Assessing the Impacts of Wool Promotion: An Equilibrium Displacement Modelling Approach

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The main goal of the International Wool Secretariat (IWS) is to increase the world demand for wool through promotion activities. Australia is a leading wool producer and the world's largest apparel wool exporter. Each year Australian wool producers contribute millions of dollars to the IWS for wool promotion. The principal aims of this paper are to demonstrate the potential for equilibrium displacement modelling to assess the impact of incremental wool promotion on wool producer incomes and profits, and, using 'best-bet' estimates of the key parameters, to indicate cross-commodity impacts of promotion of various fibres on wool producer profits.

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Glossary

apparel wool	Defined in this study as having an average fibre diameter of less than 26 microns.
carpet wool	Defined in this study as having an average fibre diameter of greater than 35 microns.
furnishing wool	Defined in this study as having an average fibre diameter of between 24 microns and 35 microns.
major wool exporters	The main exporters of apparel wool. These countries include Australia, New Zealand, Argentina, South Africa and Uruguay.
micron	A unit of measure of fibre diameter equal to a millionth of a metre.
non-apparel wool	Wool generally used for furnishing fabrics and carpets. However, for the purpose of this analysis, non-apparel wool is considered to consist of carpet wool only. This is consistent with the definition used by Connolly (1992) in developing a world wool trade model.
promotion	Promotion refers to any activity designed to increase consumers' awareness of a commodity. It includes media advertising, such as TV commercials, and other promotional activities such as fashion shows or fashion awards.
textile fibres	Textile fibres consist of natural fibres and man-made fibres. Natural fibres include protein fibres, such as wool, hair and silk, cellulous fibres, such as cotton, and mineral fibres such as asbestos. Man-made fibres consist of organic fibres and inorganic fibres. Organic fibres can be further sub-divided into natural polymer based, which includes rayon, and synthetic polymer based, such as polyester (Griffith and Farrell 1991). In this study, however, textile fibres do not include natural mineral fibres or man-made inorganic fibres.

1. Introduction

1.1 Background

While international wool promotion began in 1930, the International Wool Secretariat (IWS), which is responsible for international wool promotion, was not formed until 1937. The original member countries of the IWS were Australia, New Zealand and South Africa, with Uruguay joining in 1970. The main goal of the IWS is to increase world demand for woollen products. Generic promotion of wool has long been a tool used by the IWS to achieve this goal. Wool producers are expected to benefit from this promotional activity through increased producer returns and, as a result, the IWS is largely producer funded through a promotion tax. However, wool processors and consumers also benefit from wool promotion and share in the tax burden. While the level of total contributions has fallen significantly from the record level of $210m in 1990/91, Australian wool producers still contribute around $100m annually to the IWS for international wool promotion. For example, the 1993/94 total Australian contribution to the IWS was $111.5m, consisting of around $91.5m from producer funds and $20m from the Australian government (IWS, per comm. 1994; Wool Industry Review Committee 1993). Since 1982/83, around 75 per cent to 80 per cent of total IWS funds have been used for promotion activities annually, with the remaining funds being used for general administrative purposes (Wool Industry Review Committee 1993).

Domestic promotion activities for apparel wool have largely been the responsibility of the Australian Wool Corporation which became the Australian Wool Research and Promotion Organisation and is now the IWS. However, compared with the international activities of the IWS, domestic wool promotion expenditure has been minor, averaging around $3m annually. This is largely because the Australian market for woollen products is relatively small. Promotion of carpet wools in Australia has been undertaken and funded by the New Zealand Wool Board, as most of the carpet wool consumed in Australia is imported from New Zealand.

While the relative importance of the Australian wool industry, both as a contributor to Gross Domestic Product and exports, has declined since the 1930s, it still has a major role to play in the Australian economy, particularly with regard to earning foreign exchange. In 1988/89, at $5 995m, the export value of wool and skins reached record levels and represented 11 per cent of total exports and 37 per cent of rural exports (ABARE 1994a).

Since 1988, however, a number of supply and demand factors have combined to destabilise the world wool market and place downward pressure on prices. A number of international factors led to an unexpected contraction in the demand for wool, including: a significant reduction in the demand for wool by China from 1988 to 1990, after the Tianamen Square catastrophe in 1987; a downturn in the demand for imports by Japan after the Kuwait invasion led to an increase in world oil prices; and a reduction in the demand for wool in Eastern Europe due to political unrest and uncertainty after the collapse of the Berlin Wall (ABARE 1994b; Griffith and Goddard 1993). Wool stocks reached record levels as supply outstripped world demand for Australian wool. The excess supply was due to the floor price for wool being higher than the world equilibrium price. The reserve price scheme was abandoned in 1991 and this was followed by a dramatic decrease in prices received by producers. By 1993/94, the value of wool exports had fallen to an estimated $2 958m (ABARE 1994b).

One way to improve the viability of the Australian wool industry is to increase the demand for wool both domestically and on the international market. A method commonly used to increase demand for a range of agricultural products is generic promotion.

1.2 Aims of the Paper

In this paper the impact of changes in wool promotion on wool producer returns and profits is examined. The emphasis is on demonstrating how a particular mathematical procedure called 'equilibrium displacement modelling' can be used as an aid to decision making on incremental wool promotional expenditure. Demonstration of the procedure will utilise 'best bet' estimates of crucial parameters so that the results should be indicative of the actual outcomes. In particular, cross-commodity impacts of promotion of various fibres will be assessed.

1.3 Outline of the Paper

The format of this paper is as follows. A discussion on promotion including some theoretical considerations and a review of previous wool promotion studies is presented in Section 2. In Section 3 the benefits of using equilibrium displacement modelling to assess the impact of promotion on profits accruing to the wool industry are discussed. The model is developed in Section 4. This model is then implemented in Section 5 using 'best-bet' estimates of the crucial parameters. The policy implications of the analysis are discussed in Section 6. The conclusions of the study are presented in Section 7, along with a discussion on the benefits and limitations of using equilibrium displacement modelling and areas for further research.

2. Generic Promotion of Agricultural Commodities

2.1 Introduction

A number of recent papers have addressed the questions of whether promotion expenditure is in fact profitable and what the optimal level of promotion expenditure would be. The types of analysis undertaken range from a general theoretical exposition of promotion to an empirical examination of the profitability of promotion expenditure for specific commodities. The first section contains a discussion of promotion including the theory of promotion, while previous studies on wool promotion are reviewed in the second section.

2.2 Some Theoretical Considerations

There are two main theories on how promotion affects a consumer's desire for a particular commodity. These are: (a) the consumer's marginal utility for the promoted product is increased through promotion; and (b) the consumer's knowledge of the promoted product is increased through promotional activities. A comprehensive coverage of this debate was presented in the study on wool promotion by Conboy (1992). Conboy (1992) suggested that the Dixit and Norman approach to promotion had the greatest appeal as it combines both of the proposed theories. This approach allows promotional activity 'to shift utility both through a gain in knowledge in a good's perceived characteristics, and as a taste changing parameter' (p.41).

It is hypothesised that the type and quantity of promotion is related to the characteristics of the commodity (Boutonnat, Forker, Jones, Kinnucan and MacDonald 1991). Broadly speaking, with respect to the theory of promotion, there are two general types of product characteristics: experience and search. 'Experience' characteristics refer to those attributes of the commodity that a consumer can determine only through purchase and consumption of the commodity, such as taste and quality. 'Search' characteristics refer to those attributes that a consumer can assess without purchasing the good and includes factors such as colour, price and style. Theoretically, the relative proportion of each of these characteristics embodied in a commodity will impact on the optimal level and type of promotion for that commodity. In general, products that consist largely of experience characteristics will have relatively higher promotion-to-sales ratios than goods composed largely of search characteristics. In addition, the promotional activities will contain more non-specific information for experience goods (Boutonnat *et al* 1991). The relative proportion of experience or search characteristics could therefore be used as a guide to the appropriate level and type of wool promotion.

The main aim of promotion is to increase producers' revenue by causing an outward shift in the demand curve. However, for promotion to actually be profitable, the increase in producer revenue must not only offset the cost of promotion but also the cost of producing the extra quantity sold. Thus, producer surplus must increase. In addition to causing a shift in the demand curve, promotional activity can also, theoretically, make the demand curve of the promoted product become either more or less price elastic (Quilkey 1986). By focussing on the unique characteristics of a product, promotional activities will, in the eyes of the consumer, result in a decrease in the number of substitutes, causing the demand curve to become less elastic. Conversely, promotional activities that increase the consumer's awareness of a product's alternative uses will result in a more elastic demand curve (Boutonnat *et al* 1991). Whether promotional activities that make demand either more or less price elastic will result in increased producer surplus will partly depend on the direction of price changes caused by shifts in the supply curve. Conceptually, marketing strategies that increase the price responsiveness of demand for a commodity, but do not result in a shift in the demand curve, would be preferred when the supply of that commodity is increasing, while marketing strategies that reduce price responsiveness, without shifting the demand curve, would be preferred when supply is decreasing. Currently, with the reduction in the supply of wool, a promotional strategy that makes demand less price responsive would be the preferred option. However, as shown here, it should not be automatically assumed that promotion that results in an increase in demand and/or a less price responsive demand curve will necessarily increase producer profits.

