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THE INVENTORY SCHEME FOR AUSTRALIAN WOOL

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A model put forward by the Australian Wool Corporation to simulate the behaviour of the wool market under an inventory scheme is described. Some deficiencies in the model are pointed out and suggestions are made for alterations to improve the model's performance.

One of the latest developments in wool marketing proposals is contained in the Australian Wool Corporation's (AWC) December 1973 report, 'The Marketing of Australian Wool'. Still awaiting a government decision at the time of writing, the report urges the adoption of radical measures, including the 'acquisition' by the AWC of all export wool. It envisages a marketing system in which the Corporation would attempt to reduce the variability of wool prices in order to make them more 'reliable' to wool using manufacturers. One of the report's main economic contentions is that reduced price variability would significantly improve wool's competitive position vis-a-vis synthetic fibres. This argument seems open to doubt, but this article is not intended to canvass economic issues.

The recommended marketing system involves the operation by the AWC of an 'inventory scheme' in which prices are stabilized by regulating, in a limited way, the supply of wool to buyers. The supply would be reduced by buying into inventory when prices were falling 'too low' and increased by selling from inventory when they 'rose to a level beyond which it was believed further increases would be temporary and detrimental to the long-term interests of the wool industry' (p. 7). The problem, of course, is to decide when such levels have been reached, and then how much wool should be released to or withdrawn from the market. The report itself gives no clue as to how these decisions are to be made, though it does refer vaguely to the concept of an 'optimal inventory level' (pp. 138-139). In June 1974, however, in a further publication, 'Appendices to The Marketing of Australian Wool', the AWC gave details of a model which had been devised to simulate the operation of the scheme and the responses of the market. This article discusses from a mathematical standpoint 'Appendix 4: An Inventory Scheme for Australian Wool', in which the model is put forward, suggesting some ways to improve it. All further page references are to this appendix.

Description of the Model

The model consists of two parts. The first is a system of equations describing how supply to the market contributes to the generation of wool prices. These equations express some variables in terms of lagged values of others—an important factor explaining this year's price is last year's value of an index of world interest rates and the size of this year's sheep population is partly explained by last year's wool price.

The second part of the model is a set of rules describing how the price containment policy is to be put into action and which generates new values to be fed back into the system of equations for some of the variables. The model proceeds by steps of one year and is self-propelling after initial values are specified.

The Market Equations

The system of equations is set out below with slight changes in notation and order of equations used by the AWC. The lower case letters (except t) represent positive constants whose values are suppressed here to emphasize the structure of the system. For internal consistency in the equations the AWC's trend variable T has been replaced by t. This is achieved simply by an adjustment to the parameter a_f.

(1) $$\log N(t) = a_n + b_n \log P(t-1) - c_n \log PW(t-1) - d_n \log PB(t-1) + e_n \log G(t-1)$$

(2) $$SS(t) = a_s + b_s N(t-1)$$

(3) $$FW(t) = a_f + b_f\, t$$

(4) $$QP(t) = SS(t).FW(t)$$

(5) $$WS(t) = a_w + S(t)$$

(6) $$\log P(t) = a_p - b_p \log QP(t) - c_p \log I(t-1) - d_p \log WS(t) + e_p \log PM(t)$$

In these equations, $N(t)$ is the number of sheep in Australia in year t, P is the price of Australian wool (whole clip average), PW is the price of wheat, PB the price of beef, G the area under sown grasses, SS the number of sheep shorn, FW the average fleece weight, QP the quantity of wool produced, WS the world stocks of wool, S the Corporation's stocks, I an index of overseas interest rates and PM the price of a U.S. man-made fibre.

Equations (4) and (5) are identities, the latter being essentially a redefinition of the variable WS for the purpose of the simulation. World stocks are now regarded as constant at their 1962 level but for the variations contributed by AWC stock. Implicit in this procedure is the assumption that the existence of an Australian stockpile will minimize variability in overseas stockholding. This calls for some justification, but none is put forward.

Equations (1), (2), (3) and (6) are arrived at by least squares regression on data from the twelve years 1960-61 to 1971-72. The AWC gives no reason for not considering earlier data, though twelve is a very small number of data points in view of the number of parameters estimated in equations (1) and (6). If the reason is that earlier data were thought to be less important consideration might have been given to using more data but weighting them in favour of more recent figures.

