# THE ELASTICITY OF DEMAND FOR THE EXPORTS OF A SINGLE COUNTRY—A RECONSIDERATION

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**One country's exports of a particular commodity are usually imperfect substitutes for similar exports from other countries. Consequently, the price elasticity of export demand involves unknown cross elasticities between sub-groups of the commodity. However, there are constraints on the relative magnitudes of all the sub-group elasticities. These make it possible to assess the degree to which the whole commodity elasticity divided by the market share is an over-estimate of the export elasticity.**

It is well known that the demand for the exports of a particular commodity by a single country is more elastic than the demand for that commodity in the world market as a whole.[1] Following Powell,[2] one form of the expression for the single country elasticity is:

$$(1/f)\ (D—S) + S,$$

where $f$ is the country's share of the world market, $D$ is the elasticity of demand in the world market, and $S$ is the elasticity of supply by competing exporters. As this supply elasticity goes to zero, i.e. the competing exporters sell a more or less fixed quantity, so the elasticity of demand for the exports of the country of interest approaches its minimum absolute value $(D/f)$. Thus, even with a supply elasticity of zero, the original demand elasticity is considerably inflated.[3]

The formula refers to the case where the exports of all countries are indistinguishable; a contrasting case is one where the product of each exporter is recognisably different as far as the buyer is concerned. This is true of canned fruit, for example; the British consumer is generally well aware that a can of peaches comes from Australia, the United States or South Africa, as the case may be, and treats the others as less than perfect substitutes (indicated by the price differentials actually existing).

Horner recognised that not taking account of 'this type of friction'

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[1] See (1) Horner, F. B., 'Elasticity of Demand for the Exports of a Single Country', *Review of Economics and Statistics*, Vol. 34, No. 4, Nov. 1952, pp. 326-342.

(2) Powell, A., 'Export Receipts and Expansion in the Wool Industry', *Australian Journal of Agricultural Economics*, Vol. 3, No. 2, December 1959, pp. 64-74.

The basic relationship was also given, from a different point of view, by

(3) Yntema, T. O., *A Mathematical Reformulation of the General Theory of International Trade*, Chicago U.P., 1932, p. 44.

[2] Powell, *op. cit.*, pp. 67, 73, 74.

[3] The assumption of zero elasticity of competing supply is adhered to throughout this paper and is, of course, a considerable simplification. It has been pointed out by an unknown reviewer that, whereas the theme of the paper is the upward bias inherent in taking export demand elasticity to be $D/f$, this may be outweighed by the downward bias from the ommission of the supply elasticity.

leads to the representation of export demand as being more elastic than it actually is, except in the limiting case where the products of separate countries are indistinguishable. He also commented: 'Further research into elasticities of substitution may enable the necessary adjustments eventually to be made'.[4] The purpose of this paper is to obtain a formula, incorporating the necessary adjustments (based on cross elasticities), which will give some idea of the order of magnitude of the single-country export elasticity when the only available elasticity estimate refers to the commodity as a whole.

*Derivation of the Formula*

The elasticity of demand for the product of one exporting country is a 'total' elasticity which embraces the relevant direct and cross price elasticities.[5] The latter are related in a straight-forward way to the elasticity of demand for the commodity as a whole which is assumed to be the only known elasticity. This relationship between aggregate demand for exports of the commodity from all sources and the direct and cross elasticities of demand for the exports ($X_1$) of Country 1 and the exports ($X_2$) of Country 2 (all competing exporters) can be shown in the following tabular form:–

| Elasticity of demand for with respect to [a] | | | Row sum | Market share | Weighted row sum |
|---|---|---|---|---|---|
| | $p_1$ | $p_2$ | | | |
| $X_1$ | $d_{11}$ | $d_{12}$ | $d_{11} + d_{12}$ | $f$ | $f(d_{11} + d_{12})$ |
| $X_2$ | $d_{21}$ | $d_{22}$ | $d_{21} + d_{22}$ | $1 - f$ | $(1 - f)(d_{21} + d_{22})$ |
| | | | Aggregate Elasticity, | | $D = f(d_{11} + d_{12}) + (1 - f)(d_{21} + d_{22})$. |

[a] $p_1$ = price of $X_1$, $p_2$ = price of $X_2$.

