**Monopolistic Competition, Product Variety and Trade: Chapter 12**

In Chapter 11 we saw the possibility of a "rationalization gain from trade". A country in autarky might have a significant number of small firms with IRS, producing a homogeneous good subject to free entry (no profits). The effect of trade with another country was to expand total output (and output per firm), reducing average cost and price, itself a gain in terms of productivity and consumer benefits. But it also forced some firms to exit the market in each country, saving on fixed costs and expanding the PPF, a potentially significant form of productivity gain.

For example, suppose h and f are identical and each has 10 X firms in autarky producing at a fairly low scale. Now let trade force 3 firms out of each country because output per firm expands. That means in free trade there are 7 producing in each country at higher scale and lower average cost. Consumers now have 14 firms competing rather than 10 (autarky), which is why price falls.

One odd thing about this story is that the X firms are identical and produce a homogeneous good (goods are perfect substitutes for each other). We don't observe this in the real world: firms are not the same size or productivity and they produce *differentiated goods*. Here, goods are slightly different (in terms of quality, appearance, characteristics, brand loyalty) and are *imperfect substitutes*. That means each firm has some small degree of market power on the demand side.

A few comments on product differentiation:

1. Horizontal differentiation means goods are essentially of the same quality but appeal to consumers on the basis of other characteristics. Examples: different types of sports cars or mini-vans; different fashion apparel; medicines within the same therapeutic class; chain restaurants; on and on…There may be no limit on the demand side to how many differentiated varieties consumers are willing to purchase. What limits the scope of differentiation is most likely scale economies within each variety and the costs of achieving differentiation in consumers' minds (advertising, etc.).

2. Vertical differentiation means goods aim to meet the same market demand but are differentiated on quality grounds. That is, consumers know (maybe) that the good offered by firm A has higher quality (better gas mileage, lighter weight, faster download times,…) than the good offered by firm B. New intermediate inputs can lower production costs. The new, high-quality goods generally drive out the lower-quality goods.

This two-way description doesn't capture everything. Clearly there are higher-quality goods and lower-quality goods that offer similar utility services and exist in equilibrium. And these goods appeal to consumers of different tastes and incomes; low-income people tend to buy lower-quality goods, etc. So our analytical models abstract here by saying that within any defined quality class, there is both horizontal differentiation (which expands product variety) and vertical differentiation (which drives out the lower-quality goods in that class).

What examples can we consider where there is a tradeoff between returns to scale (high volume output per variety) and the gains from differentiating goods for consumers (low volume output per variety)? How about these, each of which (very loosely) can be described by "national types" of goods:

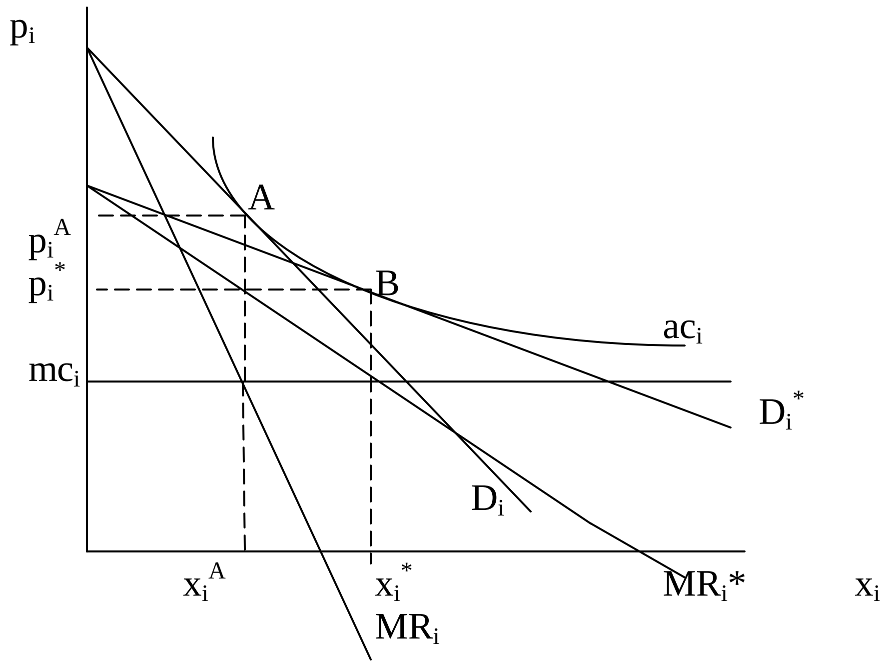
Automobiles
Furniture

Obviously, innovation is closely linked to all of this. Trade theorists develop models of "Schumpeterian Growth" (creative destruction), "Variety Expansion" and "Quality Ladders" growth and trade. We won't develop these models but I'll say a bit about it later.

