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MODELLING THE AUSTRALIAN WOOL CORPORATION'S COSTS AND REVENUES UNDER THE RESERVE PRICE SCHEME FOR WOOL

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The market intervention activities of the Australian Wool Corporation are financed from its Market Support Fund. Growers contribute to the Fund by a levy on their wool sales; the contributions of some early years have now been reimbursed, and this 'revolvement' is continuing. An econometric model is reported in which the various cost and revenue items which comprise the operation of the Fund are represented. Using the output of a model which forecasts wool prices and stocks (such as the Bureau's EMABA model), this financial model can be used to determine the costs associated with alternative settings of the minimum reserve price, and to assess the adequacy of the Fund to meet the Corporation's intervention requirements given alternative levy rates and revolvement decisions.

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Since 1972 one of the tasks of the Australian Wool Corporation has been to administer a reserve price scheme aimed at stabilising returns to Australian wool growers. The Corporation purchases wool at auction, and maintains stocks, so as to support prices at reserve levels. It buys at a published minimum reserve price for each wool grade (also termed the floor price), and may also apply 'flexible' reserve prices from time to time.

Under the current form of the scheme, which has operated since September 1974, any losses incurred in the buying, storage and sale of this wool are met from a separate Market Support Fund, to which wool growers contribute through a tax on the sale value of their shorn wool. The Corporation also draws on the Fund to finance its wool purchases, as an alternative to commercial borrowings. Fund moneys not required in the short term to meet market intervention requirements are loaned out; as the size of the Fund grows this is an increasingly important source of revenue for operating the scheme.

The purpose of setting reserve wool prices is to reduce growers' uncertainty as to the prices obtainable. In effect, price uncertainty that would otherwise face individual growers is transformed into uncertainty about the Corporation's stock levels, and hence about the amounts of finance it will require from the Fund. The level of the Fund can be manipulated to cover the range of possible requirements by changing the tax contribution rate or by returning moneys to the original contributors. In 1982, the Fund began to exceed requirements, enabling regular 'revolvements' (that is, repayments of one or more years' contributions, in full) and, in the 1986-87 season, a lowering of the contribution rate for the first time since the introduction of the scheme.

The purpose of this paper is to describe a financial model used in formulating the Bureau's annual advice on the operation of the reserve price scheme (see BAE 1987). This advice includes estimates of the expected costs to the Corporation associated with alternative settings of the minimum reserve price, and assessments of the ability of the Fund to meet market intervention requirements given different reserve price settings, grower contribution rates and revolvement decisions. Typically, the Bureau's analysis requires medium term assessments of these variables for many different possible market conditions. The model enables these assessments to be made quickly and in a reasonably rigorous fashion.

It is an econometric model, designed to employ the output of another model which forecasts wool production, prices and stocks, such as the Bureau's Econometric Model of Australian Broadacre Agriculture, EMABA (Dewbre, Shaw, Corra and Harris 1985). The financial model is made up of equations whereby, given these production and market variables, the various costs and revenues related to the storage, handling and selling of market support wool can be determined, and hence forecasts can be made of the level of the Fund.

In the next section of this paper, necessary background is presented. This includes details of the operation of the reserve price scheme and discussion of the nature of the costs incurred by the Corporation in operating it. The following section gives a detailed description of the specification of the model and reports the estimation results. The final section presents results of model evaluation procedures.

Background

Operation of the reserve price scheme

The powers and role of the Australian Wool Corporation were initially defined by the Wool Industry Act 1972 (as amended). This act empowered the Corporation to operate a flexible reserve price scheme subject to guidelines set at the discretion of the Minister for Primary Industry. In June 1987, the 1972 act was superseded by the Wool Marketing Act, which gives more autonomy to the Corporation and the Wool Council of Australia (a body representing growers) in operating the scheme. Under the original act the minimum floor prices were set by the Minister after receiving recommendations from the Corporation, the Wool Council and the then Bureau of Agricultural Economics. Under the new act the prices are set by the Corporation with the agreement of the Wool Council. The Minister will intervene only if these bodies are unable to agree.

The purpose of the reserve price scheme, according to the Corporation, is 'to provide greater price stability and predictability in Australian currency terms for Australian wool while also aiming to achieve the maximum sustainable price for growers in the long term' (Australian Wool Corporation 1986). The basis of the scheme is that the Corporation acquires wool at reserve prices and cannot subsequently dispose of it at less than the reserve prices in effect at the time of sale.

The scheme has been operated broadly in its present form since the 1974-75 season. The publicly-quoted minimum reserve prices - which are the core of the scheme - are set for each of the many wool types at the beginning of each wool selling season (July-June). These settings are based on the expected longer term supply and demand trends on international wool markets. In addition, confidential 'flexible' reserve prices may be applied when auction prices are above minimum reserve levels, if there are perceived to be short term aberrations in the market which are disadvantageous to growers. Though most of the Corporation's wool stocks are accumulated at minimum reserve prices, purchases at flexible reserve prices can be substantial at times.

Under Section 33 of the 1972 act the Corporation was required to account separately for costs and revenues related to wool carried over from forms of the reserve price scheme that had been operated prior to 1974. In what follows, it is sometimes necessary to distinguish between this 'Section 33' wool and the wool with which the Fund is concerned, which will correspondingly be termed 'Section 28' wool (that being the relevant section of the 1972 act).

Wool growers contribute to the Fund through a levy on the gross first-hand sale value of their shorn wool. The costs to be met from the Fund are the interest, purchase, storage, handling, processing and any manufacturing costs associated with market support wool. Profits or losses made by the Corporation on the sale of wool are transferred to the Fund. In the short run, moneys in the Fund surplus to requirements are invested and the interest credited to the Fund. Under the legislation, profits on the sale of wool and interest revenue are not liable to income tax. In the longer run, if the Fund becomes larger than is necessary for effective operation of the scheme, the excess can be repaid to the original contributors. These refunds are of contributions only - no interest is paid - and growers are liable to income tax on them. The historical movements in the various cost and revenue

items associated with the operation of the reserve price scheme are shown in Table 1 and are represented in constant (1986-87) dollar terms in Figure 1.

Since the implementation of the current reserve price scheme in 1974, the total tax paid to the Corporation by growers, including the Fund levy, has been 8 per cent of the value of shorn wool production. Part of this tax is used to fund the research and promotion activities of the wool industry, and is not refundable. Until the 1986-87 season, 5 per cent of the tax was devoted to market support and 3 per cent to promotion and research. In the 1986-87 season the tax was divided equally between the Fund and research and promotion. The current act sets the maximum total tax rate at 10 per cent and requires minimum allocations of 2.5 per cent to the Fund, 2.5 per cent to promotion and the general purposes of the Corporation, and 0.25 per cent to research and development. The Wool Council, after consulting with the Corporation, is free to allocate the remainder of the tax among these activities at its discretion.

