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EXPORT RECEIPTS AND EXPANSION IN THE WOOL INDUSTRY

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In the period since the war it has been a well-known Australian policy goal to encourage expansion of primary industries as a means, indeed as the principal means, of increasing our export earnings.[1] So far as I know, no one has published any quantitative estimates of the extent to which such a policy might hope to succeed. This note, which is restricted to the wool industry, attempts to add something to knowledge in this regard.

Wool is still by far our most important source of foreign exchange, accounting for about 45% of total export earnings in recent years.[2] The estimated range of values for the elasticity of export receipts with respect to gross Australian wool output developed in this note rely very heavily on Horner's pre-war estimates of the elasticity of demand for raw wool on the world market.[3] However, better or more up-to-date figures can be used as they become available, since the model is set up in fairly general terms. *Prima facie* the estimates developed in Tables 1 and 2 seem to indicate that we may have been a little too optimistic about the effectiveness of increasing export income by expanding the supply of wool.

The assumptions underlying this analysis are on the face of it somewhat unrealistic. However, except for the possible effects of an expansion in synthetic textiles—which shall be ignored at this stage—the errors introduced are probably not too large. The worst three

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[1] Commonwealth of Australia, Department of Commerce and Agriculture, *Agricultural Production Aims and Policy,* April, 1952. See also J. G. Crawford, "Australian Agricultural Policy," *Joseph Fisher Memorial Lecture,* University of Adelaide, 1952; G. O. Gutman, "Rural Exports and the Economy," *Quarterly Review of Agricultural Economics,* Vol. XI, No. 2 (April, 1958), pp. 59-65; E. A. Saxon, "The Role of Rural Industries in Providing for Future Australian Requirements," in the same *Review* (April, 1958), pp. 66-90.

[2] Commonwealth of Australia, *Yearbook* No. 44 (1958); based on pp. 353 and 946. The ratio of value of wool exported to total exports for the years 1954/55 to 1956/57 was as shown below.

1954/5	45.6%
1955/6	43.2%
1956/7	48.7%

[3] F. B. Horner, "Elasticity of Demand for the Exports of a Single Country," *Review of Economics and Statistics,* Vol. 34, No. 4 (November, 1952), pp. 326-342. See also by the same author, "The Demand Equation for a Raw Material in Empirical Studies," *Economic Record,* Vol. 25, No. 48 (June, 1949), pp. 85-91; and "The Pre-War Demand for Wool," *ibid.,* Vol. 28, No. 54 (May, 1952), pp. 13-27.

assumptions apart from the one concerning synthetics would seem to be these:

(i) The long-run price elasticity of demand for raw wool on the world market has a constant value;

(ii) The world wool market exists as such, being capable of definition in terms of participating buyers and suppliers after the effects of various price support systems, tariffs, and so on have been allowed for.

(iii) Apparel wool is a single homogeneous commodity.

With regard to (1), Horner has pointed out that the price elasticity of demand on the raw wool market would be higher at high than at low prices[4] (since manufacturers' demand for wool is by nature a derived demand). However, in this simple model it shall be assumed that the level of income in consuming countries is given and constant, and that the price changes we consider will be of sufficiently small magnitude to leave the price elasticity of demand for raw wool approximately constant. From a policy viewpoint dynamic considerations such as shifts in the *position* of the demand curve over time undoubtedly will be very important, but at present there is little evidence available upon which to predict such changes.

As for assumption (ii), the question of defining the world wool market, it will be assumed that Horner's treatment in deriving his estimates of the pre-war demand elasticities was adequate and we shall accept it as such, though something more will be said about this later. The third assumption listed above—the homogeneity of apparel wool (merino and cross-bred types)—may be taken as a working approximation for this model.