There are 3 basic (static) concepts here: **firm heterogeneity, increasing returns to scale, and product differentiation.** In this chapter we'll consider IRS and product variety. Next chapter will look at firm differences.

Again, let's start with simple partial-equilibrium story before doing some math and a more precise general-equilibrium analysis.

The following diagram is a standard monopolistic competition diagram with free entry. Each firm (i) faces a downward-sloping demand curve and marginal revenue curve so it gets to price above marginal cost. (This means there is a demand elasticity greater than one but less than infinity.) But there is free entry, so price equals average costs as shown at point A (autarky). In the diagram I've drawn constant mc and declining ac.




Initial equilibrium in autarky at A, no profits made, output of firm i is shown. (Here I use small x for per-firm output rather than industry output. The theory to this point can't distinguish among firms easily so really this small $x = x_i$ refers to the output of all firms and industry output is $X = nx$.)

Now let this h economy engage in trade with an identical f economy. The impact is somewhat different with product differentiation. Trade implies a higher (double) market size but more competition from f firms. Since goods are *imperfect substitutes* the demand for each good shifts down and becomes more elastic (flatter) in the neighborhood of A.  See the new demand curve $D_i$*, which reflects the Cournot-Nash assumption of each firm that its output expansion will not be matched by others, so perceived demand is more elastic and perceived MR exceeds marginal cost at A.

So each firm tries to expand output.  But this is impossible because as price falls some of these firms will not be able to cover fixed costs and will exit the market.
In this simple story we have the following results:

- Output per firm rises, so average cost declines (a productivity gain).
- Price falls (a consumer gain).
- Some firms exit in each country (a rationalization gain).
- There is more product variety for consumers to enjoy (a "variety gain")

Among these, the variety gain is what's new here.  We need to analyze it more closely.  Before doing so, note that one implication is that international trade should display the possibility of *intra-industry trade* (IIT), in which countries both export and import similar (but differentiated) goods.  This is a very important phenomenon in world trade.

| Table 13.1 Intra-industry Trade by Commodity and Country, 2007 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| *Country* | Organic Chemicals | Iron & Steel Products | Industrial Machinery | Office Mach. & Computers | Passenger Vehicles | Prof. & Scient. Instruments | Apparel & Accessories | Alcoholic Beverages |
| United States | 84 | 81 | 59 | 85 | 73 | 61 | 16 | 44 |
| Canada | 79 | 76 | 71 | 46 | 85 | 66 | 32 | 39 |
| Australia | 8 | 72 | 43 | 24 | 38 | 65 | 11 | 45 |
| Germany | 87 | 93 | 57 | 77 | 57 | 78 | 60 | 75 |
| UK | 92 | 83 | 72 | 79 | 97 | 84 | 52 | 77 |
| Japan | 84 | 44 | 36 | 96 | 15 | 89 | 4 | 37 |
| R. of Korea | 81 | 91 | 94 | 64 | 14 | 58 | 60 | 62 |
| Mexico | 43 | 76 | 51 | 93 | 65 | 81 | 63 | 30 |
| Brazil | 68 | 48 | 89 | 13 | 94 | 23 | 51 | 29 |
| China | 51 | 75 | 61 | 52 | 77 | 57 | 4 | 49 |
| India | 85 | 81 | 52 | 27 | 23 | 41 | 2 | 99 |