Under the original act, the decision to revolve the Fund was the prerogative of the Minister, acting after consideration of the advice of the Wool Council. The Minister had to be satisfied that the fund would remain sufficient to enable the Corporation to operate the scheme for the rest of that financial year. Under the current act, decisions on revolvement are made by the Wool Council in agreement with the Corporation, the Minister intervening only if the two organisations are unable to agree. The revolvement may be of contributions made in more than one financial year. The legislation requires that contributions made in the earliest financial years be repaid first.

In 1979 the Wool Council recommended that the 1974-75 season's contributions be returned when, at the beginning of a season, the Fund was large enough so that more than $350m would remain after the revolvement. Since 1981, the Council's rule has been that the fund can be revolved only if its level (without borrowing) will remain at least one-third of the expected value of the upcoming season's clip. The bulk of the refunds are made in October and November of each year. The first revolvement occurred in the 1981-82 season, when the 1974-75 season's contributions were returned. Subsequently, the Fund has been revolved in all seasons except 1984-85. Except for the 1986-87 season, each revolvement applied to only a single season's contributions. Two seasons' contributions (1978-79 and 1979-80) were refunded in 1986-87.

The Corporation's market support costs

It can seen from Figure 1 that there is a broad direct relationship between stock levels and costs to the Corporation. Measures of the inventory activities most relevant to this analysis are reported in Table 2.

By far the largest component of the costs of operating the reserve price scheme is the interest on borrowings to finance wool purchases. In the early years of the scheme, the Corporation drew the bulk of its funds from a federal government credit facility which was provided at commercial rates of interest. These moneys, as well as a Commonwealth grant, were repaid in the late 1970s and the Corporation has since relied on the Fund and commercial sources. The Fund has now grown to the point where the Corporation can meet most of its borrowing requirements from this source, though recourse to commercial markets may be necessary at times to meet seasonal peak financing needs. The Corporation imputes an interest cost to Fund moneys tied up in wool stocks, based on the bank overdraft rate, because this is the rate at

TABLE 1

Australian Wool Corporation Market Support Fund Operations

Item	1974 -75	1975 -76	1976 -77	1977 -78	1978 -79	1979 -80	1980 -81	1981 -82	1982 -83	1983 -84	1984 -85	1985 -86	1986 -87
	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000
RESERVE PRICE SCHEME OPERATIONS													
Trading outcome													
Sales	14 640	171 439	114 568	215 042	340 444	171 469	115 688	122 691	211 826	282 572	534 441	275 640	592 459
Cost of sales	13 272	156 460	90 225	177 600	274 589	129 395	104 777	113 694	193 692	256 550	475 996	250 518	504 709
Other income(a)	-	-	-	63	84	260	296	491	619	304	595	882	104
Gross profit	1 368	14 979	24 343	37 505	65 939	42 336	11 207	9 488	18 753	26 326	59 040	26 004	87 854
Operating expenses													
Interest													
- imputed	1 014	4 327	6 581	11 704	17 032	8 082	13 679	27 083	61 359	81 969	102 842	119 602	97 190
- commercial	16 016	35 655	26 489	24 393	11 848	101	318	200	101	2 111	6 435	337	162
Storage	2 371	5 272	4 414	4 709	4 385	2 859	2 577	3 153	5 881	7 374	8 033	7 371	6 527
Handling	3 300	4 232	3 259	2 436	2 857	1 457	1 290	2 419	7 037	6 674	4 750	4 411	1 028
Selling	412	761	972	947	1 176	920	638	775	939	1 427	1 722	1 382	1 386
Administration	-	2 588	2 972	3 899	4 180	4 843	7 271	8 027	8 411	7 801	9 549	11 605	13 211
Exchange losses (gains)	-	-	-	(39)	447	(192)	375	(323)	(891)	(843)	(1 068)	467	819
Advance to growers	3	-	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	62	56	32	31	32	47	66	67	76	79
Total expenses	23 616	52 835	44 687	48 112	41 981	18 082	26 179	41 366	82 884	106 579	132 330	145 251	120 402
Net profit (loss)(b)	(22 248)	(37 856)	(20 344)	(10 606)	23 958	24 252	(14 972)	(31 878)	(64 131)	(80 253)	(73 290)	(119 247)	(32 548)
MARKET SUPPORT FUND ACCOUNT													
Proceeds from levy	43 309	46 732	56 102	56 253	63 735	76 952	83 289	87 138	88 024	100 755	118 677	129 563	125 481
Interest													
- imputed	1 014	4 327	6 581	11 704	17 032	8 082	13 679	27 083	61 359	81 969	102 842	119 602	97 190
- commercial	53	57	1	88	913	19 787	40 751	54 427	34 949	14 451	13 248	47 451	74 184
Net profit (loss)	(22 248)	(37 856)	(20 344)	(10 606)	23 958	24 252	(14 972)	(31 878)	(64 131)	(80 253)	(73 290)	(119 247)	(32 548)
Accumulated balance	22 427	35 686	78 025	135 465	241 104	370 177	492 925	629 695	708 424	781 234	891 441	1 088 572	128 139
Fund revolvement	-	-	-	-	-	-	-	41 472	44 112	51 270	238	51 740	131 900
Closing balance	22 427	35 686	78 025	135 465	241 104	370 177	492 925	588 223	664 312	729 964	891 203	1 016 832	1 149 239

(a) Mostly export incentive grants. (b) Transferred to Market Support Fund.
Source: Australian Wool Corporation (1987 and previous issues).

