OPTIMAL INTERNATIONAL PROMOTIONAL EXPENDITURE - the case of differentiated vs. non-differentiated products

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Agri-food industries all over the world are beginning to feel increased economic pressures in both domestic and export markets. Negotiation of multilateral trade liberalisation and de-subsidisation have shifted policy scope from supply-side programs to demand building marketing strategies. An ability, therefore, to increase demand for a product and hence, sales or to increase market share is essential to remain competitive in the world today.

One method of increasing sales and/or market share is by the establishment of export promotional programs ,such as international generic advertising. Such programs can be funded either by a cooperative of exporting countries or by a single exporting country. For example, the promotion of wool to the United States and other importing countries is jointly funded by the country members of the International Wool Secretariat (IWS) - Australia, New Zealand, South Africa, and Uruguay, whereas, the U.S. has embarked independently on an export promotional program for beef to Japan.

When considering engaging in export promotion and deciding on whether to have joint or single-country funding, the key criteria are international homogeneity of product and homogeneity of advertising effects.[1]. The profitability of export promotion is dependant on the importers' responsiveness to changes in price and advertising, which, in turn depend on the structure of the advertising program and how the imported product is viewed by the importer.

If the importer views the product as homogeneous across countries of origin, an advertising program may increase the importer's total demand for that product. If the advertising is done by a single exporting country, a free rider effect may arise as other exporting countries would enjoy an increased demand for their product without incurring any advertising costs. If, however, the importing country views a product as heterogeneous, differentiated by country of origin, an advertising program initiated by a single country may increase the demand for the product from that particular country. The demand for the product from other exporting countries would be affected through cross elasticities of demand. The advertising country might then have increased its market share relative to the other exporting countries.

Optimal advertising expenditure rules have been developed for the case of a monopolist (Dorfman and Steiner, 1954) or for an organisation which has no control over supply of the product.(Nerlove and Waugh, 1961). These rules can be applied if a measure of the response in demand to advertising is known.

In this research, synthetic models for beef exported to Japan and for wool exported to the United States are determined given existing estimated elasticities. These

[1] Homogeneity of product refers to the degree of substitutability of one product from a particular country for the same type of product froma different country of origin.Homogeneity of advertising effects refers to the degree to which country of origin is emphasized in a promotion.

models are then simulated to show the various levels of increased revenue available to particular exporters assuming different importer responses to advertising. Benefit/cost ratios of this activity are calculated and assessed for the U.S. in the case of beef to Japan and for Australia in the case of wool to the U.S.

THEORETICAL RULES

Dorfman and Steiner (1954) developed a theoretical rule for an optimal advertising budget for a monopolist (cartel) producing a fixed quantity of one product. It is assumed that the firm can choose both the advertising expenditure and the price which will maximize its profits. Advertising expenditure is assumed to represent a fixed cost to the monopolist (cartel).

From the profit function:

$$\Pi = Q(P(Q,A)) - C(Q) - A$$

where Π = profit
Q = quantity
P = price
A = advertising expenditure

From the first order conditions, it can be shown that the optimal advertising budget is:

$$\left(\frac{A}{R}\right) = \left(\frac{\pi_{qa}}{\pi_{qp}}\right)$$

where $\left(\frac{A}{R}\right)$ = ratio of advertising to sales revenue
π_{qa} = elasticity of quantity w.r.t. advertising
π_{qp} = elasticity of quantity w.r.t. price

The optimal advertising expenditure is reached when the advertising to sales ratio is equal to the ratio of the elasticities of quantity demanded with respect to advertising and of quantity demanded with respect to price.

Nerlove and Waugh (1961) developed a theoretical rule for optimal advertising for an organisation with no control over supply, which is similar to that of Dorfman and Steiner's (1954) except that it takes into account the supply response to an increase in advertising expenditure. The organisation must therefore have a measure of the supply elasticity. In the short run, however, the supply of agricultural commodities is fixed (due to, for example, biological lags in production). No adjustment, therefore, can be made in supply (the supply elasticity is zero) and Nerlove and Waugh's rule reduces to that of Dorfman and Steiner's.