For the purposes of the simulation the variables PW, PB, G, I and PM are *not* treated as time dependent—they are simply assigned constant values for the duration of the simulations. (1962 values were chosen. No reason was given for this choice, but it is noted (p. 73) that 'when 1962 data are used . . . price expectations are almost doubled' compared with when 1969 data are used.) At the cost of a significant reduction in the 'degree of explanation' it would perhaps have been better to do without these variables—especially those, such as the prices, which may be subject to large fluctuations. Success in explaining the variability of the dependent variable is illusory unless the explanatory variables are independently modelled inputs to the simulation procedure. As this seems to have been considered not worthwhile some thought could have been given to omitting the exogenous variables to obtain more reliable variance estimates, based on nine or ten rather than seven degrees of freedom. In particular, the exclusion of the interest rate index I in equation (6) as a variable in the simulations is a serious weakness. The t-statistics for the parameter estimates given with the equation indicate that this variable was very important and would account for much of the 'explained' variation in price. The estimate of price standard deviation derived from this equation would probably be too small for use in simulations in which I is held constant and could not be considered reliable. A similar comment applies to equation (1), from which three explanatory variables are dropped.

For the purpose of the simulation then the equations are essentially:

(i) $\log N(t) = a + b \log P(t-1)$ where $b = b_n$
(ii) $SS(t) = c + dN(t-1)$ $c = a_s, d = b_s$
(iii) $FW(t) = e + ft$ $e = a_f, f = b_f$
(iv) $QP(t) = SS(t).FW(t)$
(v) $WS(t) = g + S(t)$ $g = a_w$
(vi) $\log P(t) = h - m \log QP(t) - n \log WS(t)$ $m = b_p, n = d_p$

It is well to note here that some confusion arises for readers of Appendix 4 from uncertainty as to whether the symbol P stands for the price or for its logarithm. The revenue function (p. 72) contains the term $P_i\Delta_s$, where $i = U$ or L and Δ_s is the change in Corporation stocks. This implies that P stands for price. But on the same page mention is made of shifting the demand function (that is, equation (6)) 'via its intercept' by an amount δ, giving a result of the form $P^{**} = \overline{P} + \delta$. Clearly P in this context means log P, as the mention of an intercept makes no sense otherwise. This uncertainty could of course have been avoided by more careful explanation on the part of the writers of the appendix, but even the necessity for this extra care could have been avoided had all, or none, of the equations been cast in logarithms. With so few data points it is unlikely that it could be decided whether a normal or a log-normal distribution (or any other) was more appropriate in each case. Thus it would seem sensible to choose on the basis of mathematical convenience. On this score it may be remarked in favour of consistent use of log-normal distributions and equations which are linear in logarithms that

(i) this would guarantee the impossibility of negative values for variables and
(ii) if SS and FW were log-normally distributed then so would QP be, and
(iii) some parameters estimated could readily be interpreted as elasticities—a fact which will be discussed presently.

The Simulation Process

The simulation section of the model uses these equations to generate future values for (yearly average) wool prices. The process is as follows:

A trial value, $N(0)$, is used in equation (ii) to calculate $SS(1)$. From a normal distribution with mean $SS(1)$, $SS^*(1)$ is drawn randomly. The variance used was the estimated variance of the forecast error from equation (2). Similarly $FW^*(1)$ is drawn from a normal distribution, and $QP^*(1)$ is calculated from equation (iv) as $SS^*(1).FW^*(1)$. A trial value, $S(1)$ (initial AWC stocks), is used to calculate $WS(1)$ from equation (v). 'Assuming that buyers observe that supply comprises production *plus* Corporation stocks' (p. 71), the AWC then replaces $QP(t)$ in equation (vi) with the quantity supplied in year one, $QS(1)$ (defined by $QS(1) = QP^*(1) + S(1)$), to calculate $\overline{P}(1)$, the expected price in the first year of the simulation.

'Ceiling' and 'floor' prices $P_U(1)$ and $P_L(1)$ are calculated as $\overline{P}(1)(1 \pm x)$, where $100x$ per cent is a desired (predetermined) maximum percentage variation of price in year one from $\overline{P}(1)$.