The aggregate elasticity, $D$, refers to the demand for the commodity as a whole and should not be confused with the 'total' elasticity of demand for the sub-class of that commodity exported by Country 1.

If the symmetry relation is imposed on the cross elasticities, one of them can be expressed in terms of the other:[6]

$$d_{21} = [f/(1 - f)]d_{12}.$$

Thus, aggregate elasticity of demand for the commodity as a whole,

$$D = f(d_{11} + 2d_{12}) + (1 - f)d_{22}.$$

The export (or total) elasticity refers to demand for the exports of Country 1 when compensating price changes by Country 2 are taken into account. The change in Country 1's export sales has two components, one being the direct response to the change in Country 1's selling price and the other being the response to the compensating change in Country 2's selling price. To put the whole thing in elasticity terms, the sum

[4] Horner, *op. cit.*, p. 329.

[5] The concept of total elasticity, taking into account the repercussions as well as the direct effect of a price change, has been used by a number of writers. An algebraic treatment is given in:
Buse, R. C., 'Total Elasticities—A Predictive Device', *Journal of Farm Economics*, Vol. 40, No. 4, November 1958, pp. 881-891.

[6] Wold, H., and Jureen, L., *Demand Analysis*, New York, Wiley, 1953, p. 112.

of these two components is expressed as a proportion of the initial exports of Country 1 and that proportion is expressed as a ratio to the proportional change in Country 1's selling price. Thus, export elasticity

$$= [(\Delta X_1 \text{ w.r.t. } \Delta p_1 + \Delta X_1 \text{ w.r.t. } \Delta p_2)/X_1]/(\Delta p_1/p_1)$$
$$= [d_{11}(\Delta p_1/p_1) + d_{12}(\Delta p_2/p_2)](p_1/\Delta p_1)$$
$$= d_{11} + d_{12}[(\Delta p_2/p_2)(p_1/\Delta p_1)].$$

The last term in square brackets represents, in elasticity form, the compensating change in the price of $X_2$ made in response to the change in price of $X_1$. A value for this term is readily obtained in the case where a fixed quantity is marketed by the competing exporters, i.e. in the case of zero supply elasticity. The fixed quantity condition is.

$$d_{21}(\Delta p_1/p_1) + d_{22}(\Delta p_2/p_2) = 0.$$

After substitution of $[f/(1-f)]d_{12}$ for $d_{21}$, the following equation is obtained:

$$(\Delta p_2/p_2)(p_1/\Delta p_1) = -[f/(1-f)](d_{12}/d_{22}).$$

The left hand side is the last term in the export elasticity formula, which now becomes:[7]

$$\text{export elasticity} = d_{11} - [f/(1-f)](d^2{}_{12}/d_{22}).$$

To eliminate the direct price elasticities ($d_{11}$ and $d_{22}$) and obtain a formula in terms of the aggregate elasticity and the one cross elasticity, we make use of the homogeneity condition: that the sum of the direct, cross and income elasticities is zero.[8] Thus, if all the cross elasticities of demand for Country 1's exports of the commodity of interest (with respect to the prices of all other goods) were the same as the cross elasticities for competing exports of the same commodity and the two income elasticities were the same,

$$d_{11} + d_{12} = d_{21} + d_{22}$$
$$= [f/(1-f)]d_{12} + d_{22}.$$

However, there may be some differences between the income elasticity and the remaining cross elasticities for one sub-commodity (the exports of Country 1) and the corresponding income and cross elasticities for the other sub-commodity (competing exports) so that the general form of the relationship is:

$$d_{11} + d_{12} = [f/(1-f)]d_{12} + d_{22} + e.$$

We also have the aggregate elasticity formula

$$D = f(d_{11} + 2d_{12}) + (1-f)d_{22}.$$

After substitution, the following expressions are obtained:

$$d_{11} = D - d_{12} + (1-f)e$$
$$d_{22} = D - [f/(1-f)]d_{12} - fe.$$

[7] The formula given here differs from Buse's formula (*op. cit.*) by the substitution of one cross elasticity and the elimination of the supply elasticities.