CONCEPTUAL MODEL

A. Demand for Imports

In modelling international trade a critical question that arises is whether or not goods from different countries can be considered homogeneous. Rationale for product heterogeneity includes the physical attributes of the traded goods, as well as, the attributes of the exporting countries (eg. reliability, differences in business or legal practices, risk of embargo, bilateral trade arrangements). Given that goods produced in different countries may not be homogeneous, Armington (1969) proposed a two stage demand system approach to modelling import demand. The first stage of the model would describe the importer's allocation of expenditure to the broad category of good imported while the second stage disaggregates the expenditure on the aggregate good into expenditure by country of origin. Necessary conditions for consistent two-stage budgeting include weak separability of the goods at the second stage from all other goods consumed by the importing country and a linear homogeneous utility function at the second stage of the demand system (Green, 1971).

In general algebraic terms the two stage demand system can be expressed as follows:

$$TEXP = a + bP + cY + dPS \; ; \qquad (1)$$

where $TEXP$ = total expenditure on good $= \Sigma p_i q_i$

P = weighted average price of good by country of origin (including domestic)

Y = disposable income

PS = price of substitute good

p_i = price of good from country i

q_i = quantity of good from country i and

$$w_i = e_i + f_i p_i + g_i p_j ; \qquad i = 1,2...n \qquad n = \text{number of exporting countries} \qquad (2)$$

where $w_i = \left(\frac{p_i q_i}{TEXP}\right)$

p_j = price of good from country j

$a, b, c, d, e_i, f_i, g_i$ are estimated parameters

Of necessity in modelling a two stage demand system is the imposition of a functional form on the utility/cost function at the second stage. Armington (1969) proposed a CES functional form while AIDS (Epp, 1989) and Generalized Box-Cox (Goddard, 1984) functional forms have also been used previously.

B. The Impact of Advertising on Demand for Imports

Few empirical studies exist on the impact of international generic advertising. The study on wool demand in the U.S. (Dewbre et al, 1986) is one of the first studies of its kind. Given the paucity of studies in this area and without actually measuring the impact of advertising on demand (because of limited data at this stage) it is possible to postulate a number of hypotheses about the role of advertising in international trade when goods are distinguished by country of origin.

If advertising is of a generic nature (ie. Consume more beef) then it is conceivable that the advertising, if effective, would increase total expenditure on the advertised product and leave the expenditure shares relatively unaffected except through the increased level of expenditure. Alternately, if advertising is aimed at the product from a particular country (ie Consume more American beef) it is possible that consumers/importers may not change the overall level of beef consumption but change the relative shares from each of the exporting (including domestic in some cases) countries. A further alternative is that both stages of the demand system could be affected by any particular advertising expenditure level. For a particular exporting country the relevant question becomes, which strategy optimizes their return on investment?

The basic model of import demand can be adjusted depending upon the effect advertising is likely to have. If advertising were to affect the first stage then equation (1) would take the following form:

$$TEXP = a + bP + cY + dPS - e\left(\frac{1}{A}\right) \quad (3)$$

where A = real advertising expenditure

To apply optimal advertising criteria the equation must be twice differentiable with respect to advertising so that the reciprocal of advertising is one possible explanatory variable.

If advertising expenditure were to affect only the second stage then the expenditure share equations would be of the following form:

$$wi = e_i + f_i p_i + g_i p_j + h_i\left(\frac{1}{A}\right) \quad , i = 1,2 \ldots n \quad (4)$$

The only condition on h_i is that the sum of the h coefficients over the demand systems equate to zero to ensure adding up is not violated.

It is conceivable that advertising expenditure could enter each stage of the demand system simultaneously. In this case the complete demand system would be composed of the equations (3) and (4) although the advertising coefficients would not be equal to e and h_i.. If advertising only affects the first stage then equation (2) and (3) would make up the demand system. If advertising only affects the second stage then equations (1) and (4) would make up the demand system.

C. Deriving the Model

In previous research (Goddard, 1984 ; Epp,1989) the demand for beef in Japan has been modelled using the two stage demand system approach as above. It is, therefore, possible to use the previous estimates as the basis for synthesing a two stage demand system to represent 1987 imports of beef by Japan. Using elasticities from the previous studies and actual data on Japanese beef imports for 1987 a synthetic two stage demand model for Japan was generated (for details on the relationship between demand and expenditure share elasticities and the synthesized equations see Appendix 1). It should be noted that the advertising elasticity used was .05 on the first and second stages of the model and in aggregate across the two stages as no previous estimates of the advertising elasticity of Japanese import demand for beef exists.

