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# COMBINATIONS OF BUFFER-STOCKS AND BUFFER-FUNDS FOR WOOL PRICE STABILISATION IN AUSTRALIA*

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**In this paper a preliminary analysis is presented of a combined buffer-fund and buffer-stock as an alternative to a pure buffer-fund or a pure buffer stock for stabilising wool prices. The alternatives analysed are designed so that each provides the same prices to producers as did the Reserve Price Scheme over the period of analysis. Least-cost combinations of policy instruments are derived. The results show that there is considerable potential for cost savings to be made by combining buffer-fund and buffer-stock instruments.**

## *Introduction*

A buffer-stock scheme operated in Australia to stabilise the price of wool (around 90 per cent of which is exported) between 1970 and 1991. The Reserve Prices Scheme was introduced in 1974 when the Australian Wool Corporation (AWC) was established in place of the former Australian Wool Commission and Australian Wool Board. The minimum Reserve Price or floor price was set annually, and the Corporation purchased wool when necessary to prevent the price of any type of wool falling below its floor price. Wool held in stock was sold when higher prices were realised in the market. There was no ceiling price to be maintained, and no stated policy governing the sale of stocks. The scheme was funded by a levy on producers which, until the 1990-91 season, was set annually at between 4 and 5 per cent of the value of production, and paid into the revolving Market Support Fund. The levy was set at 14.15 per cent at the start of the 1990-91 season, but on October 4 1990 it was increased to 21.15 per cent.

Several analyses of the impacts of the buffer-stock scheme have been undertaken. One line of investigation has been the impact of the scheme on the net revenues received by woolgrowers (see, for example, Campbell, Gardiner and Haszler 1980; Richardson 1982 and Haszler and Curran 1982). Another has been the impact of the scheme

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on the demand for wool (see Quiggin 1983). One recent study (Hinchy and Fisher 1988) was an investigation of the benefits of wool price stabilisation to Australian producers and processors. Another (Myers, Piggott and Tomek 1990) included, inter alia, an assessment of the buffer stock scheme in terms of its effects on the level of market uncertainty and the average level of prices and revenues received by producers.

There are contrasting views on the merits of the scheme. However, there seems little doubt that prices received by producers were more stable as a result of the scheme, at least until the floor price was reduced and the levy increased at the commencement of the 1990-91 season.

Insofar as more stable producer prices are viewed as a desirable objective, then a question of interest is the least-cost means of achieving a given level of stability. This question has received little attention in the literature. Given the costs associated with the purchasing, handling and storing of wool under a buffer stock scheme, it is possible that an alternative means of stabilising producer prices might be preferable. Indeed, in the first half of 1990 there was considerable commentary about the high costs of defending the minimum reserve price of 870 cents/kg clean through rapid stock accumulation, given that interest rates were high at around 20 percent. In the course of this debate the cost of storing wool, including interest costs, was estimated by the AWC at $220 per bale per year. The floor price was reduced to 700c/kg at the direction of the Minister for Primary Industries and Energy, partly in order that the costs associated with storing wool be lessened. In February 1991 the Reserve Price Scheme was suspended.

In a theoretical comparison of buffer-stocks and buffer-funds, Simmons (1988) concluded that a buffer-fund would be a less costly option. Longmire et al. (1986) compared a buffer-fund with the buffer-stock using an econometric model, and concluded that grower revenue and average prices would be reduced if a buffer-fund were to replace the buffer-stock. However, their results were influenced heavily by the design of the buffer-fund scheme and the period over which it was simulated.

A pure buffer-fund scheme and a pure buffer-stock scheme are often considered to be alternative, mutually exclusive policies. However, a buffer-fund and a buffer-stock could be operated in combination to achieve price stability goals, as happens in the New Zealand wool industry. As far as the present authors are aware, the operation of a price stabilisation scheme in which these two instruments are combined has not been considered in the literature. A preliminary analysis of such a combination of instruments is provided in the remainder of this paper.