Goddard, Griffith and Quilkey (1992) used simple algebraic models to show how optimal promotion expenditure levels are determined under various marketing conditions. Of particular relevance to this study, they demonstrated the following points:

(a) When there is trade among regions and fixed supply and there is a single producer organisation allocating a fixed promotion budget across regions, as in the case of the IWS and wool promotion, then the quantity consumed in each region will depend on the free-trade price and on the level of promotion expenditure in each region.

(b) When promotion could be either 'generic' or 'country-specific', then the impact of promotion will depend on the type of promotion undertaken.

- If generic promotion is undertaken (e.g. 'Buy woollen products') and it is successful, then the level of promotion will increase total expenditure on the promoted commodity.
- If 'country-specific' promotion is undertaken (e.g. 'Buy Australian wool'), then it is possible that the total level of expenditure will not change but that the relative shares of the quantity purchased will increase in favour of the promoted commodity. 'Country-specific' promotion of Australian wool could therefore benefit Australian wool growers at the expense of other apparel wool producing countries, such as South Africa, as importers respond by increasing the share of Australian wool that they purchase. This type of promotion, however, should have only a minimal impact on the general level of expenditure on wool from New Zealand, because New Zealand wool is predominantly carpet wool and is not in direct competition with the apparel wool exported from Australia.
- 'Country-specific' promotion could also increase the total level of expenditure on a commodity as well as increasing the promoted commodity's share of total expenditure. For example, a promotion campaign directed at Australian wool may result in a general increase in the demand for all wool, but with the increase being proportionately larger for Australian wool, resulting in Australian producers receiving a greater proportion of the increase in total wool expenditure.

The optimal level of promotion expenditure on a commodity will depend, in part, on the promotion elasticity and the level of sales in each market (Goddard *et al* 1992). Promotion elasticity can be defined as the percentage change in sales given a one per cent change in promotion expenditure. The majority of promotion elasticities for wool that were estimated by Griffith and Goddard (1993), Conboy (1992) and the BAE (1987) were positive but less than one, implying that a one per cent increase in wool promotion would result in a less than one per cent increase in wool sales (Table 2.1). The Dorfman-Steiner theorem states that, for profit maximisation, the ratio of promotion expenditure to sales must equal the ratio of the promotion elasticity to the price elasticity of demand. In effect, this means that if consumers are more responsive to promotion than to price changes, then the optimal level of promotion will be relatively large in terms of investment expenditure. Therefore, if consumers demand for wool is likely to be more responsive to promotion than to the price of wool, then the optimal investment in wool promotion expenditure will be large compared to a product whose demand is relatively price responsive but relatively non-responsive to promotion.

2.3 Previous Wool Promotion Studies

Griffith and Goddard (1993) analysed the impact of IWS wool promotion on the demand for wool in France, Germany, Italy, Japan, the United Kingdom, the United States and the Rest-of-world (excluding China and Eastern Europe). Demand equations for each of these regions were estimated using standard econometric techniques and annual data from 1976-89. The estimated advertising elasticities from this analysis are presented in Table 2.1. The results from this study showed that promotion had a positive impact in France and the United States, and therefore increasing promotion expenditure here would be beneficial. In Italy and the United Kingdom, promotion was found to be statistically significant but the results were not robust which placed some doubt on the benefit of increasing promotion expenditure in these countries. Finally, in Japan, Germany and the Rest-of-world, the value of any wool promotion expenditure was queried because the promotional responses were found not to be statistically significant. However, using simulation analysis, it was determined that in all areas except for Rest-of-world, the optimal level of promotion expenditure was higher than the IWS level for that time period. This apparent divergence in results can be caused by the changes in the level of analysis undertaken and highlights the care that must be taken when making recommendations about promotion expenditure.

In the study by Conboy (1992), linear equations representing the demand for wool in France, Germany, Italy, Japan, the United Kingdom, the United States and the Rest-of-world, the world supply of greasy wool, world sheep inventory and world wool stocks were estimated. Promotion elasticities for each country or region considered were estimated. These estimates are presented in Table 2.1. The effectiveness of wool promotion was calculated using model simulation. The results of the analysis indicated that IWS-funded promotion expenditure is effective in terms of increased consumer expenditure on woollen goods and increased returns to producers. In addition, increased promotion expenditure would benefit Australian wool producers.

A study analysing the returns from wool promotion in the United States was undertaken as a joint research project of the Australian Wool Corporation and the Bureau of Agricultural Economics (BAE 1987). Data used in this study included IWS promotion expenditure figures for the United States and records of wool apparel purchases obtained from household surveys conducted in the United States. The results of this analysis indicated wool promotion expenditure by the IWS significantly increased the demand for apparel wool in the United States. The short-run elasticity of demand with respect to changes in wool promotion was estimated to be 0.07 and the corresponding long-run elasticity was calculated to be 0.09 (Table 2.1).

Table 2.1: Wool promotion[a] elasticities from previous studies

Study	Country	Variable	Elasticity
Griffith and Goddard 1993	France	Inv of promotion (-1)	0.208
	Germany	Inv of promotion * time (-1)	0.157
	Italy	Inv of promotion (-1)	0.148
	Japan	Quantity/promotion (-1)	0.216
	United Kingdom	Promotion * time	0.21
	United States	Quantity/promotion (-1)	0.23
	Rest of world	Inv of promotion(-1)	-0.005
Conboy 1992	France	Promotion (-1)	0.159
	France[b]	Quantity * promotion (-1)	0.159
	France[b]	Quantity * promotion (-1)	0.491
	Germany	Promotion (-1)	-0.025
	Germany[b]	Price * promotion (-1)	0.018
	Germany[b]	Price * promotion (-1)	-0.016
	Italy	Promotion (-1)	0.37
	Italy[b]	Price * promotion (-1)	0.113
	Italy[b]	Price * promotion (-1)	0.357
	Japan	Promotion (-1)	-0.003
	Japan	Price * promotion (-1)	-0.003
	United Kingdom[b]	Promotion (-1)	0.067
	United Kingdom[b]	Promotion (-1)	0.478
	United Kingdom	Price * promotion (-1)	0.002
	United States	Promotion (-1)	-0.001
	United States[b]	Price * promotion (1)	-0.035
	United States[b]	Price * promotion (-1)	-0.044
BAE 1987	United States	Promotion expenditure	0.07 to 0.09

[a] Referred to as advertising in these studies.
[b] Refers to different equation specifications.

3. Using Equilibrium Displacement Modelling

Modelling demand response to promotion in a single equation usually means that, not only are the cross-promotion effects ignored, but also the supply side is omitted from the model. In a competitive industry, the full impact of promotion can only be measured if the cross-promotion effects on demand are accounted for and supply is included in the analysis. Equilibrium displacement modelling (EDM) is an analytical tool that can be used to assess the impact of incremental wool promotional activities on equilibrium prices, quantities, revenues and profits, by allowing for the cross-promotion effects of cotton and man-made fibre promotion and the supply of all fibres to be incorporated in the model. While a traditional econometric approach can also account for cross-promotion effects and supply, EDM can be relatively cost-efficient in terms of data requirements and the time spent obtaining econometric estimates. Moreover, because EDM 'entails making first order approximations to the quantitative effects of changes in exogenous variables' (Piggott, Parton, Treadgold and Hutabarat 1993, p. 171), it does not require the specification of functional forms. The savings in research time and resources are obtainable provided the analyst is prepared to exercise informed judgements about the size of key parameters. This 'judgement' can be accompanied by sensitivity analysis. Of course, if time and resources permits, the analyst might wish to use econometric estimates of key parameters rather than judgement alone.

Use of EDM to assess the impact of promotion on agricultural commodities is not new. A number of research papers examining the effect of promotional activity in the Australian meat industry have been written (Piggott, Piggott and Wright 1993; Piggott and Wright 1993). Not only have these papers shown how meat promotion has affected producer incomes and profits, but they have also emphasised the difference between statistically significant promotion and profitable promotion. Piggott and Wright (1993) showed that, in a market which is characterised by a negatively-sloped domestic demand curve and a perfectly elastic export demand curve, then even promotion expenditure that is statistically significant and has a positive impact on domestic demand, will not be profitable. While increased promotion expenditure will result in an increase in the domestic demand for the product, this increase will be offset by a reduction in amount of the commodity being exported. Prices will remain unchanged and producer profits will fall by the cost of promotion.

With regard to wool, however, as Australia is the world's leading producer and exporter, it is unlikely that Australian wool producers would face a perfectly elastic demand curve. Effective wool promotion should therefore result in an increase in producer revenue for wool. So long as this increase in revenue exceeds the increase in promotion costs and costs of extra production, producer profits will increase This study will assess the impact of incremental wool promotion on both producer returns and producer profits within an EDM framework.

4. The Model

4.1 Method

Equilibrium displacement modelling is used in this study to assess the impacts of wool promotion on wool producers. This analytical method was used by Mullen, Alston and Wohlgenant (1989) to examine the impact of farm and processing research on the Australian wool industry. It was also used to determine the impact of promotion in the Australian meat industry (Piggott, Piggott and Wright 1993).