The demand for wool in the U.S. has not previously been estimated as a two stage demand system although there is empirical evidence to support the hypothesis that wool produced in different countries is far from homogeneous (Corra et al., 1985 ; Beare and Meshios, 1990). To facilitate the synthesis of a two stage demand system for wool in the U.S. a two stage demand system was estimated. The results of this preliminary estimation are presented in Appendix 2. Using elasticities from the above estimation and actual data on U.S. wool imports for 1987 a synthetic two stage demand model for the U.S. was generated (again, see Appendix 1 for the details of the synthesized equations). The advertising elasticity used was from Dewbre et al (1986) and was .066, again for either the first or second stage of the model and, in aggregate, across the two stages for the respective scenarios.

MODEL SIMULATION

A. Optimal Advertising

To determine optimal advertising levels it was essential to apply the Dorfman-Steiner condition to the empirical model developed in the previous section. The optimal advertising condition can be restated as:

$$MVPa = -Pelas$$

where MVPa = marginal value product of advertising, $\left(\frac{\partial qi\ pi}{\partial adv}\right)$

Pelas = price elasticity of demand, $\left(\frac{\partial qi}{\partial pi}\right)\left(\frac{pi}{qi}\right)$

In the first stage equating the own price elasticity of demand and the marginal value product Of advertising results in an expression for advertising of the following form:

$$ADV = \left(\frac{-B1 - 1}{C1\ EXP(A1)\ P1^{\ B1+1}}\right)^{\left(\frac{1}{C1-1}\right)}$$

where B1,C1,A1 are synthesized coefficients from the first stage equation.

The above expression is based on the assumption that the only effect of advertising is on the first stage of the demand system. It also determines optimal advertising expenditure for the aggregate quantity consumed (sum of quantities from individual countries) or for all countries whose products are consumed in the importing country. For advertising effects isolated to the second stage of the demand system and applying the same criteria as above optimal advertising expenditure can be expressed as follows:

$$ADV = \left(\frac{(-C11*TEXP)*(-1.0)}{(B11/W1 - B1Y - 1.0)}\right)^{1/2}$$

where C11,B11,B1Y are synthesized coefficients from the second stage of the demand system and W1 is the expenditure share for the advertised good.

This optimal advertising is for a single country and is based on the assumption that the only effect of advertising is on the second stage of the demand system.

With advertising effects possible at both stages of the demand system the price elasticity of demand facing a particular country can be defined as:

$$Pelas_1 = \left[\left(\frac{B11}{W1}\right) - B1Y - 1\right] + \left[\left(\frac{B1\ W1\ P1}{PI}\right) - 1\right]$$

and the marginal value of product of individual country advertising can be expressed as:

$$MVPa1 = \left[B1Y\left(\frac{C1}{ADV}\right) - \left(\frac{C11}{ADV^2}\right)\right] TEXP + \left(\frac{C1\ P1}{ADV}\right)$$

where B11, B1Y, B1, C1, C11 are synthesized coefficients from first and second stage models and W1, P1 are respectively expenditure share and price for advertised good, PI is the aggregate price index used in the first stage.

Equating the two and solving for ADV will generate the optimal value of advertising expenditure for a particular country (in this case country 1).

B. Simulation Results

The results from simulating for optimal advertising expenditure levels are presented in Tables 1 and 2 for beef and wool respectively. The results are presented in terms of expenditure shares, quantities from individual countries, total expenditure across countries (prices are assumed fixed) and the benefit-cost ratio of the individual country (U.S. for beef and Australia for wool) moving from actual to optimal advertising expenditure level.

The base model provides the comparison for results with optimal advertising expenditure levels. All three models (advertising at first stage, advertising at second stage and advertising at both stages) are calibrated to result in the same base solution. To each of the three models the optimal advertising expenditure scenarios developed in the previous section are applied and the results presented in the respective columns.