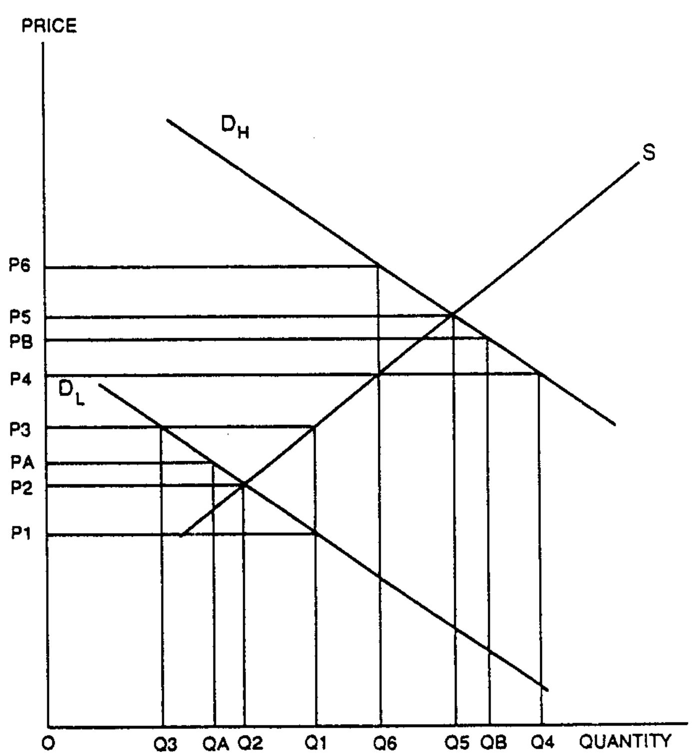
The operation of the Reserve Price Scheme (buffer-stock), a buffer-fund scheme and a combined buffer-stock and buffer-fund scheme are outlined in turn in the next section. Then follows an empirical evaluation of these alternatives with emphasis on the costs of providing a given level of price stability.

### *The Stabilisation Problem*

A price stabilisation scheme modifies the extent to which prices rise and fall. This is assumed to have been the objective of the Reserve Price Scheme. In the following analysis, the prices achieved historically under the Reserve Price Scheme are taken to be 'target prices', prices to be paid to producers under simulations of alternative schemes. The alternative policies (buffer-fund, and combinations of buffer-fund and buffer-stock) analysed here are set up so as to have the same impact on prices as did the Reserve Price Scheme.

The stabilisation problem can be described by reference to Figure 1. In this figure are two demand curves, $D_L$ and $D_H$, which apply at periods of low and high demand, respectively. P2 and P5 are the prices which would prevail without intervention. The objective of stabilisation is to reduce the price variability to a band between P3 and P4. P3 is the floor price under the Reserve Price Scheme while P4 is the market price at a period of high demand when the stabilising authority is selling stocks.

FIGURE 1
*Combined Buffer Stock and Buffer Fund*



At a time of low demand, producers receive price P3 and produce quantity Q1. Without intervention, this quantity would sell at price P1. (With perfectly inelastic supply, Q1 and Q2 would coincide, as would P1 and P2). The problem is to intervene in a manner to ensure that producers receive price P3, or to close the price gap, P3-P1. Similarly, at a time of high demand, the task is to close the price gap P4-P6.

In the case of the buffer-stock scheme, the price gap is closed by buying and selling stocks. When demand is low, the authority would purchase quantity Q1-Q3, thus closing the price gap P3-P1. When demand is high, quantity Q4-Q6 would be sold, reducing the market price to P4. The price at which wool is sold (P4) exceeds that at which it is bought (P3). The buffer-stock is expected to make a trading profit of (P4-P3) for each unit of wool bought and sold.

A potential advantage of a buffer-fund over a buffer-stock scheme is that it avoids the costs associated with handling and storing wool. A buffer fund scheme could be designed to provide more or less price stability than the Reserve Price Scheme. It could incorporate a trigger-type price ceiling as well as a price floor, or it could operate over the full spectrum of prices. Alternatively, a buffer-fund scheme could be like a deficiency payment scheme, funded by levy payments set at a constant percentage of prices above some minimum level. This would provide protection against low prices, but would do little to reduce upward instability.

The manner in which alternative schemes are designed will affect the subsequent analysis. The alternatives under comparison should be equivalent, so far as is possible, thus giving an element of control to the analysis. Hence, the buffer-fund and combinations of buffer-fund and buffer-stock schemes evaluated here are designed to have the same effect on prices received by wool growers as did the Reserve Price Scheme over the period of analysis. As producers receive the same price, it is assumed that they produce the same quantity under each alternative. Hence, any 'hidden gains and losses' will also be the same, as prices received and quantities produced will be identical under alternative arrangements.

The price gaps, which under the buffer-stock scheme are closed by buying and selling stocks, are closed under a buffer-fund by a levy or subsidy equal to the price difference. A buffer fund would grow if the quantity of wool produced at high prices, when a levy is being raised, exceeds the quantity produced at low prices when a subsidy is being paid. In Figure 1, subsidy payments are represented by (P3-P1) times Q1, while levy receipts are (P6-P4) times Q6. In the data, the correlation between price and quantity produced in each year is positive but low. Thus buffer-fund 'profits' would have been small.

Combinations of buffer-stock and buffer-fund instruments are worth considering, since a combination of instruments may provide a given degree of price stability to producers more cheaply than under either alternative scheme alone. This may be the case with a fixed combination of instruments, or with a flexible combination which allows the stabilising authority to make strategic shifts of emphasis between stockholding and funding activities.