EDM applies comparative statics to general function models. It requires a set of general supply and demand functions for a market. The approximate impact of a disturbance in the market, resulting from a change in the value of one or more exogenous variables, is determined using functions that are linear in elasticities. The main difference between EDM and comparative statics is that EDMs focus on finite changes in the exogenous variables, such as promotion, and the changes in both the endogenous variables and in exogenous variables are measured in proportionate terms or as ratios of proportionate terms. Comparative statics, however, usually uses calculus to indicate the direction of change of an exogenous variable, once the general equilibrium effects have occurred.

EDM is a powerful but relatively low-cost tool that can be applied to analyse the impact of small finite changes in exogenous variables. This is one of the main advantages of using EDM as a substitute for econometric models. It is easy to take account of the effect of cross-commodity relationships on the outcome from changes in the exogenous variables. For example, in this study the cross-promotional effects of the different fibres need to be considered. Buse (1958) showed that the expected change in the quantity of a commodity demanded and supplied resulting from a change in price, which is exogenously determined, will be different when cross-commodity effects are accounted for than if they are ignored. In general, when cross-commodity effects are included, the measured price response is smaller (less elastic) than when cross-commodity effects are omitted from the analysis. This could have considerable policy implications because different conclusions regarding the directional change in total revenue could be reached depending on whether total response or Marshallian elasticities are used. When precise measurement of all the elasticities is not possible, sensitivity analysis can be used to determine the effect on the outcome of changing the value of particular parameters, such as the own-price elasticity.

The use of EDM in this study follows the procedure set out in Piggott, Piggott and Wright (1993). EDM allows the set of models to be general, so no functional form need be specified. The models will comprise equations representing the demand and supply of apparel wool, non-apparel wool, cotton and man-made fibres. Once the models have been specified, investigation of the impacts of an incremental change in generic promotion expenditure for apparel and non-apparel wool is relatively straight forward. Questions about the changes in wool producers and the profitability of wool promotion can then be addressed.

4.2 The Structural Model

This model is based on a number of important characteristics of the fibre market. In Australia, around 97 per cent of wool is used for apparel uses. Because of its fineness and long staple length, about 85 per cent of Australia's total wool clip is suitable for the worsted process, which produces woven textiles such as suits. The remaining 12 per cent of apparel wool, which is coarser, is used in the woollen process to produce yarn for knitwear (Mullen and Alston 1989). Non-apparel wool is used for furnishing fabrics and carpets. While substitution between apparel and non-apparel wool is possible, it is limited. In this model, non-apparel wool essentially refers to carpet wool which has a fibre diameter of 35 microns or greater and is not exported from Australia. As such, apparel and non-apparel wool are considered to be marginally related in demand on the domestic market but not related on the export market. Cotton and man-made fibres are substitutes for apparel and non-apparel wool in the textile industry and are therefore considered to be related in demand, both domestically and on the export market.

Wool and cotton exports account for about 98 per cent and 93 per cent of total wool and cotton production, respectively, and it is assumed here that around 90 per cent of man-made fibres produced in Australia are also exported. Despite the existence of the Multi-Fibre Agreement, Australia's domestic fibre market at the raw fibre level is not shielded from international market forces. Therefore, the domestic and export markets for wool, cotton and man-made fibres cannot be separated and, once allowance has been made for quality differences and transport costs, a single price exists for each product irrespective of the market in which it is sold.

It is assumed that, on both the domestic and international markets, the demand for apparel wool is affected by its own promotion and the promotion of cotton and man-made fibres but not by non-apparel wool promotion. Similarly, the demand for non-apparel wool is assumed to be influenced by its own promotion, the promotion of cotton and man-made fibres, but not by the promotion of apparel wool. The demand for cotton and man-made fibres, however, are assumed to be affected by their own promotion as well as the promotion of all other competing fibres. It is also thought that the relative fibre prices of all the competing fibres would impact on the production decisions and, therefore, the fibre inputs used by international textile manufacturers.

Australian domestic promotion of apparel wool is funded by the domestic body of the IWS whereas promotion of non-apparel wool is undertaken by the New Zealand Wool Board. International wool promotional activities are undertaken by the IWS, with by far the greatest proportion being directed to apparel wool.

Promotion of cotton in Australia is the responsibility of the Australian Cotton Foundation. However, over the past three years, cotton promotion has been reduced because of the drought. From 1966 until recently, international cotton promotion has been undertaken by the International Institute for Cotton (IIC), an inter-governmental international association of cotton producing countries, which concentrated its efforts on Japan and Western Europe.

The IIC is no longer operational. The other major international cotton promotional body is Cotton Incorporated in the United States. Cotton Incorporated is a cotton farmer-supported organisation which was formed in 1971. The largest share of Cotton Incorporated's spending has been on promotion in the United States market but some promotional activities have also been undertaken in Asia and Europe.

Research and promotional activities by the man-made fibres industry are undertaken by the manufacturers and are believed to be significantly greater than that for either wool or cotton. For example, it was estimated that Dupont alone spent (US)$85m in consumer promotion in 1992 and approximately (US)$4.5m on the promotion of new micro fibres (Cotton Incorporated 1992).

With regard to supply, apparel and non-apparel wool are considered to be substitutable at the margin but neither wool type is assumed to be substitutable with cotton or man-made fibres. Therefore, while the relative prices of apparel and non-apparel wool may influence the production decisions of a wool producer, it is assumed that the price of cotton and man-made fibres will not affect the amount of wool being produced. Similarly, the supply of cotton and the supply of man-made fibres are expected to be a function of their own price but not a function of the price of competing fibres.

The model is specified as follows:

(1a) $D^d_a = D^d_a\,(P_a, P_n, P_c, P_m, A^d_a, A^d_c, A^d_m, Z_1)$ (domestic demand for apparel wool)

(1b) $D^e_a = D^e_a\,(P_a, P_c, P_m, A^e_a, A^e_c, A^e_m, Z_2)$ (export demand for apparel wool)

(1c) $D^d_n = D^d_n\,(P_a, P_n, P_c, P_m, A^d_n, A^d_c, A^d_m, Z_3)$ (domestic demand for non-apparel wool)

(1d) $D^d_c = D^d_c\,(P_a, P_n, P_c, P_m, A^d_a, A^d_n, A^d_c, A^d_m, Z_4)$ (domestic demand for cotton)

(1e) $D^e_c = D^e_c\,(P_a, P_n, P_c, P_m, A^e_a, A^e_n, A^e_c, A^e_m, Z_5)$ (export demand for cotton)

(1f) $D^d_m = D^d_m\,(P_a, P_n, P_c, P_m, A^d_a, A^d_n, A^d_c, A^d_m, Z_6)$ (domestic demand for man-made fibres)

(1g) $D^e_m = D^e_m\,(P_a, P_n, P_c, P_m, A^e_a, A^c_n, A^e_c, A^e_m, Z_7)$ (export demand for man-made fibres)

(1h) $S_a = S_a\,(P_a, P_n, Z_8)$ (supply of apparel wool)

(1i) $S_n = S_n\,(P_a, P_n, Z_9)$ (supply of non-apparel wool)

(1j) $S_c = S_c\,(P_c, Z_{10})$ (supply of cotton)

(1k) $S_m = S_m\,(P_m, Z_{11})$ (supply of man-made fibres)

(1l) $D^d_a + D^e_a - S_a = 0$ (apparel wool market clearance)

(1m) $D^d_n - S_n = 0$ (non-apparel wool market clearance)

(1n) $D^d_c + D^e_c - S_c = 0$ (cotton market clearance)

(1o) $D^d_m + D^e_m - S_m = 0$ (man-made fibre market clearance)

where D, S, P, and A are the quantity demanded, the quantity supplied, the fibre price and promotion expenditure, respectively. Other variables affecting individual fibre demand and supply are captured in the Z_i (i=1,...,11) vectors. The subscripts, a, n, c, and m relate to apparel wool, non-apparel wool, cotton, and man-made fibres, while the superscripts, d and e refer to the domestic and export markets, respectively.

This model is a static model with all lagged or carryover effects being captured in an assumed three-year adjustment period. A three-year period was chosen to allow supply and demand prices and quantities, which are endogenous in this model, to adjust to changes in promotion or other variable in the Z_i vector, the exogenous variables.