In the results it is clear that with advertising response (elasticity of .05 for beef and .066 for wool) captured at the first stage significantly higher levels of advertising expenditure are warranted than under either of the other two scenarios. The impact on beef total expenditure (which might be achieved by a generic beef promotion program) feeds through to change the expenditure shares significantly but only results in a 3:1 return on investment to advertising (without accounting for additional costs of production) for the U.S. (assumed to be the only advertiser in the market). The impact on wool total expenditure feeds through to change expenditure shares significantly and results in a 21:1 return on investment to advertising. Higher levels of return on investment are generated by both of the other scenarios. The second scenario has the response to advertising isolated at the second stage while the third scenario has the overall level of response to advertising split between the two stages (for beef .01 first stage .03 second stage, for wool .01 first stage .05 second stage) with the cumulative total being the aggregate advertising response (.05 beef, .066 wool).

For the case of beef it is not clear that it is to any exporter's advantage, either singly or as a group, to undertake pure generic advertising in the Japanese market. The U.S. could, for example, achieve its highest return on investment to its advertising activity if it only paid for half of the optimal advertising activity in model 1. It is not clear that Australia would cheerfully pick up the tab for the rest if, in fact, its revenues decrease. Under a generic advertising campaign that affected either the second stage or both the first and second stages of the model than the U.S. would achieve higher levels of return on investment as long as no other country conducted an effective (significantly shifting demand) country specific advertising activity in the Japanese market.

CONCLUSIONS

To investigate the appropriate method of measuring returns to export promotion/advertising synthetic models of Japanese import demand for beef and U.S. import demand for wool were developed. These models were based on previously estimated own and cross price and expenditure elasticities from other studies (Goddard, 1984; Epp, 1989). Various hypotheses about the role of advertising in an import market where goods are distinguished by country of origin were developed. These hypotheses, as well as, their attendant optimal advertising expenditure levels (Dorfman and Steiner,

1954) were incorporated into synthetic commodity models to investigate their implications. It is worth noting that the empirical results depend critically on the previous estimates of own and cross price, and expenditure elasticities and the assumed response to advertising expenditure for each of the commodities.

As might be expected the elasticities of demand critically affect the optimal advertising expenditure level for a particular exporter. Whether one country benefits more from a co-operative advertising effort or from promoting its own product depends on the cross price elasticities of demand. It also depends to a certain extent on the marketing characteristics of the import market, whether or notconsumers can identify country of origin of the exporter. If they can't identify the source and advertising is aimed exclusively at product from one country then it is likely that the response to advertising would be even lower than the conservative estimates used here.

TABLE 1
CALCULATED RESULTS : BEEF PROMOTION

VARIABLES	BASE	MODEL 1	MODEL 2	MODEL 3
EXPENDITURE SHARES				
U.S.	0.47671	0.57558	0.48932	0.48774
N.Z.	0.03196	0.02972	0.03151	0.03162
AUS.	0.49134	0.39470	0.47917	0.48064
QUANTITIES (MIL. KG)				
U.S.	119	175	123	123
N.Z.	12	14	12	12
AUS.	177	172	172	175
TEXP (MIL. YEN)	85519	103658	85578	86338
ADV. EXP. (MIL. YEN)	145	6098	393	353
REVENUE (MIL. YEN)				
U.S.	40763	59745	41992	41992
N.Z.	2737	3090	2648	2648
AUS.	42019	40902	40902	41615
BENEFIT/COST RATIO OF ADDTIONAL ADVERTISING		3:1*	5.1*	6:1*

1 assuming optimal advertising expenditure stage 1
2 assuming optimal advertising expenditure stage 2
3 assuming optimal advertising expenditure stage 1and 2
* change in U.S. exporter revenue/ change in advertising

TABLE 2
CALCULATED RESULTS : WOOL PROMOTION

VARIABLES	BASE	MODEL 1	MODEL 2	MODEL 3
EXPENDITURE SHARES				
AUS.	0.71448	0.73696	0.75767	0.75020
N.Z.	0.17903	0.15831	0.17703	0.17620
ARG.	0.01137	0.01073	0.01122	0.01121
R.O.W.	0.09512	0.09400	0.05408	0.06239
QUANTITIES (MT)				
AUS.	26857	39963	28429	28785
N.Z.	8451	10780	8342	8490
ARG.	449	611	442	452
R.O.W.	4801	6844	2724	3214
TEXP (000$ A)	149895	216233	149618	153000
ADV. EXP.(000$ A)	47	12302	709	427
REVENUE (000$ A)				
AUS.	113712	169203	120368	121876
N.Z.	23908	30497	23599	24018
ARG.	1403	1944	1406	1438
R.O.W.	15133	21572	8586	10130
BENEFIT/COST RATIO OF ADDITIONAL ADVERTISING		4:1*	10:1*	21:1*

