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International Trade, Crowding Out, and Market Structure: Cournot Approach

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Abstract:

Using traditional Cournot demand concepts, the effect of an increase in export demand on the price and domestic quantity demanded for a given product under different market structures and production cost structures is examined. In general, an increase in the product price will result in a reduction in the domestic quantity demanded. This is the case of "Crowding Out" (CO), analogous to that found in macroeconomics loanable funds analysis. An explicit algebraic simple model is developed for different cost structures; for which is derived several indexes of "CO". These indexes will reflect the different market structures by "n", the number of firms in the industry. With these indexes, different export trade sceneries are demonstrated and discussed. One significant result is that for the decreasing cost case, there is the opposite effect, "Crowding In". Some implications of "CO" for international trade policy are discussed briefly.

Keywords: International Trade · Exports · Imports · "Crowding Out" · Market Structures · Cost Structures

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Introduction

A simple model using traditional Cournot demand concepts is developed to examine the net effect of international trade on the domestic price of a product and on the degree (or intensity) of "Crowding Out" (CO) of local (domestic) quantity demanded of the product in question. Crowding out has been used in macroeconomics to analyze the effect in the loanable funds market of government borrowing on interest rates and funds available to the private sector. Here, we develop an explicit but simple model to examine the effect of an increase in the export of a product on the domestic price of the product and the quantity consumed of the domestic production of the product, net of the amount imported of the product.

In summary terms, the domestic demand facing the firm for its product consist of three parts, the domestic or local demand (internal demand locally produced), the foreign demand (a market's exports of the product, X,--external demand), and the local or domestic demand for the foreign source of the product (the imports given by M). The total domestic output consists of the local or domestic demand net of imports plus exports.

When foreign exports increase, overall demand is greater, the price of the product can rise, and crowding out occurs, in terms of domestic consumption. It is the net effect of X-M = Z on crowding out that is the focus of the Cournot model developed here.

To demonstrate the "CO" effect, Z = (X-M) is assumed to be positive. From the details of the model that follow, a general index of "CO" is derived and examined for the market structures of monopoly, oligopoly, and perfect competition. Also, various cost structures are considered.

In what follows, the model without cost is developed. Then, the model with cost is developed. The final section contains a summary and conclusions.

The Model Without Cost

Let the linear demand function be given by P = a + Z - bQ, where it is assumed that a = b = 1, so P + Q = 1+ Z (the traditional Cournot is P + Q =1). The Z (given exogenously) controls the intercept of the demand function. For now, as traditional, production cost is zero. Also, as traditional, all the variables are normalized appropriately.

The traditional Cournot formulae are modified to give in equilibrium P* = (1 + Z)/(1 + n), and Q* = (1 + Z)/(n/(1 + n)), where "n" is the number of firms in the domestic product market and is used to indicate the market structure.

The derivation of the above two formulae is summarized for convenience and follows Fellner's derivation (see, Fellner, 1960, pp. 60-62). For two firms, i and j, the ith firm's profit function is given by

(1) $\prod_i = [\hat{a} - b(q_i + q_j)]q_i = [\hat{a}q_i - bq_i^2 - bq_iq_j]$,

where $\hat{a} = (a + Z)$. The maximization of (1) gives the first-order rule for i

(2) $\hat{a} - 2bq_i - q_j = 0$,

and reversed for $_{j,}$ yielding the two output functions,

(3) $q_i = (\hat{a} - bq_j)/2b$ and $q_j = (\hat{a} - bq_i)/2b$.

The sum of these two functions gives

(4) $Q^* = (2/3)(\hat{a}/b) = (n/(1 + n))(1 + Z)$, for $a = b = 1$.

Then, from $P^* = (1 + Z) - Q^*$, $P^* = (1 + Z)/(1 + n)$. Then, as $n \rightarrow \infty$, $P^* \rightarrow 0$ (perfect competition).