In figure 1, let $D - D'$ be the (hypothetical) demand curve for raw wool. It is a long run curve and is considered fixed once the level of income in consuming countries and the prices of synthetic and other substitute fibres are given. Suppose that at equilibrium a total quantity Q_O is supplied at a price p_O. Further suppose that at equilibrium Australian producers supply a fraction f_O of the total supply; their gross income is given by the shaded area in figure 1 (a). Thus at equilibrium Australian woolgrowers supply a quantity $f_O Q_O$. Suppose that after undertaking some change in production technique Australian producers increase the quantity they are willing to supply *irrespective of the effect on price of their so doing from* $f_O Q_O$ to $f_O Q_O$ $(1 + r)$, where r is the proportional expansion in Australian output.[5] The size of the Australian wool cheque is now given by the shaded area in figure 1 (b). The fraction of total world production now supplied by Australia s_r is given by[6]

$$s_r = f_O\ (1+r)/(1+f_O\ r) \qquad (1)$$

[4] Horner, "Elasticity of Demand for the Exports of a Single Country," *loc. cit.*, especially pp. 326 and 334.

[5] Thus we are concerned here with an "output-increasing, cost neutral" innovation specific to Australia. Myxomatosis is a good example.

[6] See Appendix, Note 1.

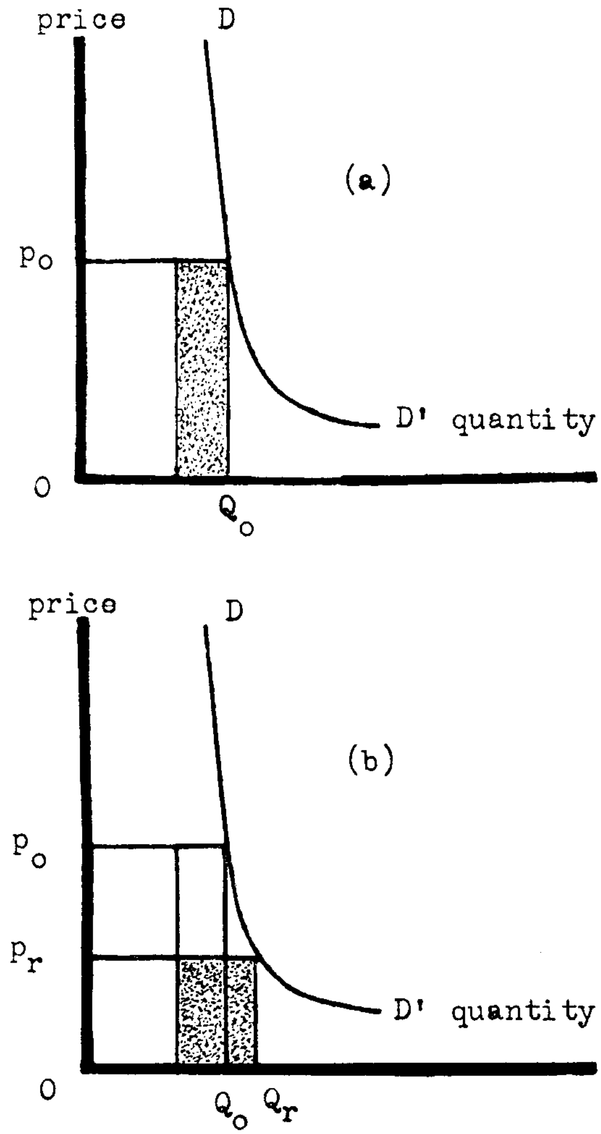

FIGURE 1.

So far for the sake of simplicity it has been assumed that the elasticity of supply in other wool producing countries is zero. When this assumption is dropped instead of s_r we must use for the final share of the market a corrected term f_r.[7] Intuitively it is obvious that the price elasticity of demand confronting Australian producers depends on three factors: the elasticity of demand on the world market as a whole, the Australian share of the market, and the elasticity of supply by the rest of the world. It can be readily shown that[8]

[7] A first approximation formula for f_r is developed in the Appendix, Note 2.

[8] See Appendix, Note 3.

$$\eta_{hp} = \frac{1}{f}(\eta_{Hp} - a_{wp}) + a_{wp} \qquad (2)$$

where

η_{hp} is the price elasticity of demand for Australian wool

η_{Hp} is the price elasticity of demand for raw wool from all sources of supply on the world market (assumed constant).

a_{wp} is the price elasticity of supply for raw wool from all sources of supply other than Australia, assumed constant; and

f is the Australian share of the world market.