1 assuming optimal advertising expenditure stage 1
2 assuming optimal advertising expenditure stage 2
3 assuming optimal advertising expenditure stage 1and 2
* change in Australia exponer revenue/ change in advertising

APPENDIX 1 Calculation of Theoretical Relationships

Calculation of the elasticity of total expenditure with respect to price

$$\pi TP = \left(\frac{\partial Q}{\partial T}\right)\left(\frac{P}{T}\right)$$

multiply by $\left(\frac{\partial Q}{\partial Q}\right)\left(\frac{Q}{Q}\right)$ and rearrange the terms

$$= \left(\frac{\partial Q}{\partial P}\right)\left(\frac{P}{Q}\right)\left(\frac{\partial T}{\partial Q}\right)\left(\frac{Q}{T}\right)$$

since $T = PQ$, $\left(\frac{\partial T}{\partial Q}\right) = P$

$$= \left(\frac{\partial Q}{\partial P}\right) P \left(\frac{Q}{PQ}\right)$$

$$= \left(\frac{\partial Q}{\partial P}\right)\left(\frac{P}{Q}\right)$$

$$= \pi QP$$

where πTP = elasticity of total expenditure w.r.t. price
P = price
TEXP = total expenditure
Q = quantity
πQP = elasticity of quantity w.r.t. price

Calculation of the elasticity of total expenditure w.r.t. advertising

$$\pi TA = \left(\frac{\partial T}{\partial A}\right)\left(\frac{A}{T}\right)$$

multiply through by $\left(\frac{\partial Q}{\partial Q}\right)\left(\frac{Q}{Q}\right)$ and rearrange the terms

$$= \left(\frac{\partial Q}{\partial A}\right)\left(\frac{A}{Q}\right)\left(\frac{\partial T}{\partial Q}\right)\left(\frac{Q}{T}\right)$$

$$= \pi QA P\left(\frac{Q}{PQ}\right)$$

$$= \pi QA$$

where πTA = elasticity of total expenditure w.r.t. advertising
A = advertising expenditure
πQA = elasticity of quantity w.r.t. advertising expenditure

Calculation of the expenditure share elasticity w.r.t. own price

$$\pi wpi = \left(\frac{\partial W_i}{\partial P_i}\right)\left(\frac{P_i}{W_i}\right)$$

multiply by $\left(\frac{\partial Q_i}{\partial Q_i}\right)\left(\frac{Q_i}{Q_i}\right)$ and rearrange the terms

$$= \left(\frac{\partial Q_i}{\partial P_i}\right)\left(\frac{P_i}{Q_i}\right)\left(\frac{\partial W_i}{\partial Q_i}\right)\left(\frac{Q_i}{W_i}\right)$$

but $W_i = \left(\frac{P_i Q_i}{TEXP}\right)$ therefore $\left(\frac{\partial W_i}{\partial Q_i}\right) = \left(\frac{P_i}{TEXP}\right)$

$$= \left(\frac{\partial Q_i}{\partial P_i}\right)\left(\frac{P_i}{Q_i}\right)\left(\frac{P_i}{TEXP}\right) Q_i\left(\frac{TEXP}{P_i Q_i}\right)$$

$$= \left(\frac{\partial Q_i}{\partial P_i}\right)\left(\frac{P_i}{Q_i}\right)$$

$$= \pi QiPi$$

where π_{wipi} = expenditure share elasticity w.r.t. own price
P_i = own price
Q = own quantity
$\pi QiPi$ = own price elasticity

Calcu ation of the expenditure share elasticity w.r.t. cross price

$$\pi wipj = \left(\frac{\partial W_i}{\partial P_j}\right)\left(\frac{P_i}{W_i}\right)$$

multiply by $\left(\frac{\partial Q_i}{\partial Q_i}\right)\left(\frac{Q_i}{Q_i}\right)$ and rearrange the terms

$$= \left(\frac{\partial Q_i}{\partial P_j}\right)\left(\frac{P_i}{Q_i}\right)\left(\frac{\partial W_i}{\partial Q_i}\right)\left(\frac{Q_i}{W_i}\right)$$

$$= \left(\frac{\partial Q_i}{\partial P_j}\right)\left(\frac{P_i}{Q_i}\right)\left(\frac{P_i}{TEXP}\right) Q_i\left(\frac{TEXP}{P_i Q_i}\right)$$

$$= \left(\frac{\partial Q_i}{\partial P_j}\right)\left(\frac{P_i}{Q_i}\right)$$

$$= \pi QiPj$$

where $\pi wipj$ = expenditure share elasticity w.r.t. cross price
P_j = cross price
Q_i = own quantity
$\pi QiPj$ = cross price elasticity

