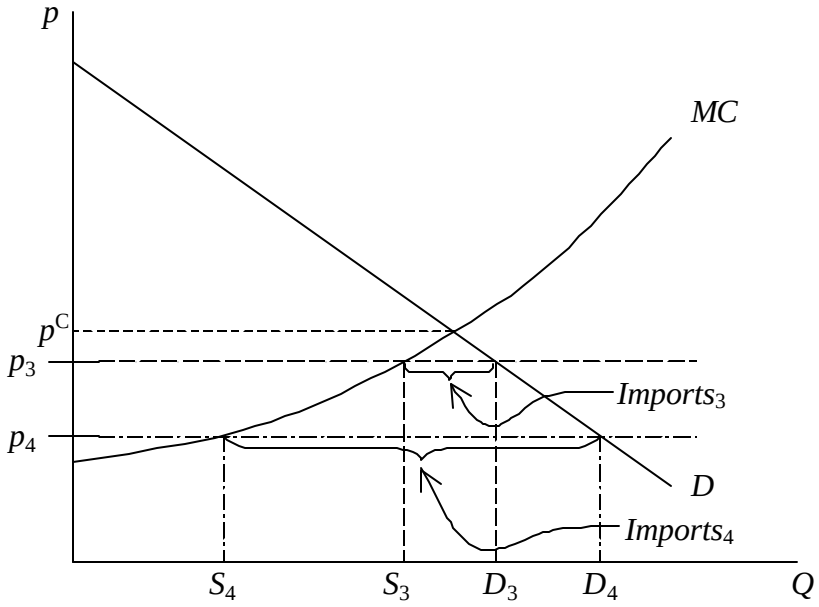


d. Repeat part (c) for each of the prices p_2, p_3, and p_4.

These are not much different from part (c), except that at lower prices, less is

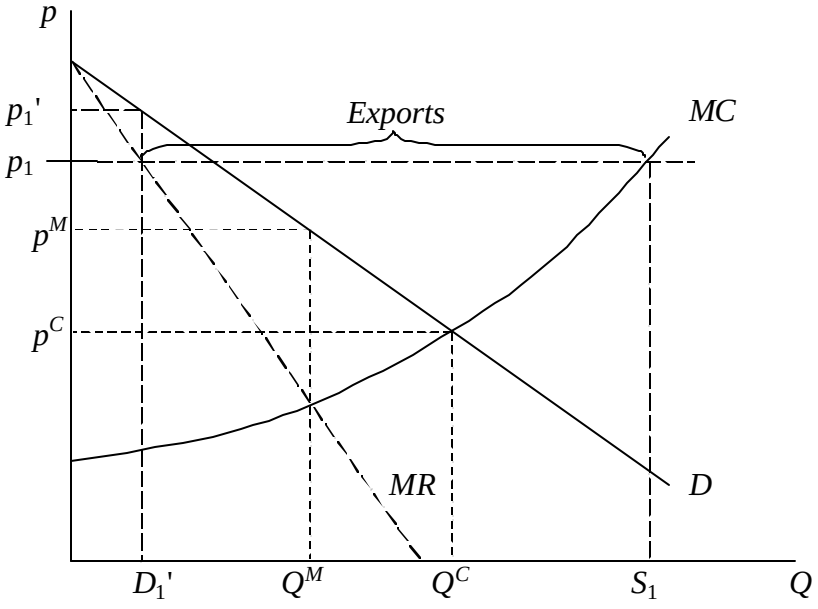


supplied by the firm and more is demanded by domestic demanders, so that for prices below p^C, the country imports the good instead of exporting it:



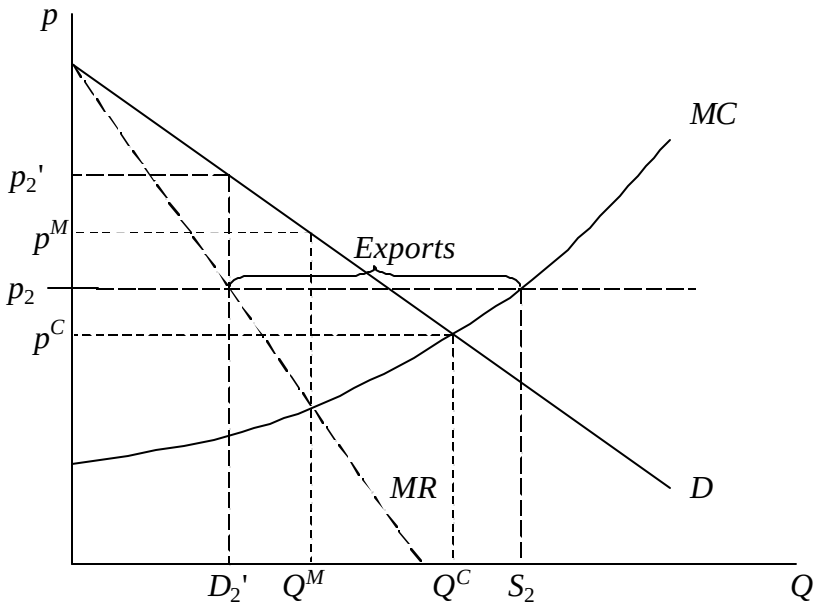
e. Repeat parts (c) and (d) assuming that imports are prohibited, but exports are permitted.

If imports are prohibited, then the firm can charge domestic consumers a higher price than the world price, while at the same time selling on the world market for the world price if it wants to. To set its price on the domestic market, it must recognize not only the marginal cost of production, but also the marginal opportunity cost of selling a unit of the good on the domestic market instead of the world market. Thus, as long as it is exporting at all, the world price is its marginal (opportunity) cost of selling on the domestic market.

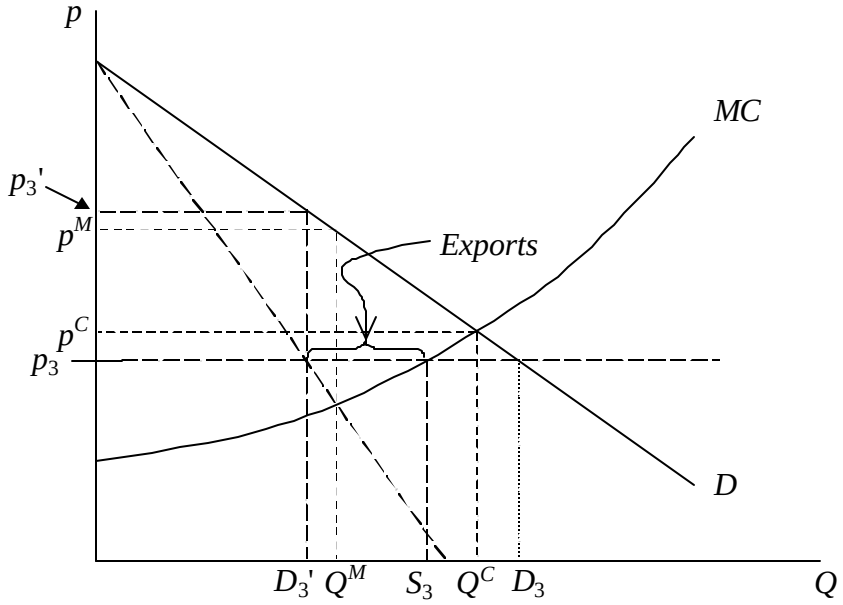


At price p_1, see above, it will sell on the domestic market a quantity at which $MR=p_1$, thus the quantity D_1' at price $p_1'>p_1$. Its production will still be S_1, and its exports will therefore be the larger $S_1–D_1'$.

At price p_2, the picture is much the same, with the firm selling D_2' on the domestic market at price p_2'. The fact that p_2 is below its monopoly price does not really