Clearly η_{hp} is not constant, but varies with f, the share of the market. Thus to speak of "the" elasticity of demand for Australian wool, even under the terms of a simple model such as this, can be quite misleading. In fact, η_{hp} can change quite considerably even over relatively small changes in the level of Australian output. This is illustrated in Table 1, which shows the final elasticity of demand confronting Australian producers after a 10% step-up in long run output for various assumptions about the other parameters. The initial elasticity is shown in parentheses.

We define the elasticity of gross Australian wool receipts as[9]

$$V_{Rq} = \frac{\triangle R}{R_O} \cdot \frac{q_O}{\triangle q} = (\triangle R/R_O)(1/r) \qquad (3)$$

where R_O is initial gross Australian wool revenue,

$\triangle R$ is the change in gross Australian wool revenue,

$q_O = f_O Q_O$ is initial Australian supply, and

$\triangle q = rq_O$ is the size of the expansion in Australian supply.

A method of evaluating this elasticity is developed in the Appendix.[10] As we would expect, this elasticity must always be less than one. It can, of course, be negative, depending on the assumptions we make.

Some of the wool produced in Australia is sold to local manufacturers and is mainly consumed here, thus adding nothing to export income, except for the very small quantity of locally made finished woollen goods which are sold overseas. The volume of trade in the latter is small enough to be ignored. We are able to estimate the greasy equivalent weight of home consumed locally produced wool.[11] Suppose this constitutes a proportion z of Australian output. If Australian consumption of wool increases at the same percentage rate as output the arc elasticity of export wool receipts is identical with V_{Rq}. On the other hand if the home consumption of apparel wool remains constant in absolute terms, the appropriate value will be $V_{Rq}/(1 - z)$. The real world situation probably lies somewhere between the two.

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[9] From a policy viewpoint an arc elasticity formulation of this form is ideal since it provides a comparison based on the initial situation.

[10] See Note 4.

[11] See Commonwealth of Australia, *Yearbook,* No. 44 (1958), p. 937, and Bureau of Agricultural Economics, *Statistical Handbook of the Sheep Industry,* Canberra, 1956.

Table 1

*SENSITIVITY OF MANUFACTURERS' DEMAND FOR AUSTRALIAN WOOL TO A 10% EXPANSION IN AUSTRALIAN OUTPUT**

Assumed value of the elasticity of supply by the rest of the world (a_{wp})	Assumed value of the elasticity of demand for raw wool on the world market (η_{H_p})			
	–0.4	–0.6	–1.0	–5.0
0	–1.01(–1.07)	–1.51(–1.60)	–2.52(–2.67)	–12.6(–13.3)
0.2	–1.30(–1.40)	–1.80(–2.11)	–2.81(–3.00)	–12.9(–13.7)
0.5	–1.73(–1.90)	–2.23(–2.43)	–3.24(–3.50)	–13.3(–14.2)

Finally, if we wish to consider the effect on total export income rather than the effect on export wool receipts as such, again using an arc elasticity formulation, we must multiply both of the above expressions through by a constant g, which expresses the proportional contribution of wool export income to all export income. Thus if we denote the elasticity of total export receipts with respect to a long run expansion in the Australian wool industry by V_{X_q}, we can write

$$V_{R_q}g/(1-z) > V_{X_q} > V_{R_q}g \quad \text{(4)}$$

Whilst it is clear that this model is a gross over-simplification perhaps the author will nevertheless be forgiven for attempting to quantify it. One weakness is the failure to take account of tariffs and transport costs, which, however, must be analysed on a country-by-country basis, and are thus beyond the scope of a brief aggregative analysis such as this.[12] More important, the only available estimates of η_{H_p}, the world elasticity of demand for raw wool, are based mainly on pre-war evidence.[13] Whilst the rapid post-war expansion in synthetics must have had some effect on the structure of demand for wool, views differ very widely on the magnitude of the effect.[14] As Professor Lewis has pointed out, any considerable expansion in synthetic textiles can be expected to increase the elasticity of manufacturer's demand for raw wool, although the price *level* of wool can be expected to decline.[15]