Substituting equations (1a) through to (1k) into the market clearing equations (1l) to (1o) gives:

(2a) $D^d_a(P_a, P_n, P_c, P_m, A^d_a, A^d_c, A^d_m, Z_1) + D^e_a(P_a, P_c, P_m, A^e_a, A^e_c, A^e_m, Z_2) - S_a(P_a, P_n, Z_8) = 0$

(2b) $D^d_n(P_a, P_n, P_c, P_m, A^d_n, A^d_c, A^d_m, Z_3) - S_n(P_a, P_n, Z_9) = 0$

(2c) $D^d_c(P_a, P_n, P_c, P_m, A^d_a, A^d_n, A^d_c, A^d_m, Z_4) + D^e_c(P_a, P_n, P_c, P_m, A^e_a, A^e_n, A^e_c, A^e_m, Z_5) - S_c(P_c, Z_{10}) = 0$

(2d) $D^d_m(P_a, P_n, P_c, P_m, A^d_a, A^d_n, A^d_c, A^d_m, Z_6) + D^e_m(P_a, P_n, P_c, P_m, A^e_a, A^e_n, A^e_c, A^e_m, Z_7) - S_m(P_m, Z_{11}) = 0$

4.3 Impacts on Equilibrium Prices and Quantities

As previously stated, equilibrium displacement analysis requires endogenous and exogenous variables to be measured in proportionate terms. The first step is to totally differentiate equations (2a) through to (2d) and convert the resulting differentials to elasticities or proportionate values. Because the purpose of this analysis is to assess the impact of a change in wool promotion expenditure, the value of all exogenous variables other than promotion are assumed to remain constant. This is achieved by setting the differentials for these variables to zero. To enable the model to be solved using matrix algebra, the promotion effects are moved to the RHS. Implementing all three steps gives:

(3a)
$$EP_a[\rho_a \eta^d_{aa} + (1-\rho_a)\eta^e_{aa} - \varepsilon_{aa}] + EP_n[\rho_a \eta^d_{an} - \varepsilon_{an}] + EP_c[\rho_a \eta^d_{ac} + (1-\rho_a)\eta^e_{ac}]$$
$$+ EP_m[\rho_a \eta^d_{am} + (1-\rho_a)\eta^e_{am}] = EA^d_a[-\rho_a \beta^d_{aa}] + EA^d_c[-\rho_a \beta^d_{ac}] + EA^d_m[-\rho_a \beta^d_{am}]$$
$$+ EA^e_a[-(1-\rho_a)\beta^e_{aa}] + EA^e_c[-(1-\rho_a)\beta^e_{ac}] + EA^e_m[-(1-\rho_a)\beta^e_{am}]$$

(3b)
$$EP_a[\eta^d_{na} - \varepsilon_{na}] + EP_n[\eta^d_{nn} - \varepsilon_{nn}] + EP_c[\eta^d_{nc}] + EP_m[\eta^d_{nm}]$$
$$= EA^d_n[-\beta^d_{nn}] + EA^d_c[-\beta^d_{nc}] + EA^d_m[-\beta^d_{nm}]$$

(3c)
$$EP_a[\rho_c \eta^d_{ca} + (1-\rho_c)\eta^e_{ca}] + EP_n[\rho_c \eta^d_{cn} + (1-\rho_c)\eta^e_{cn}]$$
$$+ EP_c[\rho_c \eta^d_{cc} + (1-\rho_c)\eta^e_{cc} - \varepsilon_{cc}] + EP_m[\rho_c \eta^d_{cm} + (1-\rho_c)\eta^e_{cm}]$$
$$= EA^d_a[-\rho_c \beta^d_{ca}] + EA^d_n[-\rho_c \beta^d_{cn}] + EA^d_c[-\rho_c \beta^d_{cc}] + EA^d_m[-\rho_c \beta^d_{cm}]$$
$$+ EA^e_a[-(1-\rho_c)\beta^e_{ca}] + EA^e_n[-(1-\rho_c)\beta^e_{cn}] + EA^e_c[-(1-\rho_c)\beta^e_{cc}]$$
$$+ EA^e_m[-(1-\rho_c)\beta^e_{cm}]$$

(3d)
$$EP_a[\rho_m \eta^d_{ma} + (1-\rho_m)\eta^e_{ma}] + EP_n[\rho_m \eta^d_{mn} + (1-\rho_m)\eta^e_{mn}]$$
$$+ EP_c[\rho_m \eta^d_{mc} + (1-\rho_m)\eta^e_{mc}] + EP_m[\rho_m \eta^d_{mm} + (1-\rho_m)\eta^e_{mm} - \varepsilon_{mm}]$$
$$= EA^d_a[-\rho_m \beta^d_{ma}] + EA^d_n[-\rho_m \beta^d_{mn}] + EA^d_c[-\rho_m \beta^d_{mc}] + EA^d_m[-\rho_m \beta^d_{mm}]$$
$$+ EA^e_a[-(1-\rho_m)\beta^e_{ma}] + EA^e_n[-(1-\rho_m)\beta^e_{mn}] + EA^e_c[-(1-\rho_m)\beta^e_{mc}] + EA^e_m[-(1-\rho_m)\beta^e_{mm}]$$

where EP_i and EA_i are the proportionate change in price and promotion expenditure, respectively, for commodity i (defined, for any commodity i, as $(i_1 - i_0)/i_0$ where the subscripts 0, 1 are the old and new values respectively); ρ_i is the proportion of commodity i sold on the Australian market; η_{ij} is the elasticity of demand for commodity i with respect to the price of commodity j; ε_{ij} is the elasticity of supply for commodity i with respect to the price of commodity j; β_{ij} is the elasticity of demand for commodity i with respect to promotion expenditure on commodity j; the subscripts a, n, c, and m and the superscripts d and e, are as previously stated.

Equations (3a) through (3d) can be written in terms of a matrix equation:

(4) $\quad Ay = Bx$

where:

$$A = \begin{bmatrix} \rho_a \eta^d_{aa} + (1-\rho_a)\eta^e_{aa} - \varepsilon_{aa} & \rho_a \eta^d_{an} - \varepsilon_{an} & \rho_a \eta^d_{ac} + (1-\rho_a)\eta^e_{ac} & \rho_a \eta^d_{am} + (1-\rho_a)\eta^e_{am} \\ \eta^d_{na} - \varepsilon_{na} & \eta^d_{nn} - \varepsilon_{nn} & \eta^d_{nc} & \eta^d_{nm} \\ \rho_c \eta^d_{ca} + (1-\rho_c)\eta^e_{ca} & \rho_c \eta^d_{cn} + (1-\rho_c)\eta^e_{cn} & \rho_c \eta^d_{cc} + (1-\rho_c)\eta^e_{cc} - \varepsilon_{cc} & \rho_c \eta^d_{cm} + (1-\rho_c)\eta^e_{cm} \\ \rho_m \eta^d_{ma} + (1-\rho_m)\eta^e_{ma} & \rho_m \eta^d_{mn} + (1-\rho_m)\eta^e_{mn} & \rho_m \eta^d_{mc} + (1-\rho_m)\eta^e_{mc} & \rho_m \eta^d_{mm} + (1-\rho_m)\eta^e_{mm} - \varepsilon_{mm} \end{bmatrix}$$

y (transposed) = $[EP_a \; EP_n \; EP_c \; EP_m]$

$$B = \begin{bmatrix} -\rho_a\beta^d_{aa} & 0 & -\rho_a\beta^d_{ac} & -\rho_a\beta^d_{am} & -(1-\rho_a)\beta^e_{aa} & 0 & -(1-\rho_a)\beta^e_{ac} & -(1-\rho_a)\beta^e_{am} \\ 0 & -\beta^d_{nn} & -\beta^d_{nc} & -\beta^d_{nm} & 0 & 0 & 0 & 0 \\ -\rho_c\beta^d_{ca} & -\rho_c\beta^d_{cn} & -\rho_c\beta^d_{cc} & -\rho_c\beta^d_{cm} & -(1-\rho_c)\beta^e_{ca} & -(1-\rho_c)\beta^e_{cn} & -(1-\rho_c)\beta^e_{cc} & -(1-\rho_c)\beta^e_{cm} \\ -\rho_m\beta^d_{ma} & -\rho_m\beta^d_{mn} & -\rho_m\beta^d_{mc} & -\rho_m\beta^d_{mm} & -(1-\rho_m)\beta^e_{ma} & -(1-\rho_m)\beta^e_{mn} & -(1-\rho_m)\beta^e_{mc} & -(1-\rho_m)\beta^e_{mm} \end{bmatrix}$$

and

x (transposed) = $[EA^d_a \; EA^d_n \; EA^d_c \; EA^d_m \; EA^e_a \; EA^e_n \; EA^e_c \; EA^e_m]$

Now define vector C as:

$$(5)\quad C = \left[\frac{1}{EA^d_a} \; \frac{1}{EA^d_n} \; \frac{1}{EA^d_c} \; \frac{1}{EA^d_m} \; \frac{1}{EA^e_a} \; \frac{1}{EA^e_n} \; \frac{1}{EA^e_c} \; \frac{1}{EA^e_m} \right]$$

where it is assumed that $EA_i \neq 0$.

Then post-multiply both sides of equation (4) by the row vector C and, to satisfy the initial assumption that only one promotion variable will change at any one time, set the ratio of proportionate changes of any two promotion variables to zero. This will yield;

(6) $\quad AG = BI$

where;

$$G = \begin{bmatrix} \pi(P_a,A^d_a) & \pi(P_a,A^d_n) & \pi(P_a,A^d_c) & \pi(P_a,A^d_m) & \pi(P_a,A^e_a) & \pi(P_a,A^e_n) & \pi(P_a,A^e_c) & \pi(P_a,A^e_m) \\ \pi(P_n,A^d_a) & \pi(P_n,A^d_n) & \pi(P_n,A^d_c) & \pi(P_n,A^d_m) & \pi(P_n,A^e_a) & \pi(P_n,A^e_n) & \pi(P_n,A^e_c) & \pi(P_n,A^e_m) \\ \pi(P_c,A^d_a) & \pi(P_c,A^d_n) & \pi(P_c,A^d_c) & \pi(P_c,A^d_m) & \pi(P_c,A^e_a) & \pi(P_c,A^e_n) & \pi(P_c,A^e_c) & \pi(P_c,A^e_m) \\ \pi(P_m,A^d_a) & \pi(P_m,A^d_n) & \pi(P_m,A^d_c) & \pi(P_m,A^d_m) & \pi(P_m,A^e_a) & \pi(P_m,A^e_n) & \pi(P_m,A^e_c) & \pi(P_m,A^e_m) \end{bmatrix}$$

and I = the 8* 8 identity matrix. The elements of the G matrix are general equilibrium elasticities, π. These elasticities show the percentage change in a price variable associated with a one per cent change in a promotion variable, assuming all other promotion variables remain unchanged, but after full economic adjustment has occurred. The G matrix is given by:

(7) $\quad G = A^{-1} B$

where A^{-1} is the inverse of A, and A is non-singular.