> 'It is assumed that, in the first instance, the Corporation does not intend to disturb its stocks unless the chosen price limits are likely to be breached. Annual production is therefore the relevant determinant of price as far as the authority is concerned . . .' (p. 71)

and so $\hat{P}(1)$, the price expected to be offered for the total wool production in year one, is calculated from equation (vi) with $QP^*(1)$ replacing $QP(t)$. It is important to note that $\hat{P}(1) \gtrless \overline{P}(1)$ according as $S(1) \gtrless 0$, because $QP(t)$ has a negative coefficient in equation (vi). $P^*(1)$, the price actually offered for $QP^*(1)$, is now found by drawing log $P^*(1)$ from a normal distribution whose mean is log $\hat{P}(1)$. (The text is ambiguous here. It is possible that $P^*(1)$ is drawn from a normal distribution with mean $P(1)$, but if this is the case negative prices could result.) One of three situations now arises. These are:

(a) $P_L(1) \leqslant P^*(1) \leqslant P_U(1)$
(b) $P^*(1) > P_U(1)$
(c) $P^*(1) < P_L(1)$

In case (a) the Corporation is happy with the price and takes no action, the actual trading price $P(1)$ is set equal to $P^*(1)$ and since stocks are not disturbed $S(2)$ (the AWC's starting stocks for year two) is set equal to $S(1)$. In cases (b) and (c) the Corporation intervenes in the market, trying to 'hold' the price down to $P_U(1)$ by selling from its stock or up to $P_L(1)$ by buying into stock. How much it needs to sell or buy is determined by calculating the *quantity demanded* ($QD(1)$) at $P_U(1)$ or $P_L(1)$, as the case may be. To do this the AWC has 'nominated' price elasticities of demand, E_U and E_L, to operate at prices $P_U(t)$ and $P_L(t)$ respectively, for the duration of a whole set of three- or five-year simulations. This will be commented on presently. If, for example, the Corporation is attempting to hold $P_U(1)$, $QD(1)$ is calculated, presumably from

$$QD(1) = QP^*(1)[P^*(1)/P_U(1)]^{E_U}.$$

If this demand can be met (i.e., if $QS(1) \geqslant QD(1)$) the AWC sells $QD(1) - QP(1)$. $P(1)$ is then equal to $P_U(1)$ and $S(2)$ is $QS(1) - QD(1)$. Otherwise a new $P(1)$ above $P_U(1)$ must be settled on and in the model this is calculated, in essence, from the formula

$$P(1) = \overline{P}(1).P^*(1)/\hat{P}(1)$$

which does give a price above $P_U(1)$ if E_U is not too large. (For clarification of this statement see the appendix attached to this article. The formula just quoted is accurate if P in the AWC appendix is interpreted as log P. The formula given there is

$$P(1) = \bar{P}(1) + P^*(1) - \hat{P}(1).)$$

If, on the other hand, case (c) applies and the AWC must try to support the floor price, $QD(1)$ is calculated from a formula identical with that above except that L's replace the U's. Correspond to the amount of stock on hand, which in case (b) decides whether $P_U(1)$ can be held, the Corporation supposes a fixed amount, K, of capital on hand above which the value of its stock may not rise. This decides whether $P_L(1)$ can be maintained. Thus if $[QS(1) - QD(1)].P_L(1) \leqslant K$, $P(1)$ is equal to $P_L(1)$ and $S(2)$ is $QS(1) - QD(1)$. If K is insufficient to hold P_L, the ruling price $P(1)$ is set using the formula quoted above for the case of a 'stockout', namely

$$P(1) = \bar{P}(1).P^*(1)/\hat{P}(1).$$

In this case the formula is unsatisfactory regardless of the value of E_L as it implies that $P(1) \leqslant P^*(1)$. Thus if $S(1) > 0$ the effect of exhausting capital by buying wool at P_L is to depress rather than boost the final ruling price. This is a serious inconsistency not acknowledged by the writers of Appendix 4. $S(2)$ is set at $K/P(1)$ which is consequently too high.

When $P(1)$ is known, a revenue function involving it is calculated, but it has no effect on the progress of the simulation.

A trial value, $P(0)$, is used in equation (i) to calculate $N(1)$, which is then used directly in equation (ii) rather than (as might have been expected) an observation from a normal distribution with mean $N(1)$. The model now proceeds to year two and continues as described for year one.