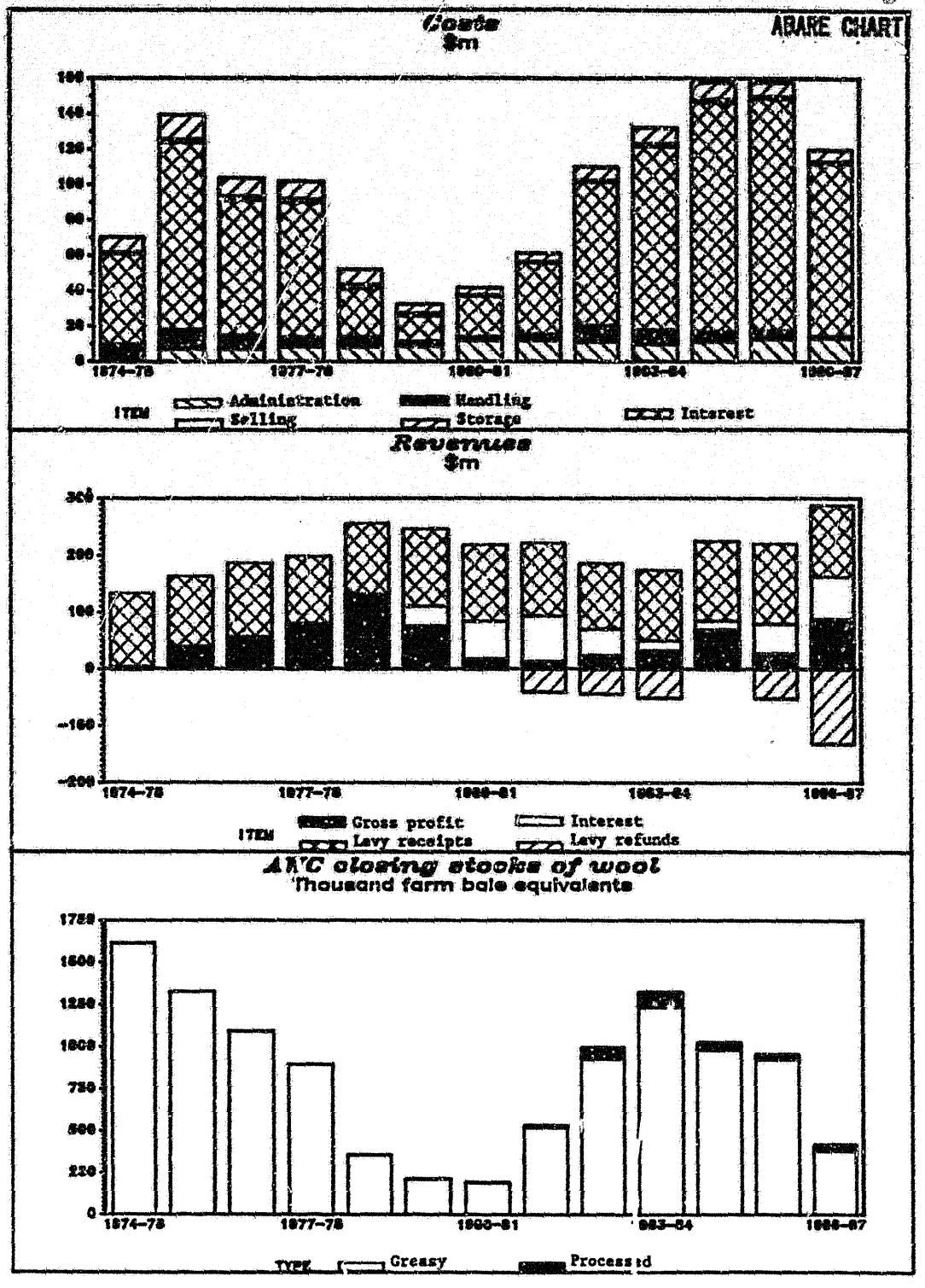

FIGURE 1 - Australian Wool Corporation Costs and Revenues Under the Reserve Price Scheme for Wool (constant 1986-87 dollars)

TABLE 2

Australian Wool Corporation Stock Activities(a)

Item	1974 -75	1975 -76	1976 -77	1977 -78	1978 -79	1979 -80	1980 -81	1981 -82	1982 -83	1983 -84	1984 -85	1985 -86	1986 -87
Purchases	1 538	601	187	494	353	229	106	572	883	864	698	386	267
Sales of greasy wool													
- resubmission to auction	48	92	132	117	97	61	28	41	34	43	37	31	15
- domestic private treaty(b)	34	513	167	351	464	83	77	113	308	309	642	280	572
- overseas private treaty	16	282	120	222	319	202	80	66	98	132	164	79	154
Total	98	887	419	690	880	346	185	220	440	484	843	390	741
Sales of processed wool	-	-	-	-	16	27	21	23	36	74	109	50	69
Transfers to processing													
- domestic	-	-	-	-	2	4	3	5	31	34	4	4	1
- overseas	-	-	-	-	14	24	18	27	61	61	60	32	74
Total	-	-	-	-	16	28	21	32	92	95	63	36	75
Overseas shipments													
- greasy	194	245	265	208	229	55	123	177	314	204	109	161	154
- processed	-	-	-	-	-	-	-	7	35	-	4	-	-
Total	194	245	265	208	229	55	123	184	349	204	113	161	154
Closing stocks													
- greasy, Australia	1 401	1 152	775	593	154	180	135	371	567	841	747	657	182
- greasy, overseas	215	174	319	304	199	28	53	137	304	303	189	238	164
- greasy, total	1 616	1 327	1 094	897	354	208	188	508	859	1 144	936	895	346
- processed	-	-	-	-	2	3	3	12	68	90	44	30	36
Total	1 616	1 327	1 094	897	356	211	191	520	927	1 234	980	925	382
Seasonal peak stocks (greasy)(d)	1 619	1 870	1 282	1 297	1 003	315	215	500	1 106	1 379	1 594	1 160	1 005
Seasonal low stocks (greasy)(d)	261	1 297	1 096	897	354	117	164	181	543	916	980	924	382
Storage throughput(c)	11 975	18 916	14 043	13 545	9 035	2 327	2 254	4 631	10 588	13 153	15 500	12 050	8 444

(a) Thousands of farm bale equivalents unless otherwise stated. (b) Includes bales transferred to special projects. (c) Thousands of farm bale-months calculated as the sum of monthly closing greasy wool stocks. (d) Peak monthly closing stocks.
Sources: Australian Wool Corporation (1987 and previous issues); unpublished Australian Wool Corporation data.

which it would have to borrow commercially. Stocks are valued at historical purchase cost plus any associated processing and (where stored overseas) maritime freight costs.

The Corporation charges to the Fund those of its costs which are attributable to the administration of the reserve price scheme. Additional administration costs have been incurred in the 1980s due to the expenses of revolving the Fund. This task is a substantial one, because the amounts refundable to each grower have to be ascertained from the transactions records of brokers, dealers, manufacturers and exporters. The 1981-82 reimbursement involved the accounting of over 125 000 transactions (Australian Wool Corporation 1981).