To obtain the index of "CO", the effect of the final equilibrium price, P* (given above), on the domestic quantity demanded (net of imports) is needed. To obtain that effect, P* is substituted into the domestic demand (net of imports) function, giving $P^* + Q_d = (1 - M)$, so $Q_d = (1 - M) - P^* = (1 - M) - (1+ Z)/(1+ n) = [(n(1 - M) - X)]/(1 + n)$. The index "CO" is given by the difference between the net domestic output without X (Q') and the net domestic output after X (Q_d). In symbols, "CO" $= Q' - Q_d = (1 - M)(n/(1 + n)) - [(n(1 - M) - X)]/(1 + n) = X/(1 + n)$. Crowding out increases with X and decreases with "n". So, if X = 0, there is no crowding out in terms of net domestic demand. As the market structure goes from monopoly (n = 1), to oligopoly (n = >2), to perfect competition ($n = \infty$), "CO" falls to zero.

The Model With Cost

Here, three cost structures are considered, the traditional one where average cost (AC) is given by "c", a positive constant so total cost is TC = cq for the firm, an alternative one where AC = cq, so total cost $TC = cq^2$, and a decreasing average cost with details to follow.

For the traditional structure, subtract cq_i from the firm's profit equation (1) and then "c" from (2) and (3) to obtain the new (4) given by

(5)) $Q^* = (2/3)(\hat{a} - c)/b) = (n/(1 + n))(1 + Z - c)$,

for $a = b = 1$ as before. The new $P^* = [(1 + Z) + nc]/(1 + n)$. To check the derivation, if $Z = 0$, then $Q^* = (n/(1 + n))(1 - c)$ and $P^* = (1 + nc)/(1 + n)$. For $c = 0$, the simple Cournot formulae are obtained.

As before, putting the new P^* into $Q_d = (1 + Z) - P^*$ gives the new $Q_d = [n(1 - M) - X - nc]/(1 + n)$. The new net domestic output (net of imports, as before) becomes $Q' = [n/(1 + n)](1 - M - c)$. The new "CO" as before is the difference between Q' and Q_d which gives "CO" = $X/(1 + n)$. The index is the same as the no-cost case, since the constant "c" cancels out in the difference equation.

The more complicated alternative increasing average cost case occurs when total cost is defined as a non-linear function, $TC = cq^2$, so $AC = cq$ (See, Zeuthen, 1968 Reprint, pp. 78-80, for an alternative method). Again, following Fellner's method (1960), summarizing the derivation steps, the new (3) now becomes

(6) $q_i = (\hat{a} - bq_j)/2b'$ and $q_j = (\hat{a} - bq_i)/2b'$,

where $\hat{a} = (1 + Z)$ as before and $b' = (1 + c)$, for $a = b = 1$, as before. The new Q^* from the sum of the two equations in (6) is

(7) $Q^* = [n(1 + Z)]/(1 + n + nc)$.

The corresponding P^* is given by $P^* = (1 + Z) – Q^*$ so

(8) $P^* = [(1 + Z)(1 + nc)]/(1 + nc + n) = (1 + Z)/[1 + n/(1 + nc)]$.

The new net domestic demand is now $Q_d = [n(1 - M) - X(1 + nc)]/(1 + nc + n)$. As a check, if $c = 0$, then $Q_d = [n(1 - M) - X]/(1 + n)$, as in the zero-cost case before.

The net domestic demand before any X is Q' = (1 - M)[n/(1 + nc + n)]. The new "CO" index is now "CO" = Q' - Q_d = X[1/(1 + n/(1 + nc)]. If c = 0, then, "CO" = X/(1 + n), as before. As $n \rightarrow \infty$ (perfect competition), "CO" $\rightarrow$ X/(1 + 1/c). To illustrate, if c = 1, then, "CO" = X/2. The mathematical explanation for this limit is embedded in the algebra of the "CO" formula. The intuitive explanation is that as X increases for a given M, the P* increases so net domestic demand quantity will fall and depending on the market structure (n = 1,2,..., ∞), crowding out will fall, but only to a fraction (c/(1 + c)) of X, the initial cause of the change.

For c > or < 1, the slope of the average cost function will vary. This can cause a design flaw (not apparent in Zeuthen's rendition) in the application of the model where for a given Z, the equilibrium price, P*, could be greater than a = 1, the net demistic demand intercept.

In any case, given a workable model, the above non-intuitive result suggests that there is a proportionality limit to the amount of "crowding out" that will occur, given the demand and cost conditions specified here. It can be argued that this limit as a special case is defensible. Designing a more elaborate model in terms of demand and cost conditions would only be defensible after a successful empirical test. Such a test is beyond the scope of this paper and awaits future research.