Deficiencies of the Model

Of the output sequences from the model, the price and stock sequences are of primary interest. The behaviour of the price sequence is what ultimately determines the effectiveness of the scheme, while the stock sequence throws some light on storage requirements. An important consideration in evaluating results should be a comparison of revenue to growers with and without the scheme. The summary of results from the model which completes Appendix 4 does not present this comparison but concentrates more on what happened to stock levels and the effects on price variability of changes in certain parameters.

It must be kept in mind by readers of the report that the results it discusses are a large number of outcomes from three, and sometimes five, iterations of the model. It should not be surprising that 'there was no appreciable difference in the results obtained between a simulation period of three years and a period of five years' (p. 77). But to interpret this as 'the model tends to stabilize after three years' is misleading. It seems to imply that after five years some stable pattern emerges (that is, more stable than in the first five years). This does not happen. The behaviour of the model in subsequent years is indistinguishable from that of the first five years because, in the absence of an optimizing criterion with a procedure to implement it, the output is 'white noise'.

As noted above much of the summary of results deals with stock levels. Two aspects of this summary deserve particular comment. One is the concept of 'intended average inventory'. Considerable space (pp. 74-75) is devoted to a discussion of the effects of changes in this intended average on the number of stockouts, closing stock levels, net revenue and price level and variability. This tends to give the misleading impression that an intended stock level is one of the input controls used in simulation. Readers of this article will readily appreciate that no such input control exists. It is then difficult to make sense of the concept. If a selective sampling of the results is in fact what is meant, it is hard to see how any deductions made could have useful implications for running the scheme.

The second aspect deserving of comment is the preoccupation with the effect of different starting values for the stock level in the AWC inventory. Were such a scheme put into action it would of course run continuously and be forced to recover from the inevitable stockouts as it ran. From this point of view there is a strong case for using only zero as the initial stock level, to simulate market behaviour after the first stockout. It is clear that the original stock level is immaterial to the course of events after a stockout. One might suspect from the reported results of the simulation that the Corporation intended to run the scheme for three years, suspend it until enough wool had been bought or sold to arrive at a suitable starting level and then start it again.

The Inflationary Effect of Stockholding

It seems, however, that whatever the starting level stockouts were frequent in the three-step simulations. 'Even with high intended average and starting inventory levels (120 and 240 m.kg respectively) it appears that stockouts at the end of a three-year cycle would still occur about 8% of the time . . .' (p. 73). 'It is also indicated by the results . . . that under random influences the Corporation would have had to use the whole of its inventory (even 240 m.kg) in one year in an attempt to contain prices . . .' (p. 75). 'As the differential [between P_L and P_U] increases from 20 to 40 percent, the number of stockouts [from an initial 80 m.kg] at the end of a three-year cycle fell from 24 per cent to 16 per cent, (p. 75). It is likely that the five-year cycles showed even higher percentages of stockouts and it is evident that their high incidence was a cause for concern.

On examining the model in the light of these comments it emerges, as may have been suspected, that the tendency to frequent stockouts is a built-in feature. There are two reasons why the model envisages frequent dramatic drops in stock levels. One is that because $E_U > E_L$ a reduction in price to $P_U(t)$ produces an increase in demand which is large by comparison with the decrease in demand caused by a price increase to $P_L(t)$ of a similar size. The other springs from a structural feature of the model—the centring of the distribution of log $P^*(t)$, at log $\hat{P}(t)$ rather than at log $\overline{P}(t)$, the 'centre' which decides $P_U(t)$ and $P_L(t)$.

The more stock the Corporation has on hand in year t the greater the difference log $QS(t)$ — log $QP(t)$, and consequently the difference log $\hat{P}(t)$ — log $\overline{P}(t)$. So the greater $S(t)$ the closer is the mean of the symmetrical distribution centred on log $\hat{P}(t)$ to log $P_U(t)$, the more likely $P^*(t)$ will be 'too high' ($> P_U(t)$) rather than 'too low' ($< P_L(t)$). In short, the more stock the AWC has on hand the greater the probability it is forced to sell to keep prices down rather than to buy to save them from falling too low. With this in mind it is not surprising that the Corporation reports:

'An increase in opening stocks from zero to 80 m.kg significantly reduces the likelihood of stockouts. However, a further increase to 240 m.kg has only a marginal impact on decreasing the incidence of stockouts' (p. 73). Again, it must be remembered that in the simulations the authority has had only three chances to buy or sell and that 240 m.kg would be close to half the annual clip.