Handling costs are incurred in moving bales to store, within stores and between stores. The Corporation recovers from the buyers the costs of breaking the wool out of its domestic stores; the handling costs shown in Table 1 are net of these recoveries. The Corporation has a policy of holding a proportion of its wool stocks at overseas locations, to be close to users and to facilitate the development of new markets (Ward 1985). When selling its overseas stocks, the Corporation generally aims to extract a premium for avoiding the delays of several months involved in transporting wool overseas. The destinations of shipments vary from year to year according to commercial opportunity. The Corporation has always maintained insurance cover on stocks in transit overseas or located in foreign stores, but has been insuring stocks in Australian stores only since 1979-80.

Since the late 1970s, the Corporation has been subjecting significant quantities of its market support raw wool to processing - either to improve the marketability of wool which had been held for relatively long periods (Australian Wool Corporation 1981) or to provide assistance to the Australian wool processing sector in times of reduced activity (Australian Wool Corporation 1983). Processed wool may earn premiums when it is sold because of improved timeliness in meeting buyers' requirements. The Fund is reimbursed for processing costs when the wool is sold. In recent years the Corporation has increasingly been compacting farm bales into higher density wool packs such as tri-packs, which can result in reduced storage, handling and freight costs (related mostly to volume rather than weight). Generally, the Corporation aims to support the adoption of such technical marketing innovations in the treatment of its market support wool (Australian Wool Corporation 1986).

Storage charges for market support wool are set at commercial rates. The Corporation has storage capacity well in excess of its normal requirements, and the excess capacity is leased out. Profit from this source is credited to a property operations account, not to the Fund, and is used to maintain, improve or expand capacity.

There is a high degree of seasonality in the Australian wool market, in both greasy wool prices and growers' deliveries to brokers and dealers (Dickson 1987). Reflecting this seasonality, the Corporation follows a fairly stable pattern in its stockholdings, generally being a net purchaser in the first half of the season and a net seller in the second. Since 1974-75 peak stocks within seasons have averaged 33 per cent higher than the average of opening and closing stocks.

Wool owned by the Corporation is sold by resubmission to auction in Australia, and by private treaty both domestically and overseas. The

Corporation has claimed that private treaty is the cheapest and most flexible method of sale (Australian Wool Corporation 1983).

The 'exchange rate fluctuation' category of costs shown in Table 1 has two components: first, realised gains or losses in foreign exchange transactions; second, notional gains and losses calculated by converting assets or liabilities held at the end of the season in foreign currencies to Australian dollar equivalents at that date.

The Model

The purpose of the financial model is to determine the Corporation's costs and revenues relating to the reserve price scheme, given the production levels, market prices and stocks forecast by a price determination model such as EMABA, and assuming various possible levy rates and revolvement decisions. In Table 3 the exogenous variables - those either obtainable from the price determination model or assumed - are indicated by an asterisk.

As discussed above, many of the Corporation's costs and revenues depend on the location of storage and method of sale. In modelling the financial operations of the Corporation it was therefore first necessary to model its inventory management strategy. The inventory movement variables of this sub-model then become explanators in later equations representing the costs and revenues. An alternative approach would be simply to assume a set of management rules. The estimation approach was preferred both because its results lend themselves to use in a forecasting mode (particularly where probabilities need to be assigned over a range of possible outcomes) and as a means of reducing subjectivity. However, it has been necessary to include some assumed management rules in the model where there were too few data for estimation.

The structure of this financial model partly reflects the fact that it is designed to use the output of an annual model of wool price and stocks determination. If a model were available that generated monthly forecasts for prices and stocks, some of the estimation steps presented below - those representing within-season conditions - would not be necessary.

It should also be noted that the inventory movements summarised in Table 2 include movements of 'Section 33' wool stocks (which is not true of the financial data of Table 1). These stocks totalled about 177 000 bales at the beginning of the 1974-75 season but had virtually been disposed of by the end of the 1977-78 season. Because it was not possible to obtain separate data on movements of this wool it was necessary to make adjustments for it throughout the model, for seasons prior to 1978-79.

Unless otherwise stated, all equations are linear and were estimated using ordinary least squares over the period 1974-75 to 1986-87. There is a potential problem of simultaneous equation bias in some equations. However, with so few observations there are probably no advantages in using a simultaneous equation estimation technique. All variables used in this paper are defined in Table 3. Where estimated equations are reported, the figures in parentheses are absolute t-statistics.

Inventory management

The Corporation's inventory management strategy was represented as a system of sequential decisions. In the specification of this system it was

TABLE 3

Description of Variables

Symbol	Unit	Description
CA	$'000	Administration costs
CU	$'000	Historical purchase cost of Section 28 wool sold
CU33 *	$'000	Historical purchase cost of Section 33 wool sold
CE *	$'000	Losses from exchange rate fluctuations
CH	$'000	Handling costs
CIO	$'000	Interest paid by the Corporation to outside lenders
CI	$'000	Total interest paid and imputed by the Corporation
CL	$'000	Levy refunds
CO *	$'000	Other costs
CD	$'000	Selling costs
CS	$'000	Storage costs of Section 28 wool
CS33 *	$'000	Storage costs of Section 33 wool
D	'000 bales	Corporation sales of greasy wool (volume)
DW *	kt	Corporation sales of greasy wool (weight)
DP *	'000 bales	Sales of processed wool
DPO *	'000 bales	Sales of processed wool from overseas stores
DT	'000 bales	Sales by private treaty in Australia
DO	'000 bales	Sales (greasy, by private treaty) from overseas stores
DA	'000 bales	Sales by resubmission to auction in Australia
F	$'000	End of season Fund balance
FM	$'000	Fund moneys not tied up in wool stocks at end of season
G	$'000	Gross wool trading profit
IR	$'000	Interest received from outside investment of Fund moneys
IL	$'000	Levy income
IN	$'000	Net interest income
IO *	$'000	Other income
ID	$'000	Income from Section 28 wool sales
ID33 *	$'000	Income from Section 33 wool sales
OG	'000 bales	Wool shipped to overseas stores, greasy
OP *	'000 bales	Wool shipped to overseas stores, processed
PF *	$/kg greasy	Minimum reserve price (floor price)
PP	$/bale	Average purchase price of Corporation wool
PG *	$/kg greasy	Price of greasy wool at auction
Q *	kt	Shorn wool production in Australia
SA	'000 bales	Stocks held in Australia
SO	'000 bales	Stocks held overseas
SP *	'000 bales	Total stocks of processed wool
SPO *	'000 bales	Stocks of processed wool located overseas
S	'000 bales	Corporation stocks (volume)
SW *	kt	Corporation stocks (weight)
SM	'000 bale-months	Storage throughput
TP *	'000 bales	Total transfers by Corporation to its processing inventory

(Continued on next page)