For the decreasing average cost case, a linear average cost function of the typical form, AC = r- sq_i , is used where r < â and s < b = 1. The AC function cuts the demand function from below. Design problems occur if the cost function cuts the demand function from above.

Equation (1) is modified to include the above AC function where r < â and s < b = 1, so

(9) $\prod_i = [\hat{a} - b(q_i + q_j)]q_i - (r - sq_i)q_i$,

and the new equation (3) for the two firms becomes

(10)) $q_i = [(\hat{a} - r) - bq_j]/(2b - 2s)$ and $q_j = [(\hat{a} - r) - bq_i])/(2b - 2s)$

The sum of the two equations as before and after rearrangement gives the new (4) as

(11)) $Q^* = (2/3)(\hat{a} - r)/(2(1 - s)) = (n(\hat{a} - r)/[(1 + n - ns)]$, for $a = b = 1$ and $\hat{a} = (1 + Z)$.

As a check, if $r = s = 0$, then $Q^* = (n/(1 + n))(1 + Z)$, as before.

The equilibrium price, $P^* = (1 + Z) - Q^* = [(1 + Z)(1 - ns) + nr]/(1 + n(1 - s))$. As $n \rightarrow \infty$, $P^* \rightarrow [(1 + Z)(-s) + r]/(1 - s)$. The corresponding Q^* under $n = \infty$ is $Q^* = (\hat{a} - r)/(1 – s)$ and $AC = [(1 + Z)(-s) + r]/(1 - s)$ which equals P^* with zero profits (perfect competition).

Putting P^* with n into $Q_d = (1 - M) - P^*$ ` gives the net domestic demand including X as

(12) $Q_d = [(1 - M)n - X(1 - ns) - nr]/[1 + n(1 - s)]$.

As before, the net domestic demand before X but net of M is $Q' = (1 - M) - P$, where the demand function is $P = (1 - M) - b((q_i + q_j)$. Profit $\prod_i = [(1 - M) - b(q_i + q_j)]q_{i - (}r - sq_i)q_i$, where by the previous optimization method gives Q’ as

(13) $Q' = [n(1 - M - r)]/(1 + n(1 - s))$.

The new "CO" is given by the difference $(Q' - Q_d) = X(1 - ns)/(1 + n(1 - s))$. As $n \rightarrow \infty$, then "CO" $\rightarrow -(s/(1 - s))X < 0$, negative. The negative "Crowding Out" is now the "Crowding In" indicator. As X increases, for the given declining average cost function, the equilibrium price P^* falls, so the domestic consumers benefit and purchase more of the product.

Summary and Conclusions

The traditional Cournot oligopoly model was redesigned and applied to international trade and "Crowding Out" in the domestic product market, under different market structures.

The balance of trade, X - M, and particularly the level of X, had a key role in the "Crowding Out" effect. This effect was examined under three different cost-structure cases. In the constant and increasing average cost cases, generally, as X increased, crowding out also increased and as competition increased, crowding out decreased. For the decreasing average cost case, the opposite effect was apparent, "Crowding In" occurred as X increased.

What was surprising for the increasing linear average cost case, as the market structure approached perfect competition, "Crowding Out' approached a proportionality limit of $X/(1 + 1/c)$. In other words, depending on the parameter "c", crowding out will be proportional to X.

The trade-policy implications of "Crowding Out" are straight forward. All other things being given, the more X, the greater the product output and the level of domestic employment. The downside is that domestic consumers pay a higher price for less quantity in constant or increasing average cost industries. The consumer reaction to such a situation may be an increase in M to offset the increase in X, so the balance of trade remains unchanged. This in itself has economic consequences, the ramifications and discussion of which are beyond the scope of this paper. On the other hand, consumers benefit when the product is produced under decreasing average cost conditions.

References

Fellner, W. (1960). Competition Among the Few. Reprints of Economic Classics, Augustus M. Kelley, New York.

Zeuthen, F. (1968). Problems of Monopoly and Economic Warfare. Reprints of Economic Classics, Augustus M. Kelley, New York. The original chapters date back to 1929.