This analysis can be extended to obtain general equilibrium elasticities for the fibre quantity variables with respect to any of the promotion variables. The general equilibrium elasticities for each fibre quantity can be obtained through the total differentiation of the supply equation and are given by:

(8) $\pi(Q_a, A_i) = \varepsilon_{aa}\,\pi(P_a, A_i) + \varepsilon_{an}\,\pi(P_n, A_i)$

(9) $\pi(Q_n, A_i) = \varepsilon_{nn}\,\pi(P_n, A_i) + \varepsilon_{na}\,\pi(P_a, A_i)$

(10) $\pi(Q_c, A_i) = \varepsilon_{cc}\,\pi(P_c, A_i)$

(11) $\pi(Q_m, A_i) = \varepsilon_{mm}\,\pi(P_m, A_i)$

where Q_i is the equilibrium quantity demanded and supplied for variable i, A_i is promotion expenditure for variable i and the subscripts a, n, c and m are as previously defined. These total elasticities can be interpreted as the percentage change in the equilibrium quantity resulting from a one per cent change in a promotion variable, assuming all other promotion variables remain unchanged but allowing for full economic adjustment of all endogenous variables.

In the real world, in any given time period, it is unlikely that only one promotion variable will change while all other promotion variables are held constant. It is more realistic to assume that changes in apparel wool, non-apparel wool, cotton and man-made fibre promotion expenditure will change simultaneously. Extension of the above analysis enables proportional changes in the price or quantity for commodity k, given simultaneous changes in promotion variables, to be derived, such that:

(12) $EP_k = \sum_i \pi(P_k, A_i)\, EA_i$; and (proportional change in price)

(13) $EQ_k = \sum_i \pi(Q_k, A_i)\, EA_i$ (proportional change in quantity)

where k = apparel wool, non-apparel wool, cotton, or man-made fibres and Σ is the summation operator.

4.4 Impacts on Revenue

General equilibrium elasticities for other variables can be calculated by an appropriate combination of the total elasticities already derived. The general equilibrium elasticities of revenue earned for any commodity k, with respect to any single promotion variable A_i, are simply the sums of the corresponding total elasticities for price and quantity. Therefore:

(14) $\pi(R_k, A_i) = \pi(P_k, A_i) + \pi(Q_k, A_i)$

where R_k is the total revenue earned from commodity k. In the case of multiple promotion expenditure changes, the proportionate change in total revenue for any commodity k can be determined as:

(15) $ER_k = \sum_i \pi(R_k, A_i)\, EA_i$.

4.5 Impacts on Profits

In this analysis, profits are interpreted as being net of the cost of promotion. Incremental promotion expenditure of wool may result in changes in the profits accruing to wool producers because of shifts in the supply function due to changes in the price of related products, or because of movements along the supply function as a result of shifts in the demand for wool. Incremental wool promotion expenditure for other fibres may also impact on the profits accruing to the wool industry. Measurement of these profits, therefore, has to account for a number of possibilities in terms of shifts in, and movements along, supply and demand functions.

As shown by Piggott, Piggott and Wright (1993), assuming linear supply functions that intersect the price axis and always move in a parallel manner simplifies the measurement of profit changes due to incremental promotion expenditure. How realistically linear supply equations represent the true economic relationship will depend on the relationship in question. The assumption of a relatively elastic supply curve may, however, be harder to accept. Nevertheless, as the analysis in this model assumes a time period long enough to allow for the supply response to be complete, and as logic would dictate a minimum price must exist before any supply of fibre would be forthcoming, a relatively elastic supply function is considered to be appropriate.

Piggott, Piggott and Wright (1993) show that the producer surplus for any commodity k that has a linear supply function and a positive price-axis intercept can be measured as:

$$(16) \quad PS_k = 0.5\, P_k Q_k / \varepsilon_k = 0.5\, R_k / \varepsilon_k$$

where ε_k is the own price elasticity of supply and is measured at the initial equilibrium price and quantity. In addition, the proportional change in producer surplus, EPS_k, can be calculated as:

$$(17) \quad EPS_k = 2\, EQ_k + (EQ_k)^2$$

so long as the shifts in the supply curves are parallel and result in positive price-axis intercepts.

Now, because in equation (13) the proportionate change in the quantity of commodity k, EQ_k, is linear with respect to the proportionate change in promotion expenditure, EA_i, EPS_k will be related to the square of the proportionate change in the promotion variables. Hence, if A_k varies while the other promotion variables remain constant, then from equation (13):

$$(18) \quad EQ_k = \pi(Q_k, A_k)\, EA_k$$

and from equation (17):

$$(19) \quad EPS_k = 2\, \pi(Q_k, A_k)\, EA_k + [\pi(Q_k, A_k)]^2\, [EA_k]^2.$$

Therefore, dividing through by EA_k gives:

$$(20) \quad EPS_k / EA_k = 2\, \pi(Q_k, A_k) + [\pi(Q_k, A_k)]^2\, [EA_k].$$

In words, equation (20) shows that, for any commodity k, the general equilibrium elasticity of the producer surplus with respect to promotion is a function of the proportionate change in promotion expenditure.

As stated previously, the profit level, χ, for any industry, k, is equal to the producer surplus for that industry net of the promotion expenditure spent in that industry. Therefore:

(21) $\chi_k = PS_k - A_k$.

Following from this, the proportional change in profits is given by:

(22) $E\chi_k = EPS_k (PS_k / \chi_k) - EA_k (A_k / \chi_k)$.

Hence, when the level of profits in any industry k changes because of a change in promotional expenditure in industry k, the proportional change in industry k's profits, and the general equilibrium elasticity of that industry's profits with respect to its promotion expenditure, will be a function of that industry's promotion expenditure because of the relationship presented in equation (19).

5. Implementation of the Model

5.1 Data

All data used in this model were for the financial years 1991/1992 to 1993/94, with the exception of data published by the United States government or United States companies. Data obtained from the United States relates to the calendar years 1991 to 1993.

Production, consumption and export data for wool and cotton were obtained from three Australian Bureau of Agricultural and Resource Economics (ABARE) publications: the *Commodity Statistical Bulletin 1994*, *Outlook 1994* and *Australian Commodities*. A breakup of apparel and non-apparel Australian wool production, consumption and export data was calculated from total wool data. The unit export value of apparel wool and cotton and the market price for 30 micron wool were also obtained from the ABARE publications. Australian consumption of man-made fibres for 1990 was obtained from Coleman and Thigpen (1991). Estimates of Australian production and exports were derived from this figure. The price of polyester in the United States was used as a proxy for the world price of man-made fibres. These data were obtained from the United States Department of Agriculture (USDA) publication, *Cotton and Wool Situation and Outlook Report*.

Promotional expenditure data for apparel and non-apparel wool were obtained from the International Wool Secretariat (per. comm. 1994). An estimate of domestic promotional expenditure was provided by the Australian Cotton Foundation (per. comm 1994). International cotton promotion expenditure data were obtained from the 1991, 1992 and 1993 *Annual Reports* of Cotton Incorporated (1991). Information contained in these annual reports, in *Cotton Research and Promotion Booster Program* (Cotton Incorporated 1992), and in *Wool: Structuring for Global Realities* (Wool Industry Review Committee 1993) was used to estimate promotional expenditure on man-made fibres.