Of course, difficulties are not confined to estimating η_{H_p}. Another vital parameter of the model, a_{wp}, the elasticity of wool supply by the

* Two values are shown in the table: the elasticity of manufacturers' demand for Australian wool after a 10% expansion in Australian long run supply; and, in parentheses, the corresponding value before the expansion. The assumptions made about the elasticity of demand on the world market (η_{H_p}) and the elasticity of supply by the rest of the world (a_{wp}) are given in the margins of the table.

[12] Compare my equation (2) with Horner's equations (1) and (2) in "The Elasticity of Demand for the Exports of a Single Country," *loc. cit.*, pp. 327 and 329.

[13] Horner, *op. cit.*, and B. P. Philpott, "Wool in the New Zealand Economy," *Economic Record*, Vol. 33 (No. 65), August, 1957, pp. 216-233.

[14] This became very evident from the contrasting views put forward by different speakers at the recent (July, 1959) Winter Forum of the Australian Institute of Political Science entitled "Wool Marketing," which was held in Sydney.

[15] J. N. Lewis, paper entitled *The Present Position of Wool in Australia*, read before the Winter Forum of the Australian Institute of Political Science, Sydney, July, 1959 (mimeo.), p. 8.

rest of the world, is unknown. In fact all we can say with certainty about this elasticity is that it is unlikely to be large, especially in the short run. With a planning horizon of about seven to twelve years, on my guess a maximum value would be about 0.2, but this is no more than a guess. Certainly the resources of other major wool producing countries are almost as irreversibly committed to wool production as our own.

In the face of these difficulties, what has been done was to compute a range of values V_{R_q} corresponding to various assumptions about η_{H_p} and a_{wp}. The value of the "initial" Australian share of the world apparel wool market, was taken as 0.375, being the mean value of this ratio over the seasons 1949/50 to 1955/6 inclusive.[16] On the basis of the estimates of Horner and Philpott, it seems likely that the value of η_{H_p}, the elasticity for demand for raw wool on the world market, was in the range –0.4 to –0.6 *prior to the advent of synthetics.* Just how much we are to revise these estimates upwards to allow for the influence of synthetics remains a moot, but unfortunately critical, point. This is amply illustrated by Table 2a, which summarises the effect of changes η_{H_p} on V_{R_q}, the elasticity of gross Australian wool income with respect to a 10% expansion in the long run supply of Australian wool. In Table 2b, a 20% expansion is considered. To simplify presentation, only four assumptions have been made about the elasticity of supply by the rest of the world; namely, values of zero, +0.1, +0.2 and +0.5. Further adjustments along the lines of the relationship (4) above have not been made, though this is done for particular cases in the Conclusion.

Table 2a

EFFECT ON WOOL RECEIPTS OF A 10% EXPANSION IN LONG RUN OUTPUT OF WOOL (V_{R_q})*

Assumed value of the elasticity of supply by the rest of the world (a_{wp})	Assumed value of the elasticity of demand for raw wool on the world market (η_{H_p})				
	—0.3	—0.4	—0.6	—1.0	—5.0
0	—0.38	—0.03	+0.31	+0.59	+0.92
+0.1	—0.14	+0.11	+0.38	+0.61	+0.92
+0.2	+0.03	+0.21	+0.43	+0.63	+0.92
+0.5	**	+0.42	+0.55	+0.69	+0.92

[16] Based on *Statistical Handbook of the Sheep Industry* (*op. cit.*), pp. 53 and 54. The value of this ratio exhibited no marked trend over the period considered. The lowest value was 0.355 in 1951/2 and the highest 0.390 in 1955/6, although this latter figure was subject to revision.

* and ** See footnotes page 70.