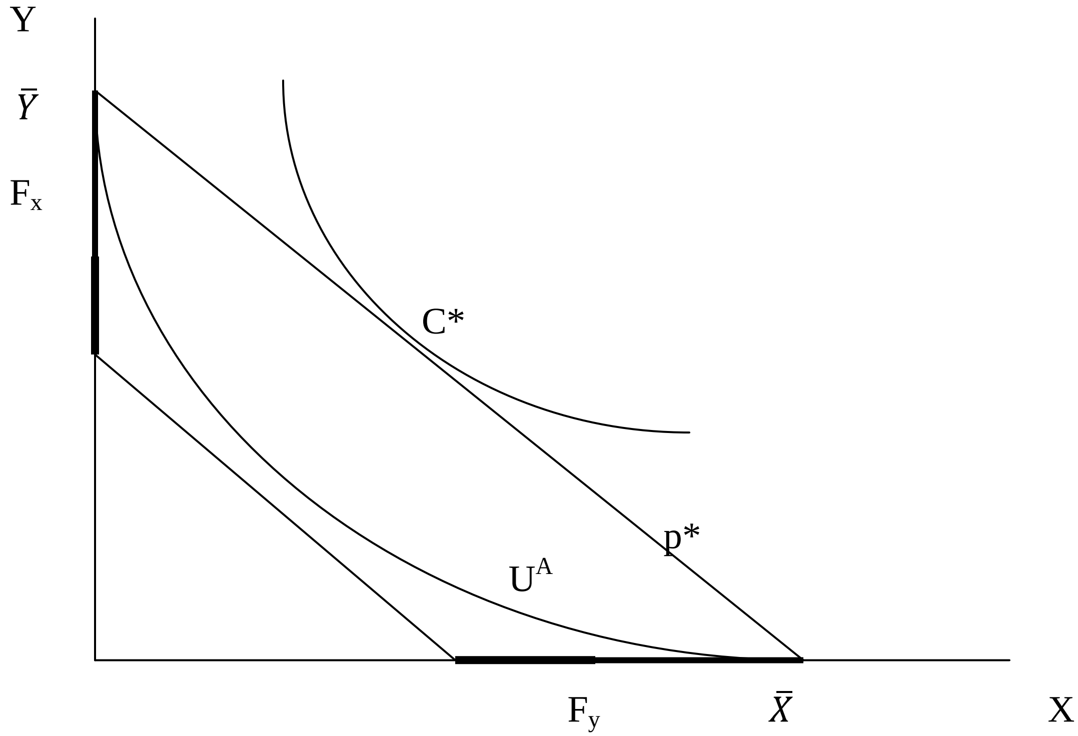
Next let's put our simple story into a gen eq context with two goods, each subject to IRS and product differentiation.

So let h and f be identical. Both X and Y are produced with IRS of our basic kind:

$$L_x = mc_x X + F_x;\ L_y = mc_y Y + F_y;\quad L_x + L_y = \bar{L}.$$

These relationships hold in both h and f. Note along the PPF where both goods are produced we have

$\frac{dY}{dX} = -\frac{mc_x}{mc_y}$ so there is a straight-line PPF where both are produced. But we need to account for fixed costs as we do on this PPF:




This is a very stylized depiction. But let $U^A$ reflect preferences between X and Y in autarky in both countries. It displays a taste for both goods X and Y. The PPF shows IRS in both goods. In this case it is possible that the max level of utility is where the indifference curve cuts each axis and both countries would completely specialize in autarky. It's not obvious which would do that so let h specialize and consume at $\bar{X}$ and f specialize and consume at $\bar{Y}$. Every firm in f produces only Y, every firm in h produces only X.

With free trade each can export the good it produces without changing outputs. This permits trade at price ratio p* and consumption for both at C*. (Note that since outputs don't change there is no productivity gain.)

This is a *pure diversity (or variety) gain* from trade and needs to be added to our (now long) list of where GFT come from.

Another note: intermediate inputs (metals, machinery, chemicals, etc.) are also differentiated and perhaps subject to IRS. So we get a similar story on the input side: openness to trade raises the number and variety of inputs available, which would reduce production costs.

Now it's worth doing a more analytical approach to monopolistic competition, product variety and trade so we can see what happens in general equilibrium.