5.2 Implementing the Approximations

A number of data requirements needed to be met before the model could be implemented. To obtain the general equilibrium price elasticities, the proportions of apparel wool, non-apparel wool, cotton and man-made fibres sold on the domestic market were obtained, as well as a base set of Marshallian price and promotion elasticities for each of the commodities. The general equilibrium quantity and revenue elasticities were calculated from the general equilibrium price elasticities. The general equilibrium producer surplus elasticities were derived, for each fibre, using the respective general equilibrium quantity

Table 5.1: Base elasticity matrix

Dependent Variable	Elasticity with respect to:											
	Apparel wool price	Non-apparel price	Cotton Price	Man-made fibre price	Domestic apparel wool promotion	Domestic non-apparel wool promotion	Domestic cotton promotion	Domestic man-made fibre promotion	Export apparel wool promotion	Export non-apparel wool promotion	Export cotton promotion	Export man-made fibres promotion
Domestic apparel wool demand	-0.70	0.05	0.20	0.30	0.40	0.00	-0.10	-0.10	0.00	0.00	0.00	0.00
Export apparel wool demand	-0.90	0.00	0.30	0.40	0.00	0.00	0.00	0.00	0.40	0.00	-0.20	0.20
Domestic non-apparel wool demand	0.10	-0.70	0.20	0.30	0.00	0.20	-0.10	-0.20	0.00	0.00	0.00	0.00
Domestic cotton demand	0.05	0.01	-0.20	0.05	-0.10	-0.10	0.40	-0.20	0.00	0.00	0.00	0.00
Export cotton demand	0.10	0.05	-0.40	0.10	0.00	0.00	0.00	0.00	-0.10	-0.10	0.40	-0.30
Domestic man-made fibre demand	0.10	0.15	0.10	-0.40	-0.10	-0.20	-0.20	0.40	0.00	0.00	0.00	0.00
Export man-made fibre demand	0.15	0.30	0.15	-0.70	0.00	0.00	0.00	0.00	-0.20	-0.10	-0.30	0.50
Apparel wool supply	1.40	-0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-apparel wool supply	-0.60	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cotton supply	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Man-made fibre supply	0.00	0.00	0.00	1.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: BAE 1987; Ball, Beare and Harris1989; Coleman and Thigpen 1991; Conboy 1992; Connolly 1990; Connolly 1992; Dewbre, Vlastuin and Ridley 1986; Griffith and Goddard 1993; Harris 1988; Mullen, Alston and Wohlgenant 1989; Muse and Simmons 1988; and authors' judgement.

elasticities and the proportionate change in promotion expenditure. The general equilibrium profit elasticities for each commodity were calculated from the respective proportionate changes in producer surplus and promotion expenditure and base values for the producer surplus, profits and promotion expenditures.

The Marshallian price elasticities for demand were based on estimated elasticities provided in a wide range of studies (Ball, Beare and Harris 1989; BAE 1987; Coleman and Thigpen 1991; Conboy 1992; Connolly 1990; Connolly 1992; Dewbre, Corra and Passmore 1983; Dewbre, Vlastuin and Ridley 1986; Griffith and Goddard 1993; Harris 1988; Mues and Simmons 1988; Mullen, Alston and Wohlgenant 1989; Simmons and Ridley 1987). Where estimates were not available (for example, the cross-price elasticity of demand for Australian wool with respect to the price of Australian cotton) the elasticities were extrapolated from other elasticities. The price elasticities of supply of wool, cotton and man-made fibres are believed to be positive. Positive supply elasticities are thought to be consistent with the three year time period, as producers would be able to adjust to price changes. Moreover, the supply of man-made fibres is expected to be more responsive to price changes because production of man-made fibres is not affected by biological lags. The Marshallian base elasticities are presented in Table 5.1.

As pointed out by Conboy (1992), there is a diversity of approaches to analysing the effect of promotion on consumer demand. This results in considerable uncertainty regarding the magnitude of promotion elasticities (Piggott, Piggott and Wright 1993). While promotion elasticities for the demand for wool in various regions have been estimated in a number of recent studies, no empirical work has been done on estimating the impact of fibre promotion

Table 5.2: Assumed base quantities, prices and revenues for the years 1991/92-1993/94

Commodity	Quantity kt	Unit Value $/t	Total revenue $m
Domestic Apparel Wool	21	3795	79.7
Export Apparel Wool	2674	3795	10147.8
Domestic Non-apparel Wool	27	2671	72.1
Domestic Cotton	86	1987	170.9
Export Cotton	1189	1987	2362.5
Domestic Man-made fibres	70	2180	152.6
Export Man-made fibres	700	2180	1526.0

Source: ABARE 1994a; ABARE 1994c; USDA 1994; Cotton Incorporated 1992; Wool Industry Review Committee 1993 on the demand for cotton or man-made fibres. In this analysis, promotion elasticities for wool, cotton and man-made fibres have been based on the promotion elasticities for wool estimated by the BAE (1987), Conboy (1992) and Griffith and Goddard (1993). It is also assumed that negative cross-commodity impacts of promotion would exist. Given that a three-year time horizon underlies this analysis, the promotion elasticities used in this study and the existence of negative cross-promotional effects are reasonable.

The base prices, quantities and revenues are presented in Table 5.2. As detailed in the previous section, the data relating to wool and cotton were obtained from publications produced by the ABARE. Data on man-made fibres were derived from the USDA publications, Coleman and Thigpen (1991), or estimated from the information gleaned.

The base promotion expenditure data are presented in Table 5.3. The figures for apparel wool, non-apparel wool and cotton are consistent with the published data. As discussed in the previous section, limited data are available on promotion expenditure on man-made fibres. As a result, the base promotion data were estimated based on the belief that manufacturers of man-made fibres generally outspend the wool industry on research andpromotion by three to one (Wool Industry Review Committee 1993). Cotton Incorporated (1992) also stated that synthetic fibre manufacturers spend considerably more

Table 5.3: Assumed Australian base promotion expenditure: amounts and percentages of total by type of promotion, average of the three year period ending 1993/1994

Commodity	Apparel Wool		Non-apparel Wool		Cotton		Man-made Fibres	
	$M	%	$M	%	$M	%	$M	%
Domestic Apparel Wool	5.9	1						
Export Apparel Wool	410.1	99						
Domestic Non-apparel Wool			3.5	8				
Export Non-apparel Wool [a]			38.6	92				
Domestic cotton [b]					0.5	0.7		
Export cotton [a]					76.0	99.3		
Domestic man-made fibres [b]							15.0	1
Export man-made fibres [ab]							1500.0	99

a Australian producers do not contribute to export promotion expenditure for these commodities.

b These figures are estimates.

money on marketing and promotion than cotton producer organisations. For example, in 1992 Cotton Incorporated spent around $30m while Dupont alone spent almost $90m. The proportion of man-made fibres sold on the domestic market was assumed to be similar to the proportion for wool and cotton.

Clearly, the data being used in this analysis are imperfect. However, this deficiency is offset, at least in part, by the fact that the analysis which follows can be repeated using alternative estimates of key parameters and magnitudes.

5.3 General Equilibrium Promotion Elasticities

The calculated general equilibrium elasticities, presented in Table 5.4, show the percentage change in an endogenous variable in response to a one per cent change in promotion expenditure for a given commodity, holding all other promotion variables constant but allowing for complete adjustment of all endogenous variables. For example, given the base parameter values, a one per cent increase in promotion expenditure on apparel wool on the export market would result in a 0.16 per cent increase in the price of apparel wool, a 0.04 per cent increase in the price of non-apparel wool, a 0.04 per cent fall in the price of cotton and a 0.06 per cent fall in the price of man-made fibres. The general equilibrium quantity and revenue elasticities can be interpreted in a similar manner.

The signs of the general equilibrium elasticities depend on a complex pattern of cross-commodity price and promotional relationships. For example, increased promotional expenditure on apparel wool will, as a 'first-round' affect, cause the demand for apparel wool to shift right and the price of apparel wool to increase. As a 'second-round' effect, the demand for a substitute (e.g. cotton) can be expected to shift rightward (because the price of apparel wool is now at a higher level) causing the price of cotton to increase. This effect will lead to further adjustments in the apparel wool market. All of this is complicated further through any cross-price relationships in supply.

The signs of the general equilibrium producer surplus elasticities are not always readily determinable from the directional movements of the price and quantity elasticities for a particular commodity. For example, in the case of export promotion of man-made fibres, the general equilibrium price elasticity for non-apparel wool is negative while the quantity elasticity is positive and the corresponding producer surplus elasticity is also positive. As stated by Piggott, Piggott and Wright (1993, p. 13), 'One needs to trace through the pattern of shifts in each commodities demand and supply functions using directional movements in equilibrium prices and quantities to determine the relative sizes of these shifts.'

With regard to profit elasticities, it should be noted that while promotion expenditure may have a positive impact on producer surplus, it may have a negative impact on producer profits. This is because the increase in producer surplus may be less than the increase in promotion expenditure. Examples of this situation include domestic promotion of all textile fibres.

Sensitivity analysis can be employed to determine just how sensitive the results are to the base parameter values. In principle, sensitivity analysis could be undertaken for every base parameter used in the model. However, given the large number of parameters in this model, sensitivity analysis will be restricted to proportionate changes in the promotion expenditure and to changes in a few of the parameters. The sensitivity of profit elasticities to proportionate changes in promotion expenditure are presented in Table 5.5. With the exception of export promotion of non-apparel wool, a proportional increase in export promotion will cause an increase in the equilibrium profits for each of the fibres. In the case of all domestic promotion, however, an increase in the proportionate change of promotion for each of the fibres will lead to a fall in their respective equilibrium profit elasticities. Of particular interest to this study is the impact an increase in the proportionate change in export