Table 2b

EFFECT ON WOOL RECEIPTS OF A 20% EXPANSION IN LONG RUN OUTPUT OF WOOL (V_{Rq})*

Assumed value of the elasticity of supply by the rest of the world (a_{wp})	Assumed value of the elasticity of demand for raw wool on the world market (η_{Hp})				
	—0.3	—0.4	—0.6	—1.0	—5.0
0	—0.50	—0.12	+0.25	+0.55	+0.91
+0.1	—0.24	+0.03	+0.32	+0.58	+0.91
+0.2	—0.06	+0.14	+0.38	+0.60	+0.91
+0.5	**	+0.37	+0.51	+0.66	+0.92

Certain analytical relationships of some interest are demonstrated by these results. The extra revenue accruing to Australian producers as a result of expanding output depends vitally on three factors: the initial Australian share of the world market, the elasticity of demand for raw wool on the world market, and the elasticity of supply by the "rest of the world." In general, the higher are these two elasticities[17] the greater will be the profitability of an expansion of aggregate Australian wool supply. However, as the supply is expanded, the Australian share of the market increases and likewise does the degree of monopoly control held in the market by Australia. That is to say, as the share of the market becomes greater, the less attractive will it become to expand supply. Thus the values of V_{Rq} in Table 2b are consistently lower than the corresponding values of Table 2a: the decrease in the latter case reflects the greater change in the share of the market. In fact, because of the inadequacy of the approximating procedure used when r is large, the values in Table 2b are probably over-optimistic; that is, the true values are probably even less than shown. It will be noticed that the sensitivity of V_{Rq} to changes in a_{wp} becomes rather small when large values of η_{Hp} are considered.

Conclusion

An attempt has been made to describe in a quantitative way the effect of an expansion in long run wool output upon gross Australian wool income. If no substantial shift in the structure of demand had occurred since the last war, then, accepting Horner's upper value of –0.6 for the elasticity of demand for raw wool on the world market and taking an arbitrary upper limit of +0.2 for the elasticity of supply by the rest of the world, it would seem that a 10% shift in the long run supply curve for Australian wool would result in less than a 5%

* The value in the table is the mean percentage increase in gross Australian wool receipts per 1% increase in Australian long run supply. This is the arc elasticity V_{Rq} of the model.

** The method used does not permit the computation of these values. See Appendix, Note 2.

[17] Ignoring the minus sign of the price elasticity of demand.

increase in gross wool revenue. If the proportion of gross output consumed locally is taken at a maximum value of about 8%, then at most the increase in export wool earnings would be about 5½%. If wool accounts for a stable 45% of our export earnings, then a 10% expansion in supply would imply, on the assumptions outlined above, an increase in total export earnings of 2½% at most. On the same sets of assumptions a 20% shift in supply would imply an increment in total export revenue of less than 4%.

It has been argued that the pre-war figure for the elasticity of demand is unduly low. Unfortunately we are not able to say just what would constitute an appropriate revision of this figure. However, an arbitrary upper limit of −1.0 will be considered here. On the basis of this assumption a 10% shift in long run Australian output would account for about a 6½% increase in gross wool revenue, and an increase in total export earnings of (at most) about 3.2%. The corresponding figure for a 20% shift in the supply curve would have an upper limit of about 6%. In other words we may have been a little too optimistic about the possibility of increasing export income by expanding the supply of wool. However, the arguments above are mainly static, and a great deal more would have to be said about dynamic features before a reasoned appraisal of post-war agricultural policy aims and methods could be attempted: but such an appraisal is outside the scope of this note.

Appendix

Notation: The major symbols used in this paper and their meanings are given below. In addition, each symbol is explained when it is first introduced in the text.

Supply

$Q = Q(p)$	:	The aggregate long run supply curve for all raw wool.
$q = q(p)$	:	The aggregate long run supply curve for Australian raw wool.
$w = w(p)$	:	The aggregate long run supply curve for raw wool produced by the "rest of the world"; $w = Q - q$.
p	:	The market price for raw wool.
$a_{wp} = \frac{dw}{dp} \cdot \frac{p}{w}$	:	The elasticity of supply by wool producers outside Australia taken in the aggregate.
$f = q/Q$	:	The Australian share of the market.
$\triangle q = rq_o$	:	An expansion in Australian supply due to the adoption of an "output-increasing" innovation specific to Australia.
r	:	The proportional size of the expansion referred to the initial size of the Australian supply.