Consider the following utility function defined for a sector X with varieties indexed by i.

$$U = \left[ \sum_i^n X_i^\alpha \right]^{\frac{1}{\alpha}} \qquad 0 < \alpha < 1 \qquad \frac{1}{\alpha} > 1 \qquad \sigma = \frac{1}{1 - \alpha} > 1$$

There are n versions of good X and they are *imperfect substitutes*. Here this is a CES utility function with elasticity of substitution equal to $\sigma > 1$. This parameter measures how easily consumers are willing to substitute between any pair of goods $X_i$ and $X_j$. In this specification $\sigma$ is the same for all pairs and the goods are symmetric substitutes. The higher is $\sigma$, the greater the substitution elasticity in demand.

This utility function is called "Dixit-Stiglitz" preferences. It permits analysis of cases where goods are imperfect substitutes. But it is highly specialized. For one thing it implies consumers always prefer more variety. That is, while 2 bottles of Chanel perfume and 2 bottles of Givenchy perfume provide the same utility, the consumer would prefer 1 bottle of each. This can be easily seen if output of each good is the same (it will be in our basic model) the term in the brackets is nX. Then

$$U = \left[nX^{\alpha}\right]^{\frac{1}{\alpha}} = n^{\frac{1}{\alpha}}X$$

Because $\alpha < 1$ this function displays increasing returns to more variety. If $\alpha = ½$ then $U = n^2X$. Consumers really like variety.

But they have an income constraint so they cannot consume more varieties for a given budget. Suppose that as n doubles consumers cut their consumption per variety in half. Then

$$U = (2n^0)^{\frac{1}{\alpha}}(X^0/2) = 2^{\frac{1}{\alpha} - 1}\left(n^0\right)^{\frac{1}{\alpha}}X^0 = 2^{\frac{1-\alpha}{\alpha}}\left[\left(n^0\right)^{\frac{1}{\alpha}}X^0\right] = 2^{\frac{1-\alpha}{\alpha}}U^0 > U^0$$

Consumers are better off with twice as many varieties, consuming each at ½ the volume. In fact, the highest utility arrives with infinitesimally small consumption of each of an infinite number of varieties, which does not seem reasonable. In any case, this is called the "love of variety" utility function.

The strange idea in the last paragraph could happen if there truly were no scale economies. Then firms could each produce a tiny amount of one good and sell to consumers. But in fact the existence of IRS means there is a tradeoff between scale of output and variety gains. We can see this kind of outcome in the last diagram above. Comparing autarky (complete specialization) with free trade the consumers in each country get less of the good they were specialized in but more of the other good. This gain in variety appeals to consumers and they are better off. See also Figures 12. 1 and 12.2.

Following is a general equilibrium model of pure variety gains (due to Krugman, JIE 1979). It is highly simplified to get the basic result.

Let utility be

$$U = \left[\sum_i X_i^{\alpha}\right]^{\frac{\beta}{\alpha}} Y^{1-\beta} \qquad \sigma = \frac{1}{1-\alpha} \qquad L = np_x X + p_y Y$$

This is a Cobb-Douglas function in Y and the aggregate of differentiated goods. Now with symmetry of all cost functions and the symmetry of demand for each variety we will get $X_i = X \; and \; U = [nX^{\alpha}]^{\frac{\beta}{\alpha}} Y^{1-\beta}$. Here X is the output per firm, same across all varieties. The 3d equation above is the national budget constraint, where we assume w = 1 and labor is the only factor of production. Maximizing U subject to this constraint generates

$$Y = (1-\beta)\frac{L}{p_y} \qquad X_i = p_{xi}^{-\sigma}\left[\sum_i p_{xi}^{1-\sigma}\right]^{-1} \beta L \qquad nX = \beta\frac{L}{p_x}$$

The first is the demand function for Y, the last is the demand for total X (= nX) and these are standard Cobb-Douglas outcomes. The second is the demand for an individual variety. Now if there are many monopolistic competition firms, the term in brackets (price index for X) is considered fixed (exogenous) to any firm. Letting that be a constant it's easy to show $\eta = -\frac{p_{xi}}{X_i} * \frac{\partial X_i}{\partial p_{xi}} = \sigma$ . That is, each firm perceives a constant demand elasticity (equal to the elasticity of substitution across varieties).

On the supply side let Y be perfect competition, CRS. Let $Y = L_y$ so $p_y = w = 1$.