Commenting in a footnote on the reason for shifting the mean of the price distribution while not shifting the price bounds, Appendix 4 says:

> 'The distinction is also important to the model because it permits trade price expectations (and hence P_U and P_L) to be depressed by a large volume of accumulated stocks, while it forces the Corporation to calculate a higher price which is closer to P_U. In this way an unforeseen upward shift in demand is more likely (in the model) to cause the Corporation to release some of its stocks to prevent the price rising too far' (p. 71).

The weakness in this argument is its failure to recognize that the mechanism referred to makes shifts in demand more likely to be upwards than downwards, and that negative random fluctuations in demand are less likely to cause the Corporation to buy. In fact, the mechanism constitutes a zeroing pressure on stocks which is greatest when stocks are high. Insofar as the existence of a large stockpile would not necessarily, in reality, coincide with a demand strong enough to force large sales, this must be viewed as a deficiency in the model.

One relatively simple way to correct this deficiency is to relocate $P_L(t)$ and $P_U(t)$ so that

$$\log P_U(t) = (1+k)\log \hat{P}(t) \text{ and}$$
$$\log P_L(t) = (1-k)\log \hat{P}(t)$$

where k is chosen so that $\hat{P}^{(1+k)} = \hat{P}(1+x)$, say. This would ensure that, in the model, the chances that prices would need to be held down by selling or shored up by buying would be the same. It would also eliminate the inflationary effect of stockholding assumed in the model and so reduce the incidence of quick stockouts from any level. Both these features would seem desirable in a model until experience of market reaction to the scheme forces modifications.

The Independence of Consecutive Years

Another structural feature of the model is worth noting. If it were not for the fact of the Corporation's stockholding the model would envisage the progress of the market as consisting of two interwoven but independent two-year-lagged processes. This can be shown by reducing the system of equations (i) and (vi) to a difference equation in $P(t)$, as follows:

$$\begin{aligned}\log P(t) &= h - m\log QP(t) - n\log WS(t)\\ &= h - m\log SS(t).FW(t) - n\log(g+S(t))\\ &= h - m\log(c+dN(t-1)) - m\log(e+ft) -\\ &\qquad n\log(g+S(t))\end{aligned}$$

$$= h - m \log (c + d10^{a+b \log P(t-2)}) - m \log (e + ft) - n \log (g + S(t))$$

This difference equation shows that in the free market as it is modelled —that is, in the situation where $S(t) = 0$ for all t—$P(t)$ is determined entirely in terms of $P(t-2)$, independent of $P(t-1)$.

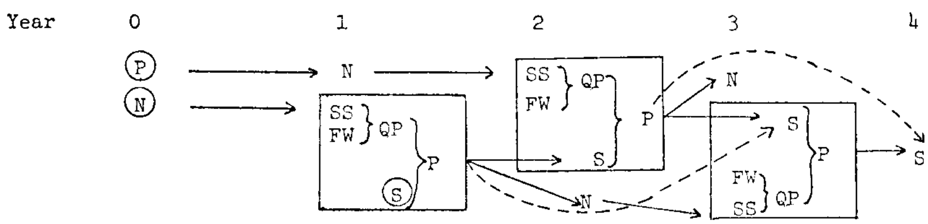
With AWC intervention as described in the model, $S(t)$, and thus $P(t)$, does depend on $P(t-1)$ if action has been taken in year $t-1$ to hold one of the price bounds $P_L(t-1)$ or $P_U(t-1)$. However, the difference equation may be used to deduce, by successive substitution for the price term, a pair of functional relationships of the form:

$P(2t) = f(P(0), 2t, S(0), S(2), S(4), \ldots, S(2t))$ and

$P(2t+1) = g(P(1), 2t+1, S(1), S(3), S(5), \ldots, S(2t+1))$.

This shows that, because of the two-year lag underlying the AWC model, it would be possible to run two entirely separate schemes by using two separate stockpiles—one for the 'even' years and one for the 'odd'.

An alternative illustration of the structure just described is seen in the diagram of the model's progress which appears below:



(Circled letters are initial data.)

If two stockpiles were used, the P to S arrows could be replaced by the broken arrows shown. This would clearly show the 'odds and evens' structure.