Demand

$H = H(p)$: The aggregate long run demand curve for all wool.

$h = h(p)$: The aggregate long run demand curve for Australian wool.

$\eta_{H_p} = \frac{dH}{dp} . \frac{p}{H}$: The elasticity of demand for raw wool on the world market.

$\eta_{H_p} = \frac{dh}{dp} . \frac{p}{h}$: The elasticity of demand for Australian wool.

Revenue

$R = pq$: Gross Australian wool receipts.

$\triangle R$: The change in long run Australian wool receipts when the Australian supply is expanded by $\triangle q$.

$V_{R_q} = \frac{\triangle R}{\triangle q} . \frac{q_O}{R_O}$: Arc elasticity of gross Australian wool receipts with respect to long run Australian wool supply.

V_{X_q} : Arc elasticity of gross Australian export receipts with respect to long run Australian wool supply.

Subscripts

All variables may have the subscripts $_O$ and $_r$. The subscript $_O$ refers to the initial situation, while the subscript $_r$ denotes the equilibrium value of the variable concerned after an expansion in Australian long run supply of proportional size r.

Note 1: That $s_r = f_O(1+r)/(1+f_Or)$ can easily be seen by rewriting f_O as q_O/Q_O and r as $\triangle q/q_O$, where q_O is the absolute size of the initial Australian supply, and $\triangle q$ is the absolute size of the expansion. Thus

$$
\begin{aligned}
s_r &= \frac{(q_O/Q_O)(1+\triangle q/q_O)}{1 + \frac{q_O}{Q_O} . \frac{\triangle q}{q_O}} \\
&= (q_O + \triangle q)/(Q_O + \triangle q) \\
&= \text{(final Australian output)/(final world output)} \\
&= \text{final Australian share of the market.}
\end{aligned}
$$

Note 2: Conceptually we are able to think of the adjustment which follows a shift in the Australian supply curve as taking place in discrete stages: in the first of which the Australian supply is increased instantaneously from q_O to $q_O\ (1+r)$. As a consequence there then follows a fall in price which gives rise to the second stage of the adjustment in which the supply of other wool producing countries is contracted. This will cause a partial recovery in price, and there will be a corresponding adjustment upward in supply. This process of "successive approximation" will continue until a stable or equilibrium price is reached. It is to be noted that the Australian supply is by *assumption* stable.

Let $\triangle_j Q$ be the adjustment in supply at the j^{th} stage of adjustment, and $\triangle_j p$ be the adjustment in price following the supply adjustment $\triangle_j Q$.

Then

$$\begin{aligned}
\triangle_1 Q &= rf_O Q_O \\
\triangle_1 p &\approx \triangle_1 Q p_O/(\eta_{Hp} Q_O) \text{ provided that } rf_O \text{ is small.} \\
&\approx rf_O p_O/\eta_{Hp} \\
\text{so that} \quad \triangle_2 Q &\approx a_{wp} \,.\, \triangle_1 p . w_O/p_O \\
&\approx (a_{wp}/\eta_{Hp}).\ rf_O\ (1-f_O)\ Q_O \\
\text{similarly} \quad \triangle_2 p &\approx (a_{wp}/\eta_{Hp}{}^2).\ rf_O\,(1-f_O)\ p_O \\
\text{and} \quad \triangle_3 Q &\approx (a_{wp}/\eta_{Hp})^2.\ (1-f_O)^2\ rf_O Q_O
\end{aligned}$$

It follows that in general

$$\triangle_j Q \approx [\,(a_{wp}/\eta_{Hp}).(1-f_O)\,]^{j-1}.rf_O Q_O$$

Thus the equilibrium quantity supplied on the world market will be given by

$$\begin{aligned}
Q_r &\approx Q_O + \sum_{j=1}^{\infty} \triangle_j Q \quad \text{(if the latter term exists)*} \\
&\approx Q_O + \sum_{i=0}^{\infty} rf_O Q_O\ [a_{wp}(1-f_O)/\eta_{Hp}]^i \\
&\approx Q_O + f_O r Q_O \sum_{i=0}^{\infty} (-m)^i, \text{ where } m = a_{wp}(1-f_O)/[\eta_{Hp}] \\
&\approx Q_O\,[1+f_O r/(1+m)] \text{ provided that } 0 < m \leqslant 1.
\end{aligned}$$