Calculation of the expenditure share elasticity w.r.t. advertising expenditure

$$\pi WA = \left(\frac{\partial W}{\partial A}\right)\left(\frac{A}{W}\right)$$

multiply by $\left(\frac{\partial Q}{\partial Q}\right)\left(\frac{Q}{Q}\right)$ and rearrange the terms

$$= \left(\frac{\partial Q}{\partial A}\right)\left(\frac{A}{Q}\right)\left(\frac{\partial W}{\partial Q}\right)\left(\frac{Q}{W}\right)$$
$$= \left(\frac{\partial Q}{\partial A}\right)\left(\frac{A}{Q}\right)\left(\frac{P}{TEXP}\right)Q\left(\frac{TEXP}{PQ}\right)$$
$$= \left(\frac{\partial Q}{\partial A}\right)\left(\frac{A}{Q}\right)$$
$$= \pi QA$$

where πWA = expenditure share elasticity w.r.t. advertising

A = advertising expenditure

πQA = elasticity of quantity w.r.t. advertising

APPENDIX 2 Estimation of U.S. Wool Demand System

The demand for wool in the U.S. is modelled as if wool from different countries of origin were not homogeneous. Following Armington (1969) the demand for wool is modelled in two stages. At the first stage aggregate expenditure on greasy wool is modelled as a function of the weighted average price of wool from different sources, rayon and cotton prices, U.S. per capita disposable income and a time trend to reflect structural change in the demand for wool over the sample period 1960 to 1987. The wool data is taken from the United Nations Commodity Trade Statistics, other data is from I.M.F. Financial Statistics, B.A.E. statistical handbook, World Cotton Outlook, and the U.S.D.A. cotton and wool situation and Outlook. The equation is estimated using Ordinary Least Squares in TSP version 4.01. The results of the estimated equation are presented in table A.1.

The second stage of the demand system contains a complete demand system for wool by country of origin in the U.S.. The regions for analysis are Australia, New Zealand, South Africa, Argentina and the Rest of the World (including Latta, Oceania, Chile and Uruguay[2]). The functional form of the Demand system is an AIDS model (Deaton and Muellbauer, 1980). The model is estimated in its basic form with adding up, symmetry and homogeneity imposed. In spite of the fact that linear homogeneity of the utility function at the second stage (expenditure elasticities equalling to one) is essential for consistent two stage budgeting it is not imposed in this analysis due to the restrictiveness of its implications. The model is estimated using maximum likelihood regression techniques in TSP version 4.01.

The AIDS model was estimated with (log of likelihood function = 189.278) and without (log of likelihood function = 153.222) a time trend to account for structural change. The likelihood ratio test statistic (71.912 distributed as Chi-squared with 4 degrees of freedom) suggests that the restriction of excluding time can not be accepted.

The results in terms of price and expenditure elasticities at the mean, substitution elasticities and fit of the estimated equations (since the equations satisfy adding up, only n-1 of the equations are independent and estimated) are presented in table A.2.

The results would suggest that wool from different sources can not be viewed as homogeneous. Cross price elasticities of demand are mostly negative which would suggest that products from different countries are mostly viewed as complements. The expenditure elasticities range across countries from .604 (New Zealand) to 1.45 (South Africa).