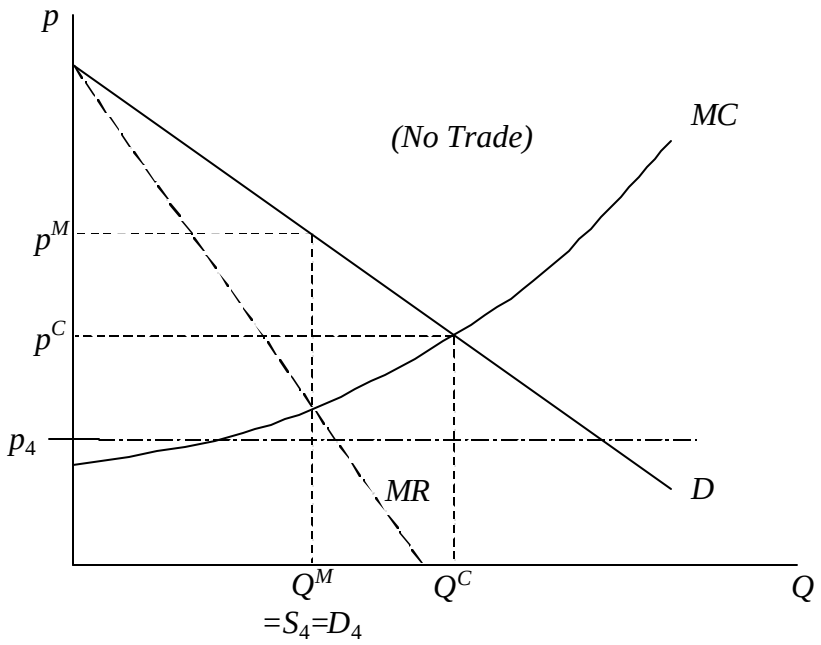


matter, since domestic buyers don't have the option of buying at p_2. At price p_3, below, it is still much the same, although there is now quite a difference compared



to when imports were permitted. At this price the country was a net importer, and now it is a net exporter, of $S_3–D_3'$.

At price p_4, however, things are very different. Now, by charging the monopoly price, the firm can expand its sales to a point at which its marginal cost exceeds the world price p_4. Therefore it will not sell on the world market at all, and will simply exploit its monopoly power at home:



2. In class we saw the following result for the gains from trade in the Reciprocal Dumping Model of international Cournot duopoly:

$$\Delta W^W = \frac{(a-c)^2}{72b}(a-1)(11a-5)$$

where a and b are the parameters of the demand curve, $p=a-bQ$, c is the constant marginal cost of production, common to both firms, W^W is the combined consumer surplus and profit of both firms from sales in the domestic market, and $a = 2t/(a-c)$ where t is the transport cost.

a. For a given value of the transport cost such that gains from trade are positive, how does the size of the gain from trade depend on the parameter b, and why? How does it depend on a, and why?

Parameter b enters this expression only in the denominator of the fraction. A rise in b, meaning a flattening of the demand curve, reduces the gains from trade. The reason, however, is not really that the trade equilibrium is worse – it's not. Rather, the rise in b means that demand is more elastic and the monopoly power of the firm without trade is reduced. Therefore the benefit to be had by reducing that monopoly power is also reduced.

Parameter a appears in the numerator of the fraction and would seem to increase the gains from trade. That is correct, but it's not that simple, since for given t a rise in a also reduces the size of a *. But since a fall in* a *increases the gains from trade (when they are positive in the first place), this just reinforces the result. To get this formally, note first that positive gains from trade means* $a < 5/11$*. Then*

$$\Delta W^W = \frac{(a-c)^2}{72b}(a-1)(11a-5) = \frac{(a-c)^2}{72b}(11a^2-16a+5)$$

$$= \frac{(a-c)^2}{72b}\left[11\frac{4t^2}{(a-c)^2} - 16\frac{2t}{(a-c)} + 5\right] = \frac{11}{18b}t^2 - \frac{4}{9b}t(a-c) + \frac{5}{72b}(a-c)^2$$

$$\frac{d\Delta W^W}{da} = -\frac{4}{9b}t + \frac{5}{72b}2(a-c) > -\frac{4}{9b}\left(\frac{5}{11}\frac{(a-c)}{2}\right) + \frac{5}{72b}2(a-c) = \frac{(a-c)}{b}\left(-\frac{20}{198} + \frac{10}{72}\right)$$

$$= \frac{(a-c)}{b}\left(\frac{10}{72} - \frac{10}{99}\right) > 0$$

b. Starting from a level of the transport cost that is high enough to prevent trade entirely, consider the effect of lowering it. At what level of *t* does a further fall in *t* first increase world welfare?