Symbol	Unit	Description
TPA *	'000 bales	Transfers to processing inventory, domestic
U	'000 bales	Purchases of wool (volume)
UW *	kt	Purchases of wool (weight)
V	$'000	End of season value of Corporation stocks, at purchase cost
V33	$'000	End of season value of Section 33 stocks, at purchase cost
W	t/bale	Season average bale weight
WS	t/bale	Average weight of bales sold by the Corporation
CPI *	1985-86 = 1.0	Australian consumer price index
E *	US$/$A	Exchange rate
I90 *	%/y	Interest rate on 90 day commercial bills
IP *	%/y	Interest rate on bank overdrafts greater than $100 000
L *	%	Levy rate of contributions to the Fund
R *		Dummy variable with a value of one in seasons when a revolvement is made, zero otherwise
D83		Dummy variable with value one in 1982-83, zero otherwise
T *	y(1974-75 = 1)	Time

Note: An asterisk (*) indicates variables which are exogenously determined.

assumed that average auction prices, shorn wool production and total Corporation sales and purchases (in weight terms) were exogenous, being obtainable from a price determination model. (The outputs of EMABA include national stocks, and in the case of wool these are almost identical to the stocks held by the Corporation.)

Because the Corporation has been processing its wool only since the late 1970s it was considered that there were too few data observations on processed wool inventory movements to permit formal modelling. Therefore, the size of these movements was assumed - that is, treated as exogenously determined.

The appropriate accounting measure for inventory movements (whose costs depends mainly on volume) is farm bale equivalents, whereas production forecasts are expressed in tonnes. Adoption of a conversion factor was complicated by a strong time trend in average farm bale weights. (This would imply declining costs per kilogram of wool handled by the Corporation.) The estimated equation for change of average bale weights with time was:

(1) $$W = 145.4 + 2.09\ T$$
$$(155)\ (18.8)$$

$$R^2 = 0.97;\ \bar{R}^2 = 0.97;\ SER = 1.496;\ DW = 1.59;\ Cond. = 4.$$

The average bale weight of Corporation wool purchases was assumed to be the market average for the season, W. Purchases in bales are thus given by:

(2) $$U = UW/W$$

where UW is purchases in tonnes.

Similarly, Corporation sales of wool in bales are:

(3) $D = DW/WS.$

To evaluate this latter expression it is necessary to make an assumption about WS, the average bale weight of wool sold by the Corporation. It was assumed that it equalled the average bale weight of wool in the Corporation's inventories throughout the season. That is:

$$(4) \qquad WS = \frac{SW_{-1} + UW}{S_{-1} + U}$$

where S and SW are stocks in volume and weight terms, respectively. (Note that, both here and below, determination of endogenous lagged variables is left to subsequent steps.)

(a) Storage throughput

Corporation closing stocks (in bales) can be obtained from the identity

(5) $S = S_{-1} + U - D - TP$

where D is sales and TP is transfers to processing. (The latter variable was assumed, for lack of estimation data.) It is then possible to determine the dependence of the storage throughput, SM, on closing stocks. The estimated equation for storage throughput was:

(6) $SM = \underset{(0.12)}{86} + \underset{(16.1)}{13.16}(S + S_{-1})/2$

$R^2 = 0.96$; $\bar{R}^2 = 0.96$; SER = 1062; DW = 2.06; Cond. = 5.

(b) Auction sales

Sales of wool by resubmission to auction (DA) appeared to be unrelated to total wool sales. However, it might be expected to be related to the amount of Corporation wool held in brokers' stores, since this constitutes a large part of resubmissions to auction. (Most resubmissions occur at country auction centres where Corporation wool is being held in brokers' stores because the Corporation does not own stores at these locations.) Since the need to use brokers' stores presumably varies with pressure on Corporation storage, in the following estimated equation for resubmissions to auction the storage throughput variable was used to proxy this storage pressure. There was also strong evidence that the higher the real auction price, PG, the more wool the Corporation resubmits to auction. Time was included in the equation because the Corporation appears to have made less and less use of auctions to dispose of its wool.

(7) $DA = \underset{(2.06)}{-322} + \underset{(2.62)}{1.02}\ PG/CPI + \underset{(2.87)}{0.0045}\ SM - \underset{(2.20)}{2.60}\ T$

$R^2 = 0.76$; $\bar{R}^2 = 0.68$; SER = 21.04; DW = 1.12; Cond. = 69.

(c) Private sales

Sales from overseas stores (greasy and processed combined) were modelled as a share of total Corporation sales (including sales of processed wool, DP). It was found to vary directly with movements in the Australian auction price in real terms, and also appeared to be related to the proportion of the Corporation's total wool stocks held at the beginning of the season at overseas locations. The estimated equation was:

$$(8) \quad DO \div DPO = \underset{(2.43)}{-\ 332} + \underset{(10.54)}{0.294}(D + DP) + \underset{(2.23)}{0.84}\ PG/CPI + \underset{(2.97)}{196}(SO_{-1} + SPO_{-1})/(S_{-1} + SP_{-1})$$

$R^2 = 0.93$; $\bar{R}^2 = 0.91$; SER = 26.82; DW = 2.13; Cond. = 50.

Given this result, sales by private treaty from Australian stores can be calculated as a residual figure:

$$(9) \quad DT = D - DO - DA.$$

(d) Overseas shipments

The volume of wool stocks shipped to overseas stores is likely to be related positively to storage pressure in Australia and negatively to the proportion of stocks already held overseas. On estimation, it was found necessary to include a dummy variable for the 1982-83 season, when record shipments were made. The estimated equation for shipments of Corporation wool to overseas locations was:

$$(10) \quad OG + OP = \underset{(0.85)}{-\ 163} + \underset{(2.22)}{43}\ \log_e SM - \underset{(1.66)}{188}(SO_{-1} + SPO_{-1})/(S_{-1} + SP_{-1}) + \underset{(3.60)}{164}\ D83$$

$R^2 = 0.74$; $\bar{R}^2 = 0.66$; SER = 43.61; DW = 1.77; Cond. = 38.

(e) Stocks

The variables above having been determined, it is then possible to obtain closing stocks, both domestic (SA) and overseas (SO), as residual figures. That is:

$$(11) \quad SA = SA_{-1} + U - DA - DT - OG - TPA$$

and

$$(12) \quad SO = S - SA.$$

Administration, handling, storage and selling costs

Regression techniques were used to estimate the influence of each type of inventory movement on administration, handling, storage and selling

costs. Each dependent cost variable was deflated using the consumer price index.

The prior expectation was that most costs would be related to throughput volume rather than weight, but account was taken of the fact that some costs, such as commissions, are related to value and hence to weight.