[8] Wold, H., and Jureen, L., *op. cit.*, p. 111.

Finally, these two expressions are substituted into the export elasticity formula:

$$\text{export elasticity} = D - d_{12} + (1 - f)e - d_{12}^2/[(1/f - 1)D - d_{12} - (1 - f)e].$$

This export elasticity formula has two significant properties.

(a) As $d_{12}$ becomes large export elasticity approaches $D/f$. A large value of $d_{12}$, i.e. a large cross elasticity, means that the two sub-classes are close to being the one undifferentiated commodity and the simple formula for the elasticity of demand for one country's exports is applicable.

(b) As the value of $e$ approaches the value of $D/f$, export elasticity also approaches $D/f$, regardless of the magnitude of $d_{12}$. The practical importance of this property is that at small values of $D/f$, say between 0 and $-1$, export elasticity calculated by the formula derived in this paper does not differ substantially from the elasticity calculated by the simple formula. Conversely, large negative values calculated by the latter formula are heavily discounted when they are re-calculated by the formula of this paper.

*Numerical Evaluation*

The major unknown in the export elasticity expression is the cross elasticity of demand for Country 1's exports of the commodity with respect to the price of Country 2's (i.e. $d_{12}$). Little is known about elasticities of demand for sub-classes of one commodity, except that, on *a priori* grounds, the cross elasticities between the sub-classes must, in general, be relatively large in comparison with cross elasticities between distinct commodities. Estimates have been made for hard and soft wheat in the international market and the results suggest that cross-elasticities between close substitutes in the range of $+3$ to $+5$ could be expected when the market share is 30 per cent or more.[9] Small values of the cross-elasticity of interest cannot be expected when the market share is small; this follows from the symmetry condition.

The minor unknown in the export elasticity expression is the elasticity residual $e$. Because it represents the difference between one sum of income and cross elasticities (other than the major cross elasticity between the sub-classes) and another very similar sum, $e$ is not expected to deviate substantially from zero. It is assumed to fall within the range $-0{\cdot}5$ to $+0{\cdot}5$.

The effect of variations in the magnitude of $d_{12}$ in selected hypothetical cases is shown in Table 1. It will be noted that, in most of these cases, demand for the exports of the single country is appreciably less elastic than the simple formula would suggest, even when the cross-

[9] Taplin, J. H. E., 'Demand in the World Wheat Market and the Export Policies of the United States, Canada and Australia', Ph.D. thesis, Cornell University, 1969, pp. 177, 178. In tabular form the following elasticity estimates were obtained in the study of the international wheat market ($t$ values in brackets):

| | | *with respect to price of* soft wheat | hard wheat | market share |
|---|---|---|---|---|
| *elasticity of demand for:* | soft wheat | $-7{\cdot}4(3{\cdot}5)$ | $+5{\cdot}4(2{\cdot}3)$ | 0·34 |
| | hard wheat | $+3{\cdot}1(1{\cdot}5)$ | $-3{\cdot}6(1{\cdot}6)$ | 0·66 |

TABLE 1

*Elasticity of Demand for the Exports of a Particular Commodity by a Single Country under Various Conditions*[a]