The transport cost does not matter for the level of welfare achieved under autarky, so it suffices to look just at the effect of reducing t on ΔW^W*. Differentiating* ΔW^W *from part (a) with respect to t:*

$$\frac{d\Delta W^W}{dt} = \frac{d}{dt}\left[\frac{11}{18b}t^2 - \frac{4}{9b}t(a-c) + \frac{5}{72b}(a-c)^2\right] = \frac{11}{18b}2t - \frac{4}{9b}(a-c)$$

This is negative (so that a fall in t increases welfare) whenever

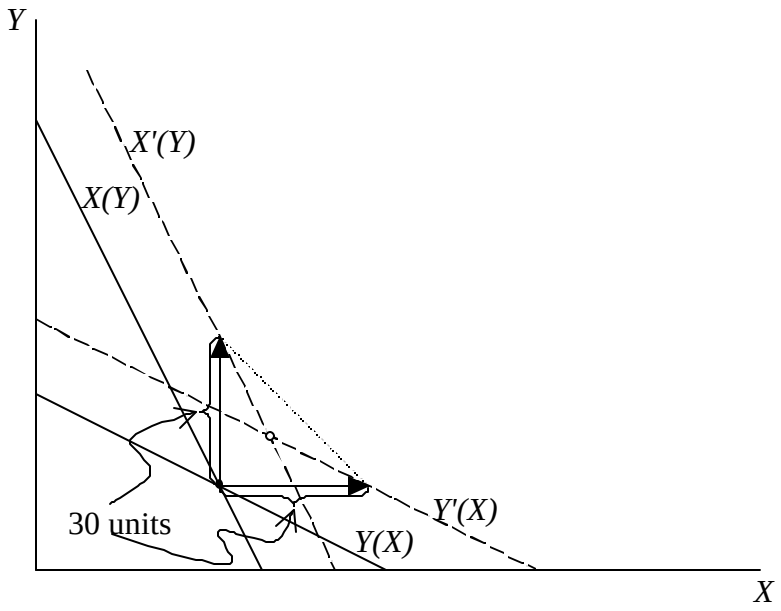
$$\frac{11}{18b}2t < \frac{4}{9b}(a-c) \quad \Rightarrow \quad t < \frac{18b}{22}\frac{4}{9b}(a-c) = \frac{4}{11}(a-c)$$

Thus a fall in t starts to increase welfare at t=4(a-c)/11 (or $a = 8/11$*).*

3. Suppose that domestic demand expands in the Reciprocal Dumping Model in the following sense: for any given price, the quantity demanded increases by 30 units. What will happen to the outputs of both firms and to the Nash equilibrium domestic price?

This is a shift to the right in the demand curve by 30 units. From the point of view of each firm, the demand curve that it faces will remain unchanged if there is an increase in the sales of the other firm by 30 units. Therefore, both reaction curves shift out, moving in the direction of the other firm's output by 30 units. Recalling that the two reaction curves have the same slope relative to the other's axis, the change in the Nash equilibrium must be symmetric, with both firm's increasing their outputs by

the same amount. But from the figure below, we can also see that the increase in total output is less than 30 units, and therefore each firm increases its output by less than 15. Since an increase in total output of 30 units would have cleared the market at the old price, this increase of less than 30 units must cause the price to rise.