The existence of this underlying structure would not be very significant if it were not for the fact that the simulations were allowed to run for only three iterations. It is possible that in a sizeable proportion of the simulations the events of year two have no bearing at all on the final state of affairs, which is a direct consequence of what happened in year one. These simulations would of course be those in which there is no stock change in year two—a situation which could arise in three ways: $P^*(2)$ may fall within the price bounds, or above $P_U(2)$ after a stock-out in year one, or below $P_L(2)$ after a moneyout in year one.

A simple expedient which would avoid this problem would be to relate $SS(t)$ to $N(t)$ rather than to $N(t-1)$, a procedure which does not seem unreasonable. This would mean that $SS(t)$ could be expressed in terms of $P(t-1)$, instead of the present relationship which from equations (i) and (ii) is $SS(t) = c + d10^a P(t-2)^b$.

Time Scale

The above remarks raise again the question of what time scale would be most suitable for use in the model. The AWC remarks that 'The model is too rigid to take account of policy decisions which could logically occur during the season and hence alter the outcome of the year's trading operations. The introduction of a quarterly model incorporating progressive decisions by the Corporation could provide more flexibility' (p. 78). The rigidity referred to results from the direct correspondence of one iteration to one year. Shortening the period corresponding to one iteration to a quarter or even a month is to be recommended for at least two reasons. Firstly, more information could be gained about the likely effects on price stability of various possible policy decisions, especially if monthly data were used, since any stability properties would be more apparent after the number of iterations corresponding to, say, five years. Secondly, the influence on the outcomes and therefore on policy decisions of whatever initial conditions are assumed would be diminished. (On this point it would perhaps be advisable to use average figures rather than choose a particular year to supply starting data.) As hinted by the Corporation, more flexibility and obvious practical advantages could be introduced with the shorter time-scale by reducing the number of price policy decisions per iteration (presently one).

The Question of Elasticity

> 'A critical factor for a wool inventory policy is the relative elasticities of demand ruling at the time the Corporation buys and sells the wool. The inventory model was simulated many times with different combinations of E_L and E_U, but concentrated on situations in which E_U was greater than E_L. It could be argued that this approach unnecessarily favoured the Corporation's trading position, but it is believed that buying behaviour follows this pattern . . .' (p. 77).

Whether this actually is the case has been the subject of some discussion among economists. Grubel [4] and Powell and Campbell [5] argue that a higher elasticity at lower prices is in fact more likely, but there seems to be no broad consensus on the issue. Given this state of affairs it would perhaps have been more reasonable to assume that elasticity is the same at high and low prices.

If this had been done there would have been no need to *nominate* a value for the elasticity, as one is already calculated from the data used to formulate the system of market equations. Equation (vi) may be written:

$$P(t) = 10^h/(QP(t)^m WS(t)^n)$$

and transformed to give

$$QP(t) = 10^{h/m}/(P(t)^{1/m} WS(t)^{n/m}).$$

Since in the long term quantity produced can be equated to quantity demanded it is apparent that $-1/m$ is an estimate of the price elasticity of demand. From the AWC's equation this would mean an across-the-board elasticity estimate of about 2·96. The nominated values mentioned in Appendix 4 for the pair (E_L, E_U) are (1, 2) and (0·5, 1·5) (pp. 73, 75). Leaving aside the question of the relative magnitudes of E_L and E_U, it would seem that all of these values may be under-estimates. However, as explained in the appendix to this article, it is a curious fact that unless E_U is less than 2·96 the procedure given for determining the ruling price after a stockout gives rise to prices below P_U. This would be an inconsistency as serious as that which already occurs after money-outs. When the calculated elasticity is used the corresponding procedure is straightforward; the price realized is simply the price which would have been offered for the quantity which is available, which is *QS* if prices are high and whatever is left after the Corporation has bought all it can afford if prices are low.

Conclusion

Despite its defects the model is basically a sound idea. It is susceptible to improvements beyond those suggested here and could be developed into quite a useful econometric tool. Of the deficiencies pointed out, some lie in the way the results were handled and reported. The two major structural defects—the zeroing pressure on stocks and the independence of consecutive years—are fairly easily corrected. A fairly straightforward method of setting prices consistent with the theory of operation of buffer stock schemes after stockouts and moneyouts is described in the appendix to this article.