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[2] insufficient data for Uruguay prevented its inclusion into this study

Table A.1 Regression Results for Estimated Wool Equation
Demand equation statistics

	Coefficient	T- Statistic	Elasticity
intercept	2.920	0.327	2.920
price	0.753	1.704	-0.247
per cap disposable income	-2.561	1.370	-2.561
rayon price	-2.840	2.044	-2.840
cotton price	0.269	0.389	0.269
time trend	0.036	1.042	0.036

$R^2 = .65$
D-W = 1.8
F(5, 13) = 4.8

Table A.2 Elasticities and Fit of Estimated Equations

Price and Expenditure Elasticities

	Aus.	N. Z.	S. Afr.	Arg.	R. of W.	Expenditure
Aus.	-0.638	-0.149	-0.111	-0.197	0.008	1.087
N.Z.	-0.023	-0.446	-0.317	0.104	0.002	0.680
S.Afr.	-1.625	-2.518	1.169	0.383	-0.056	2.134
Arg.	-1.407	0.425	0.347	-0.218	-0.013	0.844
R. of W.	0.229	-0.106	-0.119	-0.069	-1.090	1.153

Substitution Elasticities

	Aus.	N. Z.	S. Afr.	Arg.	R. of W.
Aus.	-0.200	-0.619	-2.209	-2.642	1.600
N.Z.	0.619	-0.529	-2.350	2.409	0.750
S.Afr.	-3.893	-2.349	17.025	5.373	-0.043
Arg.	-1.911	2.409	7.416	-3.050	-0.015
R.of W.	1.600	0.750	-0.043	-0.552	-58.580

Fit of Estimated Equations

	R^2	D.-W. statistics	Mean of Dependent Variable
Aus.	0.77	1.45	0.506
N.Z.	0.79	1.54	0.336
S.A.	0.79	1.60	0.075
Arg.	0.51	1.01	0.064

APPENDIX 3 Calculation of Demand Systems for wool

First stage without advertising:

$$\ln TEXP = 12.1 - .16 \ln P_I$$

First stage including advertising as a shift parameter

$$\ln TEXP = 11.8 - .16\ln(P_I) - .066\ln(ADV)$$

First stage including advertising as a shift parameter at both stages

$$\ln TEXP = 11.8 - .16\ln(P_I) - .066\ln(ADV)$$

Second stage without advertising

The resulting expenditure share equations:

$$W_1 = -0.59 + 0..303\ln(P_1) + 0.106\ln(P_2) - 0.079\ln(P_3) - 0.141\ln(P_4) + 0.0061\ln(P_5) + 0.062\ln\left(\frac{TEXP}{P_I}\right)$$

$$W_2 = 0.664 - 0.004\ln(P_1) + 0.089\ln(P_2) - 0.056\ln(P_3) - 0.019\ln(P_4) + 0.0003\ln(P_5) - 0.057\ln\left(\frac{TEXP}{P_I}\right)$$

$$W_4 = 0.035 - 0.016\ln(P_1) + 0.005\ln(P_2) + 0.004\ln(P_3) + 0.009\ln(P_4) - 0.001\ln(P_5) - 0.002\ln\left(\frac{TEXP}{P_I}\right)$$

$$W_5 = -0.061 + 0.022\ln(P_1) - 0.012\ln(P_2) - 0.011\ln(P_3) - 0.006\ln(P_4) - 0.007\ln(P_5) + 0.014\ln\left(\frac{TEXP}{P_I}\right)$$

where 1 = Aust. 2 = N.Z. 3 = Sth. Afr. 4 = Arg. 5 = Rest of World

Including advertising at the second stage yields:

$$W_1 = -0.011 + 0.303\ln(P_1) + 0.106\ln(P_2) - 0.079\ln(P_3) - 0.141\ln(P_4) + 0.006\ln(P_5) + 0.062\ln\left(\frac{TEXP}{P_I}\right) - 2.22\left(\frac{1}{ADV}\right)$$

$$W_2 = 0.661 - 0.004\ln(P_1) + 0.089\ln(P_2) - 0.056\ln(P_3) - 0.019\ln(P_4) + 0.0003\ln(P_5) - 0.057\ln\left(\frac{TEXP}{P_I}\right) + 0.139\left(\frac{1}{ADV}\right)$$

$$W_4 = 0.034 - 0.016\ln(P_1) + 0.005\ln(P_2) + 0.004\ln(P_3) + 0.009\ln(P_4) - 0.001\ln(P_5) - 0.002\ln\left(\frac{TEXP}{P_1}\right) + 0.009\left(\frac{1}{ADV}\right)$$

$$W_5 = -0.062 + 0.022\ln(P_1) - 0.010\ln(P_2) - 0.011\ln(P_3) - 0.006\ln(P_4) - 0.007\ln(P_5) + 0.014\ln\left(\frac{TEXP}{P_1}\right) + 0.074\left(\frac{1}{ADV}\right)$$