(a) Administration costs

It was found that administration costs could largely be explained by a time trend, together with a zero-one dummy variable, R, for the seasons when added expenses were incurred in revolving the Fund. From experimentation with lags on this dummy, it appeared that most revolvement costs are incurred in the season immediately preceding the one in which the repayment is made. That is, the dummy variable assumed the value of one in every season from 1980-81 onwards except 1983-84, which preceded a season in which no refund was paid.

There was no evidence to suggest that administration costs were significantly influenced by exchange rate movements, the volume of purchases and sales or the level of stocks. Because no administration costs were charged to the Fund in the first season of the current reserve price scheme, the following equation was estimated over period 1975-76 to 1986-87:

$$(13) \quad CA/CPI = \underset{(15.8)}{6009} + \underset{(4.36)}{275}\,T + \underset{(5.09)}{2216}\,R_{+1}$$

$$R^2 = 0.95; \quad \bar{R}^2 = 0.94; \quad SER = 520; \quad DW = 1.87; \quad Cond. = 7.$$

(b) Handling costs

The main explanators of handling costs were expected to be purchases (a proxy for costs of putting into storage), bale-months of storage (a proxy for within-store movements), overseas shipments, domestic private treaty sales (in which costs of removal from storage are recovered from the buyers) and overseas sales. The equation finally adopted was:

$$(14) \quad CH/CPI = \underset{(1.61)}{-1918} + \underset{(2.93)}{3.25}\,U + \underset{(3.26)}{0.336}\,M + \underset{(2.21)}{12.6}\,OG - \underset{(2.46)}{6.05}\,DT + \underset{(1.87)}{9.5}\,DO$$

$$R^2 = 0.91; \quad \bar{R}^2 = 0.84; \quad SER = 1142; \quad DW(0) = 1.91; \quad Cond. = 12.$$

It can be seen that the prior expectation of a negative relationship with domestic private treaty sales was borne out.

(c) Storage costs

The main explanator of storage costs (including the costs of storing Section 33 wool) was bale-months of storage. A constant term and the time variable were also found to be strongly significant. The estimated equation was:

$$(15) \quad (CS + CS33)/CPI = \underset{(8.08)}{4373} + \underset{(14.10)}{0.481}\,SM - \underset{(5.32)}{235}\,T$$

$$R^2 = 0.96; \quad \bar{R}^2 = 0.96; \quad SER = 584.9; \quad DW(0) = 2.25; \quad Cond. = 7.$$

The negative time trend indicates that unit storage costs rose more slowly than consumer prices in general. The large constant term indicates that there are economies of scale in storage (which are passed on to wool growers in the form of lower unit charges). It was considered possible that diseconomies might occur at high levels of wool storage, and attempts were therefore made to fit U-shaped cost curves, using higher powers of the bale-month variable. However, there were no grounds on statistical criteria for preferring any of these specifications over the linear form.

(d) Selling costs

Since unit selling costs can vary with the method of sale, separate explanatory variables were tested representing sales made by each method. The appropriate measure for sales by auction was considered to be value, because the main cost associated with this method is brokers' commissions. Costs associated with other methods of sale were expected to be related to volume. Sales from overseas stores were indexed to the exchange rate, because this affects costs in Australian dollars. The estimated equation was:

$$(16) \quad CD/CPI = \underset{(4.72)}{513} + \underset{(7.03)}{19.1}(DA.W.PG/CPI) + \underset{(2.09)}{1.24}\ DO/E + \underset{(3.56)}{4.39}\ DPO/E$$

$$R^2 = 0.92; \quad \bar{R}^2 = 0.90; \quad SER = 126.9; \quad DW(0) = 1.71; \quad Cond. = 8.$$

Sales by auction and from overseas stores were found to be significant. Private treaty sales from Australian stores did not appear to be a significant explanator of selling costs - perhaps because the number of personnel employed to negotiate these sales changed little throughout the estimation period, irrespective of the volume of sales. The costs of these sales are probably captured by the constant term.

Interest costs and revenues

(a) Total interest costs

The aim here was not to explain costs, as above, but to replicate the accounting procedures of the Corporation, which imputes interest on Fund moneys tied up in wool stocks as well as paying interest on borrowings from commercial sources for this purpose. If monthly data were available for the value of inventories, these interest costs could be simply calculated from an identity. However, because the model was designed to use the output of an annual model an additional estimation step was needed. The approach was first to construct a notional interest paid series, calculated as the interest rate times the average of opening and closing purchase costs of wool inventories, and then to use this notional interest as an explanator of the actual interest series.

The purchase value of wool inventories is given by the expression:

$$(17) \quad V = V_{-1} + PP.U - CU$$

In this expression, the average price per bale at which the Corporation purchases wool, PP, may differ from the average floor price, because the Corporation may purchase in particular micron categories and in bales whose weights differ from the market average. An estimation step was therefore needed to determine the Corporation's average purchase price. The prior expectation was that the purchase price would be based on the floor price,

PF, and would also include a component that varied directly with the ratio of the average auction price to the floor price. The estimation results supported this hypothesis:

$$(18) \qquad PP = \underset{(3.00)}{-\ 646} + \underset{(13.2)}{1.153\ PF.W} + \underset{(3.22)}{618\ PG/PF}$$

$$R^2 = 0.95; \quad \bar{R}^2 = 0.93; \quad SER = 41.30; \quad DW = 2.53; \quad Cond. = 44.$$

To evaluate equation (17) it was necessary also to make some assumption as to the original purchase price of wool sold. It was assumed to be the average purchase price of wool in the inventory. (This assumption has implications for the time distribution of the Corporation's gross profits from sales.) Including an adjustment for Section 33 wool, the original cost of wool sold is therefore given by:

$$(19) \qquad CU = \frac{D\ (V_{-1} + V33_{-1} + PP.U)}{(S_{-1} + U)} - CU33.$$

(This expression is also employed below in evaluating the Corporation's gross profits.)

The regression equation for total interest was:

$$(20) \qquad CI = \underset{(1.07)}{-\ 2340} + \underset{(30.1)}{1.308(IP/100)(V + V_{-1})/2}$$

$$R^2 = 0.99; \quad \bar{R}^2 = 0.99; \quad SER = 4379; \quad DW = 2.13; \quad Cond. = 3.$$

It can be seen that actual interest costs were about 30 per cent higher than notional interest. The most probable reason for this is that stocks usually peak within the season, so that the average of opening and closing stocks will usually be an underestimate of the average stockholdings.