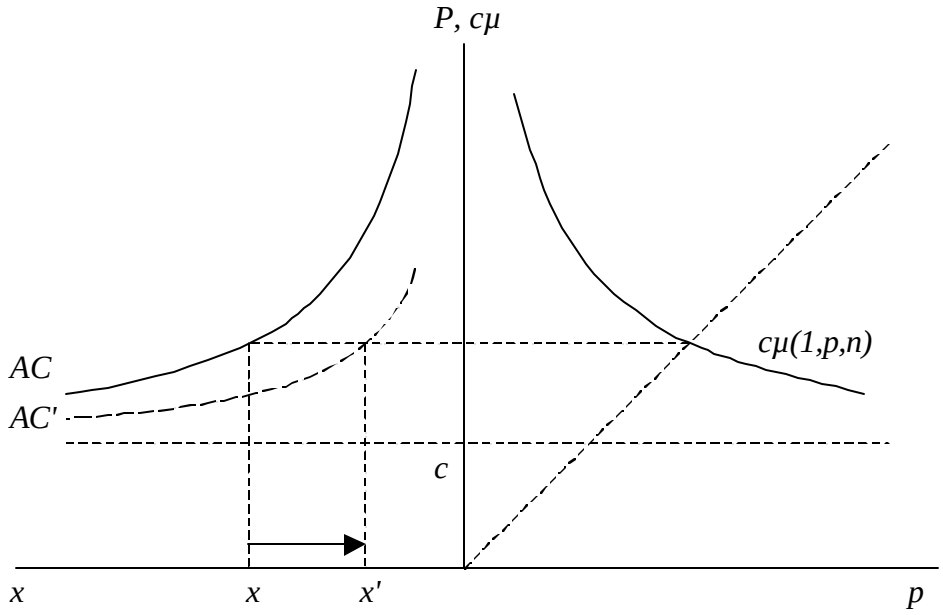


To get these results algebraically, first note that a parallel outward shift in the demand curve means an increase in the parameter "a". Since p = a –bQ, at a constant price ?p = 0 = ?a – b ?Q, or ?a = b?Q = 30b.

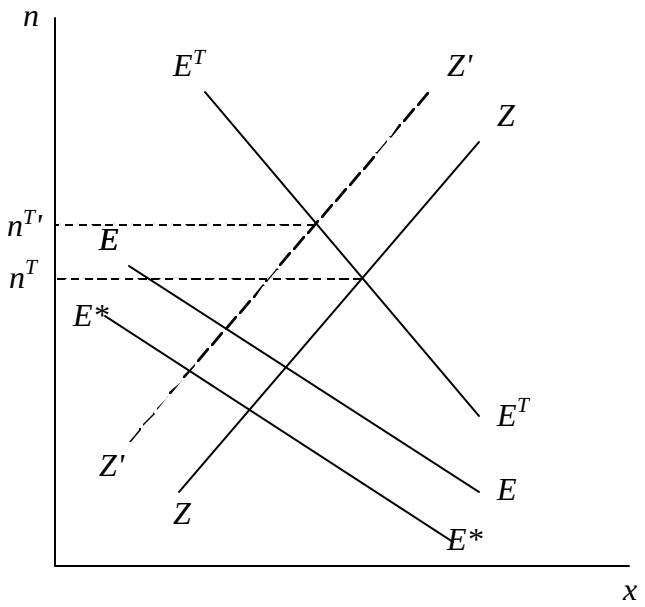
In class we saw that the Nash equilibrium outputs are $X^N = (a–c+t)/3b$ and $Y^N = (a–c–2t)/3b$. Thus $?X^N = ?Y^N = ?a/3b = 30b/3b = 10$. We also had $P^N = (a+2c+t)/3$, so that $?P^N = ?a/3 = 30b/3 = 10b > 0$.

4. In the partial equilibrium, monopolistic competition model, suppose that the fixed cost, *F*, of all actual and potential firms in both countries were to fall to half of what it was before. What would happen to the number of firms in the world, their outputs per firm, and total output and trade of the world economy?

A fall in fixed cost reduces average cost for any given level of output, and for any given markup of price over marginal cost, therefore reduces the output per firm needed to break even. This is shown in the following diagram for a given number of firms, n, and thus elasticity of demand and corresponding markup, μ:



It follows that the zero-profit locus shifts to the left (less x for each n) for both countries and for the world as a whole:



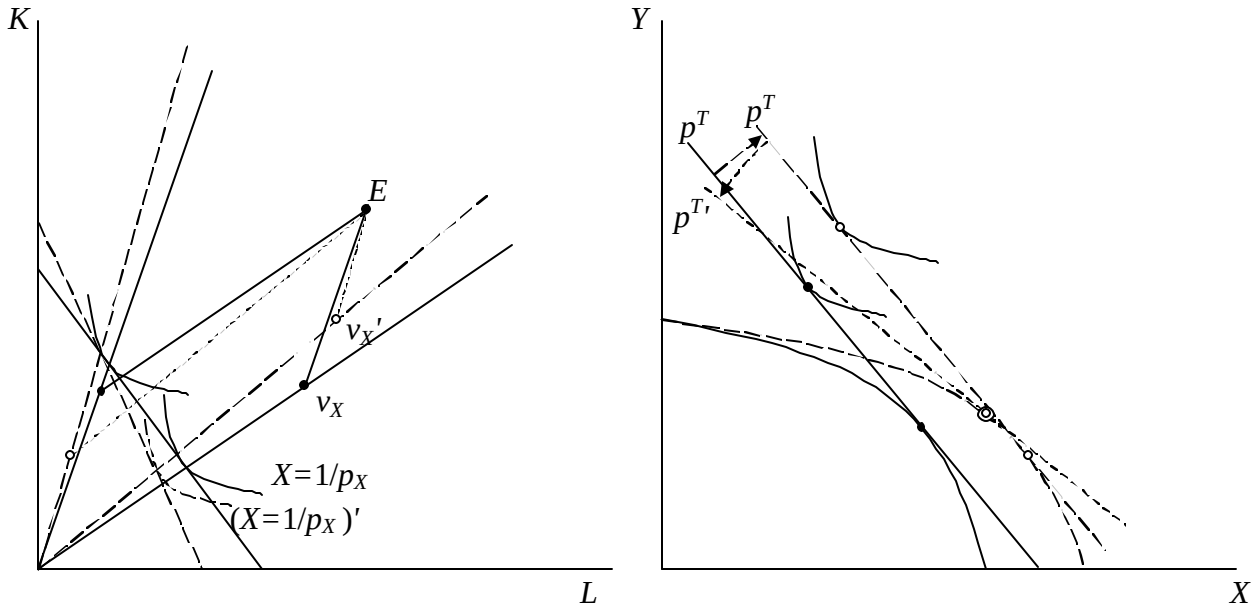
From this we know that the number of firms in the world expands, while output per firm declines. Since demand elasticity rises with the number of firms, this implies a decline in the markup over marginal cost, and therefore a fall in price. With a lower

price of each variety, demand for each will rise, and since there are also more varieties, total output of the industry world-wide increases. We don't know, in this partial-equilibrium context, exactly where these varieties are produced, and so we can't know much about trade, although it seems plausible that trade will increase.

5. Consider an industry in which a country is initially, with free trade, a net exporter (its exports are positive, and greater than its imports, if any). Suppose that an improvement in technology were to cause marginal cost of production to fall in that industry, in that country only, by the same amount for any and all firms and for any and all levels of output. What will happen to the output of that industry in the country and to the quantity of the good exported in each of the following models?

   a. The Heckscher-Ohlin Model

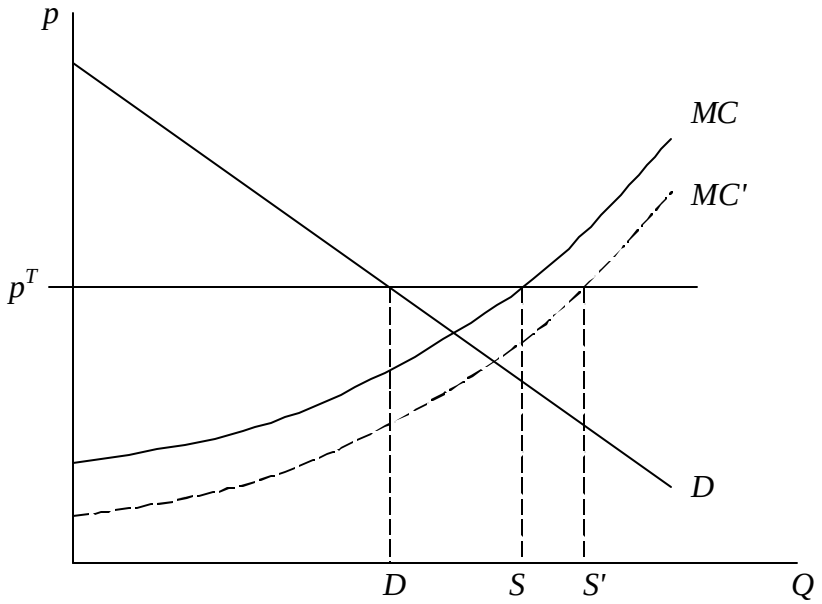
   In the HO Model, this improvement in technology means that the inputs needed to produce any given output are reduced, and therefore that the country's isoquants for the industry are shifted inwards toward the origin. The Lerner Diagram, on the left below, shows that at initial prices the country will allocate more resources to this industry (here called X and taken to be labor intensive, though that doesn't matter). It follows, using the PPF on the right below, that the country will increase its exports of X, also at initial prices. This in turn, if the country is large,