| Aggregate Elasticity ($D$) | Country 1's Market Share ($f$) | Magnitude of $e$ (see text) | Export Elasticity: Cross elasticity of demand for Country 1's exports with respect of the price of Country 2's (i.e. $d_{12}$) 1 | 3 | 5 | 10 | $\infty$[b] |
|---|---|---|---|---|---|---|---|
| −0·4 | 0·2 | 0 | [c] | −1·44 | −1.61 | −1·78 | −2·0 |
| −0·4 | 0·2 | −0·5 | [c] | −1·66 | −1·77 | −1.87 | −2·0 |
| −0·4 | 0·2 | +0·5 | [c] | −1·20 | −1·43 | −1·67 | −2·0 |
| −0·4 | 0·4 | 0 | −0·78 | −0·90 | −0·94 | −0·97 | −1·0 |
| −0·4 | 0·4 | −0·5 | −0·93 | −0·97 | −0·98 | −0·99 | −1·0 |
| −0·4 | 0·4 | +0·5 | −0·57 | −0·79 | −0·86 | −0·93 | −1·0 |
| −0·8 | 0·2 | 0 | [c] | −2·35 | −2·75 | −3·23 | −4·0 |
| −0·8 | 0·2 | −0·5 | [c] | −2·65 | −3·00 | −3·39 | −4·0 |
| −0·8 | 0·2 | +0·5 | [c] | −2·04 | −2.49 | −3.05 | −4·0 |
| −0·8 | 0·4 | 0 | −1·35 | −1·66 | −1·77 | −1·87 | −2·0 |
| −0·8 | 0·4 | −0·5 | −1·57 | −1·79 | −1·86 | −1·93 | −2·0 |
| −0·8 | 0·4 | +0·5 | −1·10 | −1·50 | −1·65 | −1·81 | −2·0 |

[a] In all cases, elasticity of supply by competing exporters is zero.
[b] In the last column, the results are identical with those obtained by dividing the aggregate elasticity by Country 1's market share (i.e. export elasticity is $D/f$).
[c] In view of the symmetry condition, these combinations of market share and cross elasticity are unlikely.

elasticity with respect to the price of competing exports ($d_{12}$) is as high as ten.

Exceptions to this general result are seen in the fourth and fifth lines of the table. In these two cases the limiting value of the export elasticity is the relatively small figure (in absolute terms) of −1·0. This is sufficiently close to the conditions set out in property (b), that $e = D/f$, for the export elasticity to be little changed by employing the more complex formula. Conversely, where it is very elastic in the limit, export elasticity can be reduced by one half in some cases.

## *Conclusion*

The spirit of this paper has been to make some advance in quantification in an area where few estimates are available. It has set out to show that where the well known and very simple estimator of the elasticity of demand for a single country's export must be used it is, in many cases, both prudent and correct to discount the result.

With this limited objective in mind, one can review the assumptions underlying the derivation.

(i) The simplified symmetry condition between two cross elasticities is assumed to hold. However, any plausible deviations from this condition would have little influence on the general result.

(ii) The homogeneity condition for demand elasticities is assumed to hold and in this context it is assumed that, for the two sub-commodities, the income elasticities and the cross elasticities with respect to other goods are similar. In other words, it is assumed

that the balancing term $e$ is small. Within a moderate range of values of $e$, however, the general result is not upset.

A further simplifying assumption is that supply elasticities of competing exports are zero. However, all comparisons have been made with the classical formula under the same simplifying conditions.

In summary, if a particular commodity exported by Country 1 is treated by consumers as being appreciably different from the same commodity exported by Country 2, then the elasticity of demand for the commodity as a whole divided by Country 1's market share is an overestimate of the elasticity faced by Country 1, and the degree of overestimation increases as the elasticity obtained by the simple calculation increases.

The relationship is of considerable operational significance; elasticity of demand for a country's exports can be important in determining the allocation of a crop between domestic and export markets. An economist faced with such a problem will, at best, have available to him a few estimates of price elasticity of demand for the commodity as a whole in various markets. In such a situation it is inevitable that the simple calculation, in which aggregate elasticity is divided by the market share, will be the basis for any inferences.

For practical purposes, one can now prescribe two loosely delineated rules of thumb. First, aggregate elasticity divided by the market share will be a satisfactory approximation to the export elasticity, faced by the particular country, when it is not appreciably greater than unity in absolute value. Second, if the resultant elasticity is appreciably greater than unity then it should be discounted by some factor which increases in step with increases in the apparent elasticity. For example, the table indicates that apparent export elasticities of $-2{\cdot}0$ and $-4{\cdot}0$ should be reduced to about $-1{\cdot}5$ and $-2{\cdot}5$ respectively.