(b) Net commercial interest revenues

The extent to which the Corporation is a net lender (or borrower) in the commercial money market depends upon its total finance requirements relative to the size of the Fund. Initially it had been intended to model commercial interest revenues and payments separately. However, problems arose with non-normalcy of error terms which could not be solved satisfactorily with so few observations. An equation was therefore estimated for net interest revenue from the commercial market.

Again, a two-step estimation procedure was employed. First, a variable was constructed for notional interest receivable on Fund moneys not tied up in wool stocks. These uncommitted funds are:

$$(21) \qquad FM = (F + F_{-1} - V - V_{-1})/2$$

The notional interest variable was then used as an explanator in the following equation for net interest receipts.

(22) $IN = 355 + 0.959\ I90.FM - 1745\ T$
(0.61) (9.59) (1.63)

$R^2 = 0.97$; $\bar{R}^2 = 0.96$; SER = 7005; DW = 1.33; Cond. = 9.

Gross profits from wool trading

The Corporation makes substantial gross profits on its wool trading operations (see Table 1). The price it receives differs according to how and where the wool is sold. For example, the price received for wool sold from overseas stores will reflect the transportation and handling costs of placing the wool at those stores, and may include premiums that buyers are willing to pay for improved timeliness. To allow for such differences the equation for gross revenue from the sale of wool included explanators representing the value of sales by each broad sale type. In all cases the unit of valuation was the Australian average auction price, so the coefficient on each method of sale may be taken as roughly indicating the average premium or discount that the Corporation received relative to the Australian auction price. With the appropriate adjustment for Section 33 sales, the estimated equation was:

(23) $ID + ID33 = -743 + 0.79\ PG.WS.DA + 1.01\ PG.WS.DT$
(0.06) (1.36) (11 4)

$+ 1.57\ PG.WS.DO + 0.70\ PG.WS.DP$
(6.79) (1.61)

$R^2 = 0.99$; $\bar{R}^2 = 0.99$; SER = 13820; DW = 1.78; Cond. = 11.

Gross profit on wool trading operations was defined as:

(24) $G = ID - CU$

Levy receipts and repayments

Levy receipts were calculated by a two-step process. First, notional levy receipts were calculated at the given tax rate on the value, at auction prices, of shorn wool production. Actual levy receipts were then regressed against these notional levy receipts, both in the current year and (because there appears to be some lag in receipts) in the preceding year. The main reason why actual levy receipts may differ from the notional receipts is that a substantial quantity of private wool sales are made at less than auction prices. The price differences mostly reflect marketing costs between the point of private sale (usually the farm gate) and the point of auction sale (Samuel, Metcalfe and Combe 1978).

The estimated equation was:

(25) $IL = -883 + 964\ L.S.PG + 43\ L_{-1}.Q_{-1}.PG_{-1}$
(1.14) (22.4) (1.17)

$R^2 = 0.997$; $\bar{R}^2 = 0.995$; SER = 1582; DW = 1.36; Cond. = 19.

For a variety of reasons, when the Fund is revolved not all eligible growers' contributions are claimed (see Table 1). With the first five revolvements, repayments averaged 93.5 per cent of the amount of eligible contributions, and this ratio was used in the model.

The closing level of the Fund

The closing balance of the Fund is given by the expression:

$$(26) \quad F = F_{-1} + IL - CL - CH - CS - CD - CA + IN + ID - CU - CO + IO - CE.$$

It should be remembered that, in the model, net interest receipts from outside investments and the level of uncommitted funds are determined simultaneously.

Model Evaluation

The financial model is used to generate forecasts by providing it with the output of a model in which average auction prices and total Corporation sales and purchases are determined. The purpose of the analysis reported in this section was to discover whether there are any problems with the structure of the financial model alone which affect the quality of forecasts generated. For this purpose, historical auction prices and total sales and purchases were used as input. The appropriateness of the various assumptions and of the determinations of some of the variables as residual figures were tested by assessing the performance of the model in ex post simulation.

The simulations were conducted for the period 1975-76 to 1986-87. Levy repayments were treated as exogenously determined, as were exchange rate losses and gains and the minor items 'other costs' and 'other revenues'. Test statistics were computed from both dynamic and static simulation runs, and are shown in Table 4. (Where the two simulations do not differ, the results are shown once only.) The ability of the model in dynamic simulation to reproduce the behaviour of the key variables is illustrated in Figure 2.

To ensure that forecast quality was examined as critically as possible, the recommendation of Granger and Newbold (1977) was followed, that the ability of a model to predict changes, rather than merely levels, should be tested. Consequently, all the statistics in Table 4 refer to the predicted changes. The statistics shown are for only those endogenous variables determined in the system of inventory equations or dependent upon this system for the values of explanators; for the other endogenous variables, the most relevant diagnostics are the single-equation statistics already given.

As suggested by Theil (1966), mean squared prediction errors were decomposed into bias (U^M), regression (U^R) and disturbance (U^D) proportions. U^M values significantly different from zero indicate the presence of systematic biases; U^R values significantly different from zero indicate that the predictor can be improved by multiplying it by a constant. The values of these statistics are found to be sufficiently close to zero, for all variables, to suggest that the assumptions employed in the model are reasonable representations of reality, at least for the period examined.

Concluding Remarks

The reserve price scheme for wool is operated so that the physical and interest costs related to handling, storage and sale are offset by gross profits on sales and interest revenues from the investment of Fund moneys not needed immediately for market intervention operations. The Corporation can influence the costs and revenues related to its wool stocks through its

TABLE 4

Historical Simulation Performance Statistics(a)