Including advertising at both stages yields a second stage yields:

$$W_1 = -0.020 + 0.303\ln(P_1) + 0.106\ln(P_2) - 0.079\ln(P_3) - 0.141\ln(P_4) + 0.006\ln(P_5) + 0.062\ln\left(\frac{TEXP}{PI}\right) - 1.86\left(\frac{1}{ADV}\right)$$

$$W_2 = 0.661 - 0.004\ln(P_1) + 0.089\ln(P_2) - 0.056\ln(P_3) - 0.019\ln(P_4) + 0.0003\ln(P_5) - 0.057\ln\left(\frac{TEXP}{PI}\right) + 0.116\left(\frac{1}{ADV}\right)$$

$$W_4 = 0.035 - 0.016\ln(P_1) + 0.005\ln(P_2) + 0.004\ln(P_3) + 0.009\ln(P_4) - 0.001\ln(P5) - 0.002\ln\left(\frac{TEXP}{P1}\right) + 0.007\left(\frac{1}{ADV}\right)$$

$$W_5 = -0.062 + 0.022\ln(P_1) - 0.010\ln(P_2) - 0.011\ln(P_3) - 0.006\ln(P_4) - 0.007\ln(P_5) + 0.014\ln\left(\frac{TEXP}{P1}\right) + 0.062\left(\frac{1}{ADV}\right)$$

Calculation of Demand Systems for beef

Calculation of first stage yields:

$$\ln TEXP = 10.51 - .15\ln(PI)$$

Including advertising in the first stage as a shift parameter yields:

$$\ln TEXP = 10.26 - .15 \ln (PI) - .05 \ln ADV$$

First stage including advertising as a shift parameter at both stages

$$\ln TEXP = 10.46 - .15 \ln (PI) - .01 \ln ADV$$

Calculation of second stage yields the resulting expenditure share equation:

$$W_1 = -1.24 - 0.139\ln(P_1) + 0.164\ln(P_2) - 0.354\ln(P_3) + 0.630\ln\left(\frac{TEXP}{PI}\right)$$

$$W_2 = 0.034 + 0.006\ln(P_1) - 0.023\ln(P_2) + 0.031\ln(P_3) - 0.014\ln\left(\frac{TEXP}{PI}\right)$$

$$W_3 = 0.462 + 0.008\ln(P_1) + 0.066\ln(P_2) - 0.088\ln(P_3) + 0.010\left(\frac{TEXP}{PI}\right)$$

where 1 = United States
2 = New Zealand
3 = Australia

Including advertising at the second stage yields:

$$W_1 = -1.23 - 0.139\ln(P_1) + 0.165\ln(P_2) - 0.354\ln(P_3) + 0.6303\ln\left(\frac{TEXP}{PI}\right) - 3.45\left(\frac{1}{ADV}\right)$$

$$W_2 = 0.033 + 0.006\ln(P_1) - 0.023\ln(P_2) + 0.031\ln(P_3) - 0.0143\ln\left(\frac{TEXP}{PI}\right) - 0.116\left(\frac{1}{ADV}\right)$$

$$W_3 = 0.450 + 0.0085\ln(P_1) + 0.0658\ln(P_2) - 0.0884\ln(P_3) + 0.0098\ln\left(\frac{TEXP}{PI}\right) - 1.78\left(\frac{1}{ADV}\right)$$

Including advertising at both stage yields a second stage

$$W_1 = -1.24 - 0.139\ln(P_1) + 0.165\ln(P_2) - 0.354\ln(P_3) + 0.6303\ln\left(\frac{TEXP}{PI}\right) - 1.85\left(\frac{1}{ADV}\right)$$

$$W_2 = 0.033 + 0.006\ln(P_1) - 0.023\ln(P_2) + 0.031\ln(P_3) - 0.0143\ln\left(\frac{TEXP}{PI}\right) - 0.062\left(\frac{1}{ADV}\right)$$

$$W_3 = 0.455 + 0.0085\ln(P_1) + 0.0658\ln(P_2) - 0.0884\ln(P_3) + 0.0098\ln\left(\frac{TEXP}{PI}\right) - 0.952\left(\frac{1}{ADV}\right)$$

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