KRUGMAN MODEL - MONOPOLISTIC COMPETITION

Overview:

This model uses economies of scale, differentiated products and heterogenous preferences to explain intra-industry trade. The essence of the model is as follows:
- preferences are heterogeneous between and within countries
- production experiences economies of scale
- products are differentiated

Industries within a country will produce goods which are targeted for the majority of their home consumers, thereby, exploiting economies of scale. However, not all consumers have the same preferences. Some minority will have preferences for the styles etc. produced elsewhere. Domestic firms find small production runs costly and forgo this segment of the market. This minority then winds up buying imported goods. The converse is also true that some portion of foreign consumers will have a greater preference for home country goods and home country winds up exporting to foreign's minority's share of the market.

The implications for this model transcends a simple explanation of intra-industry trade. It lies at the heart of the controversy of managed trade and industrial policy. With economies of scale there are only a feasible small number of firms to satisfy world demand (aircraft, for example). Under these conditions, the principle of first movers winning market share makes for compelling logic for advocates of managed trade.

The model:

Preliminaries -

Economies of scale can be modelled by the following total cost linear equation,

\[ C = F + cX. \]

Total cost is equal to the sum of fixed costs (F) and variable costs cX. Note that the parameter \( c \) is constant marginal cost.

Average cost are: \[ AC = F/X + c \]

Monopolistically competitive firms face a downward sloping demand due to brand loyalty etc. Profit maximization Marginal revenue = Marginal Cost, but unlike perfect competition, marginal revenue no longer equals price.

Marginal Revenue (MR) - is the change in total revenue due to a change in quantity.

Assuming a linear demand curve given by:
\[ X = A - BP, \]

then by simple algebra - \( A = X + BP. \)

The inverse linear demand curve is \( P = A/B - X/B. \) \( MR \) from this is \( MR = (A - 2X)/B. \) Substitute in for \( A, \) \( MR = (X + BP - 2X)/B = (BP - X)/B, \) therefore

\[ MR = P - X/B. \]

Assumptions of the model.

Demand facing typical monopolistically competitive firm:

\[ X = S[1/n - b(P - P_{avg})], \]

where \( X \) is the firm's sales, \( S \) is the total sales of the industry, \( n \) the number of firms in the industry, \( P \) the price charged by the firm itself, and \( P_{avg} \) the average price charged by its competitors. The following intuition follows from this equation: if all firms charge the same price then \( P = P_{avg} \) and the firms equally share the market. A firm charging more than the industry average will have a smaller market share and a firm less than the average will gain market share. A simplifying assumption is that total industry sales, \( S, \) is unaffected by price. This means that price competition simply rearranges market share without increasing the total.

Market equilibrium - first assume all firms are symmetric, the demand and cost functions are the same for all firms even though they are producing differentiated products. In order to determine the behavior of the firm we first need to describe the industry, that is to determine \( n \) and \( P_{avg}. \) This is a 3 step process:

1) derive the relationship between the number of firms and the average cost of a typical firm. This relationship is upward sloping. The greater the number of firms the lower each firms output and with economies of scale the greater the average costs.

2) derive the relationship between the number of firms and the price that each firm charges which must equal \( P_{avg} \) in equilibrium. This will be downward sloping, the greater the number firms the greater the competition and consequently the lower the price charged by each firm.

3) with monopolistically competitive industry long profits equal zero. If price is greater than average cost then the number of firms
will increase, if less then the number decreases. Thus the number of firms in the industry is determined by the relation of average costs and price to n.

*The number of firms and average cost.* Since all firms are symmetric then in equilibrium \( P = P_{avg} \) then the firm's demand curve devolves into:

\[
X = \frac{S}{n}, \text{ that is all firms equally share the market. Using the average cost function derived earlier,}
\]

\[
AC = \frac{F}{X} + c = \frac{nF}{S} + c.
\]

The more numerous the firms the higher the average cost, ceteris paribus.

*The number of firms and the price.* The price that the typical firm charges is also dependent on the number of firms. Each firm takes \( P_{avg} \) as exogenous. We can rewrite the firm' demand curve as:

\[
X = \left(\frac{S}{n} + SbP_{avg}\right) - SbP
\]

which is nothing more than a linear function with \( (S/n + SbP_{avg}) \) being the intercept term and \( Sb \) the slope. Going back to the earlier derivation of MR we can write the firm's marginal revenue as:

\[
MR = P - \frac{X}{Sb}.
\]

Profit maximization requires the equality of MR and MC, therefore:

\[
P - \frac{X}{Sb} = c,
\]

which rearranged leads to:

\[
P = c + \frac{X}{(Sb)},
\]

but with each firm charging the same price then \( X \) is an equal share of the market, \( S/n \), thus:

\[
P = c + \frac{1}{(bn)}.
\]

*Equilibrium number of firms.* The following diagram shows the equilibrium number of firms such that there are zero profits.
Equilibrium occurs at n2 where price is equal to average cost, i.e., zero economic profits. This is a long run equilibrium. Suppose that the number of firms was equal to n1. Then price would be P1 and average cost AC1. Under these conditions economic profits would be positive leading to entry increasing the number of firms up to n2. Should the number of firms be greater than n2 then the opposite would occur.

International Trade

We can now use this model to derive some important implications for international trade.

With international trade the size of the market increases. This enters in the average cost equation as S. An increase in S shifts the average cost curve downwards thus lowering the price of the good while increasing the number of viable firms. The greater the number of firms the more the number of differentiated products, thus international trade provides consumers with greater variety and lower prices. The P line is independent of S and therefore does not shift. Note though that with a non-horizontal P line the number of firms that will exist in the long run with trade is less than the sum of the numbers across countries in autarky. Who will win? Those who get there first!

Numerical example from the book:

\[ AC = \frac{n \times 7.5 \times 10^8}{X} + 5000 \]
\[ P = \frac{1}{\left(\frac{1}{(3 \times 10^4)} \times n\right)} + 5000 \]

IN TERMS OF THE VARIABLES USED ABOVE:
FIXED COST (F) = 7.5 * 10^8
MARGINAL COST (c) = 5000
PRICE ELASTICITY OF DEMAND (b) = 1/(3 * 10^4)
HOME X = 9 * 10^5
FOREIGN X = 1.6 * 10^6

Solving for the equilibrium number of firms, recall that long run profits are driven to zero, i.e., P=AC.

Thus,

\[ n \times \frac{7.5 \times 10^8}{X} + 5000 = \frac{1}{\left[ \frac{1}{(3 \times 10^4)} \right] \times n} + 5000 \]
\[ n^2 = \frac{X \times (3 \times 10^4)}{7.5 \times 10^8} \]

For Home X = 9 * 10^5
\[ n^2 = \frac{4 \times 9 \times 10^5}{10^5} = 36 \]
Therefore n=6,

For Foreign X = 1.6 * 10^6
\[ n^2 = \frac{4 \times 1.6 \times 10^6}{10^5} = 64 \]
Therefore n=8

Since \( P = 5000 + \frac{3 \times 10^4}{n} \)
Home \( P = 5000 + 5000 = 10,000 \)
Foreign \( P = 5000 + \frac{30}{8} \times 10^3 = 8,750 \)

If trade is allowed between the two countries then the sum of their markets becomes the relevant industry size, \( (0.9 + 1.6) \times 10^6 \) or \( 2.5 \times 10^6 \)

\[ n^2 = \frac{2.5 \times 10^6 \times 4}{10^5} = 2.5 \times 4 \times 10 = 100 \]
Therefore n=10

World price \( P = 8,000 \)