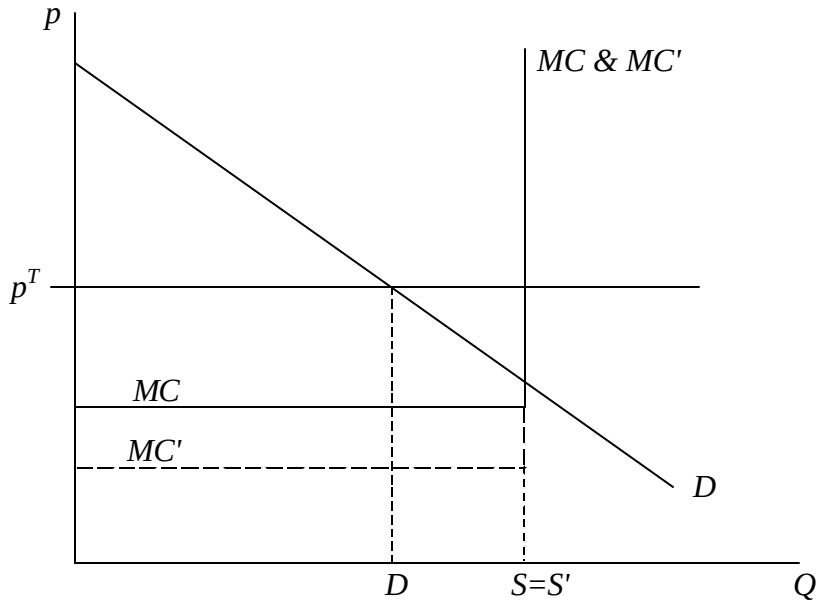
will cause the price of X to fall, from p^T to $p^{T'}$ as shown. Without the price change, the country's output of X certainly rises. Even with the price change, its output of X is likely to rise, as shown, although the fall in price does work against that.

b. The single-domestic-firm model

With a single domestic firm such as the one in question 1 above, the fall in marginal cost shifts the MC curve down and, as long as MC is upward sloping at the initial equilibrium, causes the firm to produce more output as shown below:

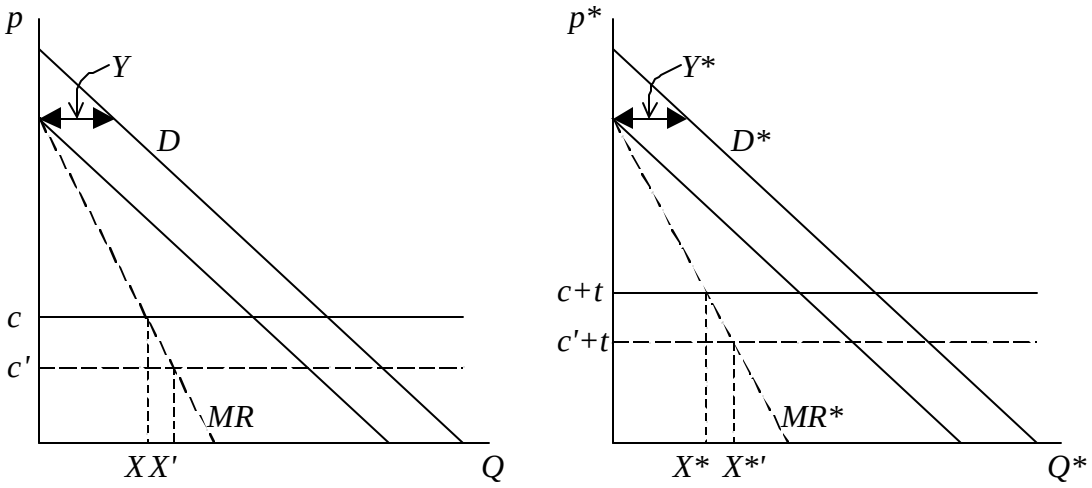


However, if the firm has limited capacity as we assumed in class, and if it is initially producing at capacity, then its output cannot rise, and the picture is as shown below:

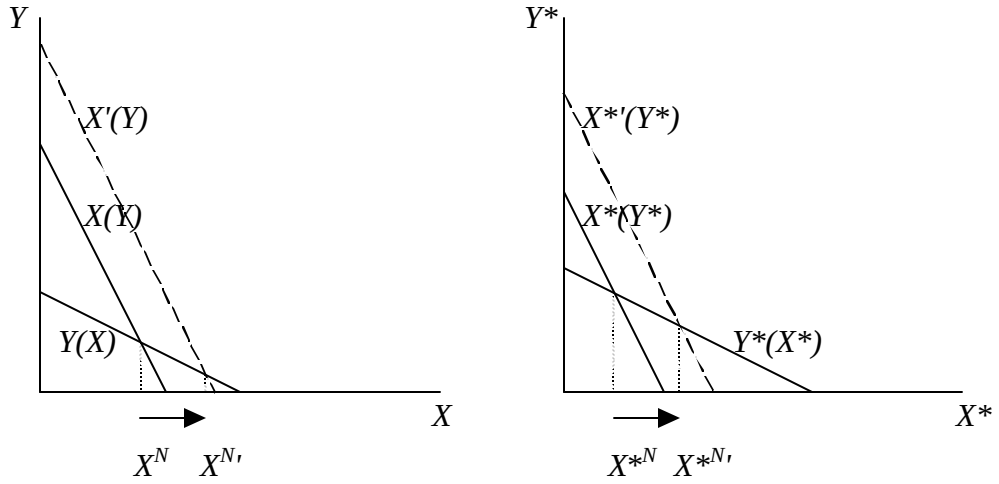


c. The Reciprocal Dumping (duopoly) Model

In the Reciprocal Dumping Model, if one firm experiences a drop in its marginal cost, then its reaction curve will shift outward in both markets. Suppose it is the home-country firm, with cost c, whose cost falls to c'. Then in the home market, for any given level of sales there by the foreign firm, Y, it will increase its sales, X, as shown on the left below. Likewise, in the foreign market, for any given level of foreign-firm sales there, Y, it will increase its sales X*, as shown on the right below.*

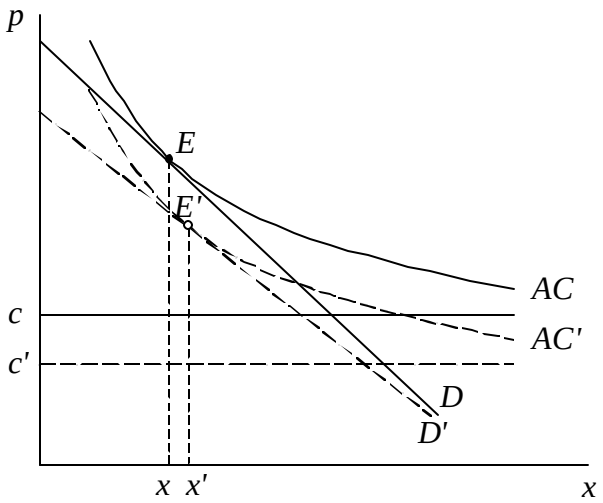


The outward shift of the X(Y) and X(Y*) reaction curves leads to new Nash equilibria with higher sales by the domestic firm in both markets, as shown below:*



d. The monopolistic competition model

In the monopolistic competition model, if marginal cost falls, this reduces average cost by the same amount. Starting from a zero-profit equilibrium as at E below, the lower-cost firms are now making a profit and there will be entry by new firms, also with the lower cost. Entry will continue, causing the demand curve to shift to the left and also become more elastic (due to the increased number of varieties), until a new zero-profit equilibrium is reached like E'



The new equilibrium markup and output per firm are, strictly speaking, ambiguous. On the one hand, the fall in price is assumed to cause elasticity of demand to decrease and the markup to increase. On the other hand, entry of new firms and production of additional varieties is assumed to increase demand elasticity and lower the markup. If the latter effect dominates – if the markup falls, or even stays the same – then output per firm must rise in order to keep the markup equal to AC/c for zero profit, since otherwise the fall in marginal cost would raise AC/c. Even if markup rises, output per firm must rise as shown above, as long as the increase in the markup is smaller than the rise in AC/c at initial x.

As for exports, these increase even more, because all foreign firms cease to operate. Since the initial equilibrium had zero profit for new entrants with the old cost, c, and since all foreign firms still have that cost but price has fallen, they will not survive. The world market is taken over by the domestic firms.