Variable	Symbol	Mean	Root mean square error of change	Corr. coef. (b)	Inequality coefficient (U)	Bias proportion (U^M)	Regression proportion (U^R)
			DYNAMIC SIMULATION				
Sales							
- auction	D	61	17	0.73	0.78	0.064	0.241
- private domestic	DT	323	39	0.99	0.16	0.001	0.002
- private overseas	DO	160	29	0.95	0.32	0.009	0.062
Overseas shipments	OG	187	43	0.87	0.48	-	0.004
Closing stocks							
- domestic	SA	530	41	0.99	0.15	0.019	0.024
- overseas	SO	201	42	0.92	0.40	0.026	-
Sales revenue	ID	262 757	9 891	0.99	0.07	0.007	0.006
Cost of wool sold	CU	227 350	9 651	0.99	0.14	0.001	0.071
Total interest cost	CI	54 967	4 794	0.98	0.26	0.086	0.068
Handling costs	CH	3 488	884	0.91	0.25	0.008	0.116
Selling costs	CD	1 087	206	0.66	0.80	0.002	0.163
Storage costs	CS	5 211	371	0.95	0.32	0.011	0.021
Net interest revenue	IN	32 234(c)	6 642	0.96	0 31	0.001	0.197
Inventory value	V	303 035	13 938	0.99	0.10	0.101	0.101
Fund closing balance	F	532 763	15 774	0.90	0.15	0.023	0.009
			STATIC SIMULATION(d)				
Overseas shipments	OG	187	40	0.89	0.44	-	0.042
Closing stocks							
- domestic	SA	530	38	0.99	0.14	0.001	0.007
- overseas	SO	201	39	0.93	0.37	0.003	0.004
Sales revenue	ID	262 357	12 025	0.99	0.07	0.003	0.187
Cost of wool sold	CU	227 350	9 164	0.99	0.07	0.123	0.024
Total interest cost	CI	54 967	4 043	0.98	0.22	0.038	0.064
Handling costs	CH	3 488	864	0.92	0.44	0.008	0.229
Selling costs	CD	1 087	196	0.69	0.76	0.001	0.142
Net interest revenue	IN	32 234(c)	6 671	0.95	0.18	0.023	0.182
Inventory value	V	303 035	9 163	0.99	0.06	0.124	0.004
Fund closing balance	F	532 763	14 653	0.93	0.14	0.080	0.086

(a) The range of the simulations was 1975-76 to 1986-87. (b) Correlation between actual and predicted change. (c) Mean of the series in absolute value terms. (d) Where different from dynamic run.
Note: A dash (-) indicates a negligible number (less than 0.001).

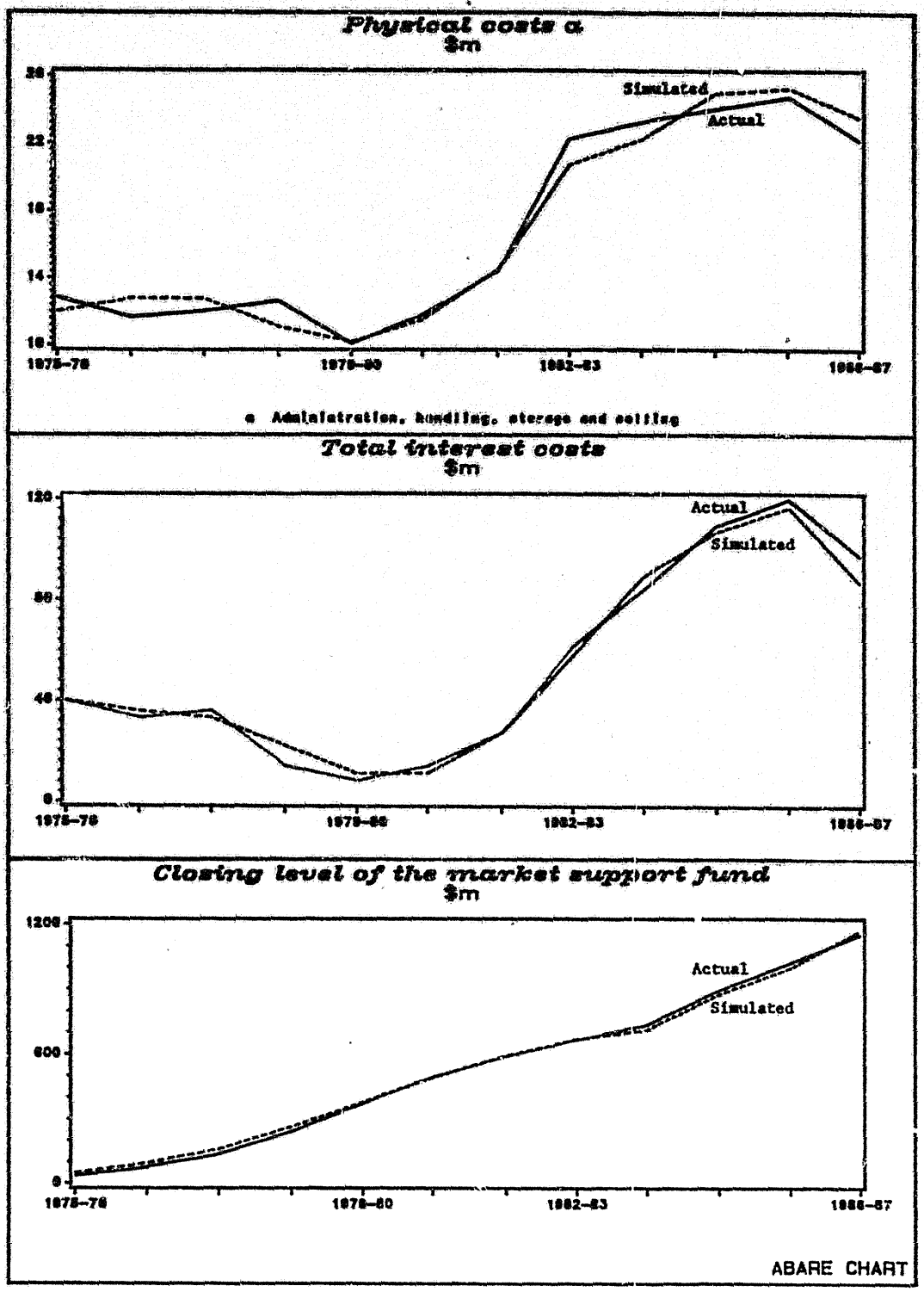

FIGURE 2 - Tracking Ability of the Model in Dynamic Simulation

choice of location of the wool, the degree to which it is processed and the method by which it is sold. Therefore, an important part of the model reported here is its representation of the Corporation's inventory management strategy. The model is found to explain historical movements in costs and revenues with reasonably high precision.

The model reported in this paper, when linked to a model of wool price determination, can be used to forecast Corporation costs and revenues, and hence the level of the Fund. Applications of the model have recently been reported by ABARE (1987). All involved the use of stochastic simulation procedures, whereby econometric models can be used to generate probability distributions which represent the uncertainties associated with a range of possible outcomes for variables. The first application was aimed at identifying how, through the setting of minimum reserve prices, reductions in uncertainty about future auction prices can be traded off against increased costs of market intervention. The second application was to estimate the probabilities of the Fund meeting future market intervention requirements given various assumptions about contribution rates and fund revolvement decisions.

In conclusion, it is important to note that the net operating costs incurred by the Corporation should not necessarily be regarded as the true costs to growers of the reserve price scheme. Calculation of the true costs would require a comparison of the costs that would be incurred, and who would bear them, with and without a stabilisation scheme.

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