From a practical point of view it would be desirable to set the price bounds in the previous time period rather than determine them concurrently with the actual price. A more far-reaching improvement would be to link the revenue function (or some more appropriate utility function) to a *decision* which sets the price bounds for the next period. This would enable some form of optimal control to be introduced so that the model could simulate a scheme for which some policy objectives had been set. The revenue function is merely an adjunct to the present model, included to provide some more examinable output, and would need modification to be used as a utility function. Another possibility is to use a quadratic loss function of the type suggested by Dalton [3], but this would put a premium on stability to the exclusion of revenue considerations. In the last analysis the choice of a utility function must depend on the objectives set for the scheme—and these seem rather hazy at present. Although the AWC declares: 'maximization of net gains is the optimizing criterion, to which minimization of price variability is the dual solution' (p. 68) the model does not incorporate these aims. It is far from apparent that the duality exists, but no argument is advanced to support this extraordinary statement. In practice the aims of buffer stock/price stabilization schemes are diffuse but an attempt to specify more closely how stability and trading profits are to be reconciled would be a useful aid to the construction of a utility function.

The search for a utility function entails the consideration of questions much larger than those which have been discussed in this article. Among them is the question of whether the considerable costs involved in merely seeking to limit the variability of prices, in the face of such imponderables as changes in overseas exchange rates and changes of government both overseas and in Australia, are justified.

APPENDIX

The Price in the Event of a Stockout or Moneyout

The procedure given (p. 72, (9)(c)) by the AWC for determining the new price after a stockout or moneyout seems a rather arbitrary one, especially as no explanation of it is put forward. This appendix suggests an alternative procedure for price formation in these cases, if elasticities are nominated.

Suppose that $P^*(1) > P_U(1)$ and that $QD(1) > QS(1)$. This is the situation in which stocks are insufficient to hold the price down to P_U (a stockout).

With the AWC, suppose that the actual demand relation can be expressed as a "shift" of the theoretical relation and that quantity demanded at price P is given by

$$QD = QP^*(1)[P^*(1)/P]^{1/m}$$

instead of equation (vi) which would give $[10^h/WS(1)^n \,.\, P]^{1/m}$ if QP were read as QD. It is readily seen that this equation gives $QP^*(1)$ as the quantity demanded at price $P^*(1)$.

In this case quantity demanded must be set equal to quantity supplied $(QS(1))$, so that

$$P(1) = [QP^*(1)/QS(1)]^m P^*(1)$$

is the new ruling price. This is the same as the formula given in Appendix 4, viz.

$$P(1) = \bar{P}(1) \,.\, P^*(1)/\hat{P}(1)$$

However, to arrive at this price it was supposed that

$$QD(1) > QS(1)$$

i.e., $$QP^*(1)[P^*(1)/P_U(1)]^{E_U} > QS(1)$$

so that $$P^*(1) > P_U(1)[QS(1)/QP^*(1)]^{1/E_U}$$

Now $$\begin{aligned} P(1) &= [QP^*(1)/QS(1)]^m P^*(1) \\ &> P_U(1)[QS(1)/QP^*(1)]^{1/E_U - m} \\ &> P_U(1) \text{ if } E_U < 1/m \approx 2.96 \end{aligned}$$

So the consistency requirement that $P(1) > P_U(1)$ is satisfied as long as E_U is chosen to be less than 2·96.

An argument similar to that given above leads to the ruling price

$$P(1) = P^*(1)[1 - K/P_L(1).QP^*(1) + S(1)/QP^*(1)]^m$$

which satisfies the consistency requirement that $P_L(1) > P(1) > P^*(1)$ if $E_L < 2{\cdot}96$. The K in this equation is the capital constraint imposed as in Appendix 4. Clearly this price is not that given by the AWC's procedure.

References

[1] Australian Wool Corporation, *The Marketing of Australian Wool.* (AWC, Melbourne 1973.)

[2] ————, 'Appendix 4—An Inventory Scheme for Australian Wool'. *Appendices to The Marketing of Australian Wool.* (AWC, Melbourne 1974.)

[3] Dalton, M. E., 'Dynamic Stockholding Policies for Stabilizing the Wool Market'. *Quarterly Review of Agricultural Economics* XXIX: 3, 179-192, 1976.

[4] Grubel, H. G., 'Foreign Exchange Earnings and Price Stabilization Schemes'. *American Economic Review* 54, 378-385, 1964.

[5] Powell, A. A. and K. O. Campbell, 'Revenue Implications of a Buffer Stock Scheme with an Uncertain Demand Schedule'. *Economic Record* 38, 373-385, 1962.