A sufficient set of restrictions to ensure that m lies in the specified interval is that

$0 \leqslant a_{wp} \leqslant 0.5$, $-0.4 > \eta_{Hp} > -\infty$, and $1 > f_O \geqslant 0.375$.

When the above or equivalent restrictions are satisfied we may write

$$\begin{aligned}
f_r &\approx q_O(1+r)/Q_r = Q_O f_O\ (1+r)/Q_r \\
&\approx f_O(1+r)/[1+f_O r/(1+m)]
\end{aligned}$$

It is easily seen that when $a_{wp} = 0$, the above formula for f_r agrees with the equation for s_r developed in Note 1. It is not to be expected that the above approximation will yield good results when $f_O r$ is large. The largest value of $f_O r$ assumed in this paper is 0.075.

Note 3: Let the market demand curve be

$$H = H(p),$$

where H is the total quantity of raw apparel wool purchased on the world market at a price p. Let

$$h = h(p)$$

be the quantity of Australian wool demanded when the market price is p, and

$$w = w(p)$$

be the supply curve for all countries other than Australia taken in the aggregate. Then

$$h = H - w.$$

* Strictly speaking, if the Limit $\lim_{n \to \infty} \sum_{j=1}^{n} \triangle_j Q$ exists.

Differentiating with respect to p:

$$\frac{dh}{dp} = \frac{dH}{dp} - \frac{dw}{dp}$$

$$\frac{dh.p}{dp\,h} = \frac{dH.p}{dp\,h} - \frac{dw.\,p}{dp\;\;h}$$

At equilibrium,

$$H = Q$$
$$\text{and } h = q$$
$$\text{so that } h/H = q/Q$$
$$= f.$$

$$\text{Hence } \eta_{hp} = (1/f)\eta_{H_p} - \frac{(1-f)}{f} a_{wp}$$
$$= \frac{1}{f}(\eta_{H_p} - a_{wp}) + a_{wp}$$

Note 4: By an extension of the argument introduced in Note 2 we can approximate the final equilibrium price, p_r, by the equation

$$p_r \simeq p_O + \sum_{j=1}^{\infty} \triangle_j p$$

$$\text{where } \triangle_j p \simeq (rf_O p_O/\eta_{H_p}).[a_{wp}(1-f_O)/\eta_{H_p}]^{j-1}$$

Thus

$$p_r \simeq p_O + (rf_O p_O/\eta_{H_p}) \sum_{i=0}^{\infty}(-m)^i$$
$$\simeq p_O\ [1+f_O r/[\eta_{H_p}(1+m)]] \text{ provided } 0 < m \leqslant 1.$$

The change in Australian revenue at equilibrium will be given by

$$\triangle R = R_r - R_O = p_r q_r - p_O q_O$$

where

R_r is final gross Australian wool revenue,
and R_O is initial revenue.

Making the appropriate substitutions

$$\triangle R \simeq p_O[1+f_O r/[\eta_{H_p}(1+m)]]q_O(1+r) - p_O q_O$$

so that

$$\frac{\triangle R}{R_O} \simeq \triangle R/p_O q_O = [1+f_O r/[\eta_{H_p}(1+m)]]\ (1+r) - 1.$$

Dividing through by $q_O/\triangle q = 1/r$ we obtain

$$V_{Rq} \simeq \frac{1}{r}[1+f_O r/[\eta_{H_p}(1+m)]].(1+r) - 1/r$$

where

V_{Rq} is the arc elasticity of gross Australian wool revenue with respect to Australian wool supply. This is the elasticity tabulated in Table 2 for a variety of assumptions about η_{H_p}, a_{wp} and r.