But let X have IRS in the simple way

$L_{xi} = F_{xi} + mc_{xi}X_i$ But assume that fixed and marginal costs are the same for each firm. It will also imply the same average cost per firm and therefore the same price $p_x$. In turn output per firm is the same; each variety is produced at X units and total X = nX, where n is the number of firms (varieties). EACH FIRM PRODUCES JUST ONE VARIETY.

In this model there are 4 endogenous variables (X, Y, n, $p_x$) and 4 exogenous variables ($F_x$, $mc_x$, $p_y$, $\bar{L}$). To solve it we can use these 4 equations:

1. $p_x\left(1-\frac{1}{\sigma}\right) = mc_x$ Markup equation in X
2. $(p_x - mc_x)X = F_x$ Zero profits (free entry), determines the number of firms n.
3. $\frac{\beta L}{p_x} = nX$ Demand = supply for X.
4. $L_y + L_x = \bar{L}$ Labor market clearing.

(There would also be a market-clearing equation for Y but it's solvable from these relationships.) Now $L_y$ = Y and $L_x = n * mc_x X + nF_x$

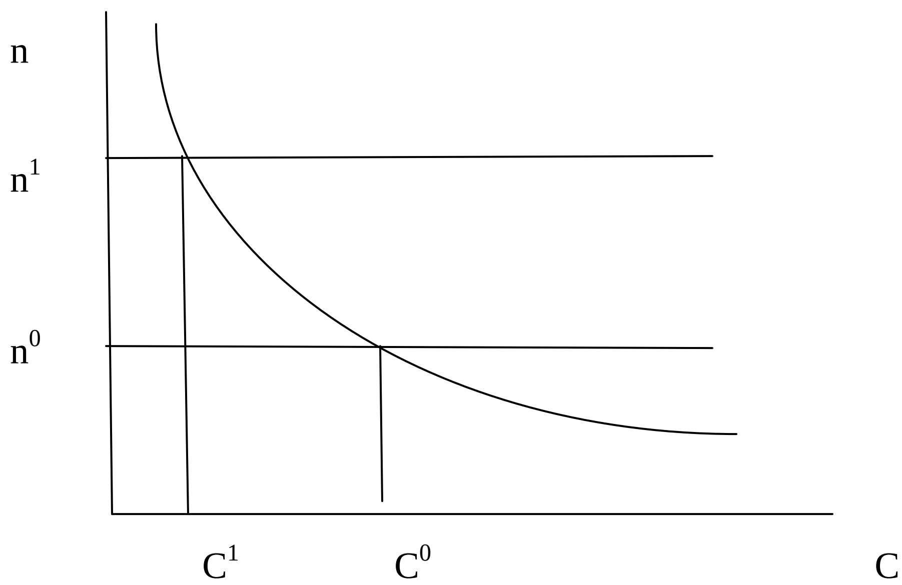
If you solve this system you'll get the following outcomes:

$$X = (\sigma-1)\frac{F_x}{mc_x};\;\; n = \frac{\beta\bar{L}}{\sigma F_x};\;\; nX = \frac{(\sigma-1)}{\sigma} * \frac{\beta\bar{L}}{mc_x}$$

This says that output per firm (X) is constant. The number of firms (n) is constant also but rises with an increase in country size ($\bar{L}$). Total X output goes up also.

Finally, define $C = \frac{X}{\bar{L}}$ as per-capita consumption of each variety of good X produced. $nC = n\frac{X}{\bar{L}} = \frac{(\sigma-1)}{\sigma} * \frac{\beta}{mc_x}$ is constant. So total consumption of all varieties per person is constant.

Figure 12.3 in the text shows the equilibrium. The line labeled C is actually the nC equation above; nC is a constant so C rises as n goes down.




The n lines come from the expression for n above; it is constant for a given L endowment. Now let the economy enter free trade with another economy the same size. This doubles the size of the market so the new labor endowment is twice as large. That in turn doubles the number of firms in the new equilibrium, though it cuts output per capita of each variety in half to $C^1$ .

This very specialized model gets the following results:

1. Output per variety does not change, so there are no IRS gains (no lower average costs) or rationalization gains.
2. There are more varieties, so a pure diversity gain exists.
3. Consumption of each variety per capita falls but there are more people, so total consumption per variety does not change.

Again, this is a pure variety gain from trade.