Table 5.4: Base general equilibrium promotion elasticities

Dependent Variable	Promotion Variable							
	Domestic apparel wool A^d_a	Domestic non-apparel wool A^d_n	Domestic cotton A^d_c	Domestic man-made fibres A^d_m	Export apparel wool A^e_a	Export non-apparel wool A^e_n	Export cotton A^e_c	Export man-made fibres A^e_m
Price								
Apparel wool	*	0.004	-0.003	-0.005	0.158	-0.015	-0.081	-0.076
Non-apparel wool	-0.001	0.108	-0.055	-0.108	0.044	-0.018	-0.027	-0.017
Cotton	-0.004	-0.001	0.013	-0.010	-0.043	-0.053	0.187	-0.144
Man-made fibres	-0.004	0.005	-0.014	0.003	-0.061	-0.042	-0.106	0.167
Quantity								
Apparel wool	0.001	-0.002	*	0.002	0.217	-0.019	-0.112	-0.106
Non-apparel wool	-0.001	0.126	-0.064	-0.126	-0.042	-0.012	0.016	0.026
Cotton	-0.006	-0.001	0.019	-0.015	-0.065	-0.079	0.280	-0.216
Man-made fibres	-0.008	0.008	-0.025	0.005	-0.110	-0.076	-0.191	0.301
Revenue								
Apparel wool	0.001	0.002	-0.003	-0.003	0.375	-0.034	-0.193	-0.182
Non-apparel wool	-0.002	0.234	-0.118	-0.234	0.002	-0.030	-0.011	0.009
Cotton	-0.010	-0.001	0.032	-0.026	-0.108	-0.132	0.467	-0.359
Man-made fibres	-0.012	0.013	-0.039	0.008	-0.171	-0.119	-0.297	0.468
Producer surplus								
Apparel wool	*	-0.005	*	0.003	0.429	-0.039	-0.223	-0.211
Non-apparel wool	*	0.003	-0.001	-0.002	-0.001	*	*	0.001
Cotton	*	*	*	*	-0.001	-0.002	0.006	-0.004
Man-made fibres	*	*	*	*	-0.002	-0.001	-0.003	0.007
Profit								
Apparel wool	-0.002	-0.137	-0.001	-0.030	0.357	-0.039	-0.223	-0.211
Non-apparel wool	-0.002	-0.129	-0.002	-0.036	-0.128	*	*	0.001
Cotton	-0.002	-0.132	*	-0.034	-0.128	-0.002	0.006	-0.004
Man-made fibres	-0.002	-0.132	-0.001	-0.033	-0.129	-0.001	-0.003	0.007

Profits are net of promotion cost. * indicates that the general equilibrium elasticities are approaching zero.

Table 5.5: Sensitivity of profit elasticity to a percentage change in promotion variables

Commodity	Promotion Variable							
	Domestic Apparel Wool	Domestic Non-apparel Wool	Domestic Cotton	Domestic Man-made Fibres	Export Apparel Wool	Export Non-apparel Wool	Export Cotton	Export Man-made Fibres
	1 per cent change in expenditure							
Apparel Wool	-0.002	-0.137	-0.001	-0.030	0.357	-0.039	-0.223	-0.211
Non-apparel Wool	-0.002	-0.129	-0.002	-0.036	-0.128	*	*	0.001
Cotton	-0.002	-0.132	*	-0.034	-0.128	-0.002	0.006	-0.004
Man-made Fibres	-0.002	-0.132	-0.001	-0.033	-0.129	-0.001	-0.003	0.007
	5 per cent change in expenditure							
Apparel Wool	-0.009	-0.685	-0.003	-0.150	1.800	-0.194	-1.112	-1.053
Non-apparel Wool	-0.009	-0.640	-0.008	-0.175	-0.638	-0.001	0.002	0.003
Cotton	-0.009	-0.659	-0.001	-0.168	-0.640	-0.006	0.048	-0.010
Man-made Fibres	-0.009	-0.658	-0.005	-0.166	-0.642	-0.006	-0.010	0.053
	10 per cent change in expenditure							
Apparel Wool	-0.018	-1.371	-0.005	-0.300	3.617	-0.387	-2.219	-2.101
Non-apparel Wool	-0.018	-1.272	-0.014	-0.342	-1.274	-0.002	0.004	0.006
Cotton	-0.018	-1.319	-0.001	-0.335	-1.277	-0.010	0.135	0.003
Man-made Fibres	-0.018	-1.316	-0.010	-0.331	-1.278	-0.010	-0.002	0.151

Profits are net of promotion costs. * indicates that the general equilibrium elasticities are approaching zero.

Table 5.6: Sensitivity of profit elasticity to a change in parameter values with respect to a one per cent increase in promotion expenditure

Commodity	Promotion Variable							
	Domestic Apparel Wool	Domestic Non-apparel Wool	Domestic Cotton	Domestic Man-made Fibres	Export Apparel Wool	Export Non-apparel Wool	Export Cotton	Export Man-made Fibres
				Base	Values			
Apparel Wool	-0.002	-0.137	-0.001	-0.030	0.357	-0.039	-0.223	-0.211
Non-apparel Wool	-0.002	-0.129	-0.002	-0.036	-0.128	*	*	0.001
Cotton	-0.002	-0.132	*	-0.034	-0.128	-0.002	0.006	-0.004
Man-made Fibres	-0.002	-0.132	-0.001	-0.033	-0.129	-0.001	-0.003	0.007
				Promotion	Elasticities	Doubled		
Apparel Wool	-0.002	-0.142	*	-0.027	0.842	-0.077	-0.446	-0.422
Non-apparel Wool	-0.002	-0.125	-0.003	-0.038	-0.128	*	0.001	0.001
Cotton	-0.002	-0.132	*	-0.034	-0.129	-0.003	0.014	-0.007
Man-made Fibres	-0.002	-0.131	-0.002	-0.033	-0.131	-0.003	-0.006	0.016
				Supply	Elasticities	Doubled		
Apparel Wool	-0.004	-0.311	-0.001	-0.064	0.429	-0.026	-0.288	-0.275
Non-apparel Wool	-0.004	-0.299	-0.003	-0.072	-0.292	*	*	*
Cotton	-0.004	-0.304	-0.001	-0.069	-0.293	-0.002	0.007	-0.004
Man-made Fibres	-0.004	-0.304	-0.002	-0.068	-0.294	-0.002	-0.004	0.008
				Export	Demand	Elasticities	Doubled	
Apparel Wool	-0.002	-0.130	-0.003	-0.037	0.201	-0.049	-0.149	-0.145
Non-apparel Wool	-0.002	-0.129	-0.002	-0.036	-0.127	*	*	*
Cotton	-0.002	-0.132	*	-0.034	-0.128	-0.001	0.005	-0.003
Man-made Fibres	-0.002	-0.131	-0.001	-0.034	-0.128	-0.001	-0.003	0.005

Profits are net of promotion costs. * indicates that the general equilibrium elasticities are approaching zero.

promotion of apparel wool has on the equilibrium profit elasticity for apparel wool. The results show that the profit elasticity increases from 0.357 per cent to 3.617 per cent as the promotion variable is increased from one per cent to 10 per cent.

The effects of changing a number of parameters on the elasticity of profits with respect to a one per cent change in promotion variables are presented in Table 5.6. In relation to export apparel wool, doubling all of the promotion parameters will cause the equilibrium profit elasticities for apparel wool to rise, as will a doubling of the supply parameters. However, the effects of a doubling of the own-price and cross-price elasticities of export demand for all fibres results in reduced profits to the apparel wool industry.

5.4 General Equilibrium Promotion Elasticities With Competitive Promotion

5.4.1 Introduction

In a competitive market, changes in commodity prices, quantities and profits can result from changes in the promotion expenditure of a commodity, k, while promotion expenditure on related commodities remains unchanged. These changes are given by the general equilibrium elasticities in Table 5.4, for a one per cent change in promotion expenditure. Changes in the price, quantity and profit levels of commodity k can also result from changes in the promotion of one or more of the related commodities, while the promotion of commodity k remains unaltered. Alternatively, simultaneous changes in promotion expenditure on one or more of the related commodities and commodity k will also result in price, quantity and profit changes. Examples of the last two situations will be presented here.

5.4.2 Cross Impacts

The general equilibrium elasticities presented in Table 5.4 show the own and cross impacts on the prices, quantities, revenues, producer surplus and profits from a one per cent change in the promotion variable for a particular commodity. In a real world situation, it is feasible that the promotion of one commodity will remain constant while the promotion of related commodities will change, referred to as 'cross-impacts' by Piggott, Piggott and Wright (1993). By combining the equilibrium elasticities from Table 5.4, the cross-impacts of changes in promotion variables can be measured. Questions such as 'If export promotion of both cotton and synthetics were to increase by five per cent, while the promotion expenditure for export apparel wool was to remain constant, how would this effect profits accruing to wool producers?' can be answered.

Following the analysis provided by Piggott, Piggott and Wright (1993), if there is a five per cent increase in promotion expenditure for cotton and man-made fibres on the export market, but promotion of apparel wool remains constant, then equation (22) is changed so that:

(23) $E\chi_k = EPS_k(PS_k/\chi_k)$.

Substituting equation (17) into equation (23) gives:

(24) $E\chi_k = [2EQ_k + (EQ_k)^2]\ [PS_k/\chi_k]$.

In this example, from equation (18):

(25) $EQ_a = \pi(Q_a, A_c^e)\, EA_c^e + \pi(Q_a, A_m^e)\, EA_m^e$

Therefore, substituting equation (25) into equation (24) provides the answer to the question: a five per cent increase in the promotion expenditure of both export cotton and man-made fibres will result in a 2.44 per cent fall in profits to producers of apparel wool.

5.4.3 Catch-up Promotion

The general equilibrium elasticities presented in Table 5.4 can also be used to measure the effects of simultaneous changes in one or more promotion variables when the promotion of commodity k, is not held constant. This was referred to as 'catch-up advertising' by Piggott, Piggott and Wright (1993). In this case, the proportionate change in producer profits is given by:

$$(26) \quad E\chi_k = EPS_k(PS_k/\chi_k) - (A_k/\chi_k)\, EA_k$$

and substituting equation (17) into equation (26) gives:

$$(27) \quad E\chi_k = [2EQ_k + (EQ_k)^2]\ [PS_k/\chi_k] - (A_k/\chi_k)\, EA_k$$

In the situation where there is a five per cent increase in promotion expenditure for cotton and man-made fibres on the export market, and the promotion expenditure of apparel wool also increases by five per cent, then:

$$(28) \quad EQ_a = \pi(Q_a, A_a^e)\, EA_a^e + \pi(Q_a, A_c^e)\, EA_c^e + \pi(Q_a, A_m^e)\, EA_m^e$$

Therefore substituting equation (28) into (27) shows that if promotion expenditure for apparel wool, cotton and man-made fibres were all to increase by five per cent, then profits to apparel wool producers would decrease by 0.67 per cent.

6. Policy Implications

The principal aim of this paper was to demonstrate the potential of using EDM to assess the impact of wool promotion on wool producer incomes and profits. While 'best-bet' estimates of essential parameters were used in this demonstration, the data used were imperfect. Regardless, a number of preliminary policy implications can be drawn from the analysis. Of direct importance to policy makers in the wool industry are the indications that the comprehensive set of general equilibrium elasticities provide on the responsiveness of producer surplus and profits to a one per cent change in wool promotion expenditure, holding all other promotion variables constant but allowing for complete adjustment of all exogenous variables.

With regard to international wool promotion, the general equilibrium producer surplus and profit elasticities indicate that a one percent increase in wool promotion expenditure will result in a 0.43 per cent increase in apparel wool producer surplus and a 0.36 per cent increase in profits accruing to the apparel wool industry (Table 5.4). However, because of the interrelationships in the textile fibre industry, an increase in international apparel wool promotion will also impact on the non-apparel wool, cotton and man-made fibre industries. As can be seen from the general equilibrium producer surplus and profit elasticities presented in Table 5.4, a one percent increase in international apparel wool promotion will result in a decrease in producer surplus and profits accruing to competing fibre industries. In contrast, a one per cent increase in domestic promotion expenditure on apparel wool will result in decreased profits to the apparel wool industry. This is because the increase in promotion expenditure does not cause the producer surplus to change and so profits fall by the increased cost of promotion. Similarly when domestic promotion expenditure on non-apparel wool is increased by one per cent, profits to the non-apparel wool industry will fall. In sum, the implications of these results are that a one per cent increase in international promotion expenditure on apparel wool would have a positive impact on apparel wool industry profits, while a one per cent increase in domestic promotion expenditure on apparel (non-apparel) wool would have a negative impact on apparel (non-apparel) industry profits.

This analysis also provides information on the impact on wool industry profits when simultaneous changes in promotion expenditure on more than one of the related fibre commodities occurs. For example, using the general equilibrium elasticities, it can be shown that if export promotion of both cotton and man-made fibres were to increase by five per cent while the promotion expenditure for export apparel wool was to remain constant, profits to apparel wool producers would fall around 2.44 per cent. If policy makers in the wool industry want to offset the effects of increased international promotion of competing fibres, this analysis can be used to indicate the extent to which wool promotion expenditure will need to be increased. For example, as was shown in the previous section, if international promotion expenditure for apparel wool, cotton and man-made fibres were all to increase by five per cent, then profits to apparel wool producers would still fall, but by only around 0.67 per cent. Therefore to completely offset the impact of a five per cent increase in promotion of cotton and man-made fibres on producer profits, international promotion expenditure on apparel wool would need to be increased by more than five per cent.

Clearly EDM is a useful research tool that is suited to policy analysis. With regard to wool promotion activities, EDM can be used to answer questions relating to: the benefits or costs of incremental changes in domestic or international promotion expenditure; the impact that increased promotion expenditure on competing fibres will have on wool producer profits; and how the wool industry could best respond to a change in promotion expenditure by the competing textile industries.

7. Conclusions

7.1 Conclusions

The world textile industry is very competitive. While promotion expenditure of textile fibres on the domestic market is relatively minor, each year over $100m is spent internationally promoting apparel wool, non-apparel wool, cotton and man-made fibres. Australia is the world's largest producer and exporter of apparel wool. Australian wool producers contribute large sums of money annually to the IWS to be used to promote wool in the major importing countries.

The primary aim of this paper was to demonstrate the potential for EDM to be used as a means for assessing the impact of incremental wool promotion on producer returns and profits. The analysis undertaken showed that EDM is a very useful mathematical procedure that can aid policy decision making about incremental promotion expenditure on wool. 'Best-bet' estimates of the parameters were used in the model to determine the impact of promotion of wool and related textile fibres on wool producer returns and profits. The results of the analysis showed that a one per cent increase in the promotion of non-apparel wool on the domestic market would result in only a marginal increase in non-apparel wool producer surplus and a 0.13 per cent decrease in producer profits. A one per cent increase in domestic promotion of apparel wool would also result in only a marginal increase in the producer surplus of apparel wool producers and a fall in industry profits. On the export market a one per cent increase in the promotion of apparel wool would cause Australian producer surplus to increase by 0.43 per cent and profits to the Australian apparel wool industry to increase by 0.36 per cent.

The degree of accuracy of the estimated impacts is inversely related to the size of the change in the exogenous variable. This is because EDM is a mathematical technique based on differential calculus. It has been suggested that the degree of accuracy is high for changes in exogenous variables of 10 per cent or less (Alston and Wohlgenant 1990). A sensitivity analysis of the results for a one per cent, five per cent and 10 per cent change in the promotion variable was undertaken. With the exception of domestic textile fibres, producer profits were found to be directly related to the size of the promotion variable. Sensitivity of the results to changes in various parameters was also undertaken. In general, it was found that an increase in the promotion elasticities would result in an increase in profits accruing to the respective industries, that a doubling of the supply elasticity would also increase profits to apparel wool producers, but a doubling of export demand elasticities would have the opposite effect. EDM was also used in this study to determine how cross-commodity relationships affect the outcomes from changes in promotion expenditure. The results showed that if promotion expenditure for both cotton and man-made fibres, on the export market, was to increase by five per cent, while promotion of apparel wool remained constant, then profits to apparel wool producers in Australia would fall by 2.44 per cent. However, if export promotion of apparel wool was also to increase by five per cent, then the profits accruing to the apparel wool producers would fall by only 0.67 per cent.

7.2 Strengths and Limitations of Equilibrium Displacement Modelling

EDM is a mathematical technique that allows assessments to be made about the impacts on endogenous variables of small finite changes in exogenous variables. Because of the competitive nature of the textiles industry, the full impact of promotion on industry profits can only be measured if the cross-promotion effects on demand are accounted for, and supply is included in the analysis. EDM is a mathematical procedure that can be used to assess the impact of incremental wool promotional activities on equilibrium profits, by allowing for the cross-promotion effects of promotion of textile fibres, and the supply of all fibres, to be incorporated in the model. As such, EDM is a useful technique that can aid decision making about incremental promotion expenditure on wool.

While a traditional econometric approach can also account for cross-promotion effects and supply, a major benefit of using EDM is that it is comparatively cost-efficient in terms of data requirements and the time needed to 'fine-tune' econometric estimates. However, as stated previously, a reduction in the cost of research time and resources requires the analyst to be prepared to exercise informed judgement about the size of key parameters. Sensitivity analysis can accompany this 'judgement'.

A perceived limitation of EDM is that it provides only approximations to effects of changes in exogenous variables. It should be noted, however, that traditional econometric methods also provide only approximations. While the functional forms used in econometric models can be 'fine-tuned' using *a priori* reasoning and statistical tests, the 'true' functional form cannot be known with complete certainty (Piggott 1992).

Another criticism levelled at EDM is that the procedure uses linear approximations to measure the impacts on endogenous variables of finite changes in exogenous variables. It is argued that this being the case then why not just explicitly assume linear functional forms at the outset? The main reason is that while the technique provides exact results when the functional forms are linear, this does not justify the use of linear functional forms. It is better to state that the functional form is unknown and that the results are first-order approximations to any underlying functional form (Piggott 1992).

Finally, being a static technique, the paths of adjustment from one equilibrium period to another are not accounted for. However, adjustment paths are also ignored in most econometric modelling. In EDM, paths of adjustment could be incorporated into the analysis by repeated applications using different elasticities which correspond to the different lengths of time (Piggott, Parton, Treadgold and Hutabarat 1993).

7.3 Areas for Further Research

EDM requires the use of a base set of own- and cross-price demand and supply elasticities and promotion elasticities. In this study, while the assumed parameter values were based on elasticities derived from previous econometric studies, information on some elasticities was extremely limited, particularly with regard to promotion elasticities for cotton and man-made fibres. Further simulations could be undertaken to determine the impact of various changes of promotion and other key parameters on the results of the model. This would indicate areas where further econometric estimation of key parameters could be undertaken, if time and resources permit. These 'new' econometric parameters could improve the accuracy of the model in assessing the impact of incremental wool promotion on producer incomes and profits.

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