With a combination of instruments, part of the price gap might be closed with one instrument, and the remainder with the other. In this analysis, an 'x' combination of instruments signifies that proportion 'x' of the price gap is closed by a buffer-stock operation, while proportion '1–x' is closed by a subsidy or levy. For example, the authority might choose x = 0.67. When demand is low it would purchase quantity Q1-QA, thus making up two thirds of the required price gap. Meanwhile a subsidy payment of P3-PA (on each of the Q1 units produced) would close the remaining one third of the price gap. The two instruments together would increase producer prices from P1 to P3. When demand is high, following the same strategy, QB-Q6 would be released from stocks. This reduces the price from P6 to PB, closing two thirds of the P6-P4 price gap. The remaining one third of the price gap is closed by a levy of PB-P4.

Alternatively, the two instruments could be combined in such a way that market prices and quantities sold to the trade would be the same as if there were no intervention, but with producer prices the same as under the buffer-stock scheme. This would entail the stabilising authority purchasing stocks of Q1-Q2 when demand is low and paying a subsidy of P3-P2. When demand is high it would sell Q5-Q6 from stocks and impose a levy of P5-P4. Such a combination might be advantageous if one aim was to avoid interfering with market conditions faced by buyers.

In this study, several fixed combinations of the two instruments are evaluated. Then, using non-linear programming and allowing a different combination each year, the set of combinations is found which minimises the total cost of operation.

## *Empirical Analysis*

### *Data*

Annual data on the operation of the Reserve Price Scheme from 1970-71 to 1987-88 are used to simulate the effects of the policy instruments. Price data used are the average auction price for greasy wool as published by the Australian Bureau of Agricultural and Resource Economics (1988). Data on wool production and stocks are from the same source. The Reserve Price Scheme commenced with no wool in stock in 1970-71 and only 1.5 kt was held at 30 June 1988. Thus the period of analysis is one which begins and ends with virtually no stocks.

### *Method of evaluation*

From annual data on the market price (P3 or P4), quantity produced (Q1 or Q6), and the quantity purchased or sold by the AWC (Q1-Q3 or Q4-Q6), and using assumptions about the nature of the demand schedule, the market prices which would have been observed under a buffer-fund (P1 or P4) were derived. From these, the operations of a buffer-fund and of combinations of a buffer-stock and buffer-fund were simulated.

The alternative policies considered here result in producers receiving identical prices. Policies are evaluated on the basis of the cost of providing a given degree of price stability to producers. All receipts and all payments are made into and out of a (simulated) fund, and an annual interest charge/receipt is applied to the end-of-year balance. The alternative with the largest balance of the fund at the end of the 18 year period is the one which provides price stability at the lowest cost. The balance of the fund is calculated as:

$$(1) \qquad Fx_t = (Fx_{t-1} + TOTLEVx_t - TRDVALx_t - STCSTx_t + MSF_t \,.\, ROFI_t$$

where:

| | | |
|---|---|---|
| $Fx_t$ | = | the balance of the fund at end of year t; |
| $TOTLEVx_t$ | = | the total levy collections for buffer-fund operations in year t (negative values indicate subsidy payments): |
| $TRDVALx_t$ | = | net expenditure on wool purchased for stockholding (negative values indicate net sales); |
| $STCSTx_t$ | = | cost incurred by the AWC for handling and storing wool; |
| $MSF_t$ | = | Market Support Fund levy, calculated at 5 per cent annually (the value of MSF is the same under each alternative, so there is no 'x' attached); |
| $ROFi_t$ | = | 1 + rate of interest; |
| x | = | the proportion of buffer-stock in the policy mix, where $0 \leq x \leq 1$; and |
| t | = | subscript denoting years (t = 1, ..., 18). |

The closing value of the fund at the end of the 18 year period was calculated for the buffer-stock, buffer-fund, and for the arbitrarily chosen combinations of x = 0.5 and x = 0.8.

There is no need for the value of x to be the same each year. The stabilising authority might be given the power to choose whatever combination of buffer-stock and buffer-fund policies it judged to be the best at any time. In order to find the combination of policies in each of the past 18 years which would have produced the highest closing balance of the fund, equation (1) has been treated as an objective function to be maximised using the non-linear program MINOS (Murtagh and Saunders 1983). Constraints were imposed to ensure that each value of $x_t$ fell between 0 and 1, that stock levels in each year were not negative, and that closing stocks at the end of year 18 equalled zero.[1]

[1] Because of the logarithmic cost-of-storage function described in equation (3), stock levels of zero cause problems. Stock levels were actually constrained to a minimum of a very small positive value.

*Assumptions*

A wide range of estimates of auction-level elasticities of annual demand for Australian wool appear in the literature. Dewbre and Smith (1984) report that the elasticity of demand for Australian wool lies in the range –0.6 to –0.8. An elasticity of demand for Australian and New Zealand combing and carding wools of around –0.8 is consistent with Davidson et al. (1988). This is used as the most likely value in the analysis in this paper, although a range of elasticities from –0.2 to –2.0 by intervals of 0.3 is used in sensitivity analysis.

It is assumed that demand is linear, and that any shifts in demand are parallel. The demand function is represented as:

(2) $$Q_t = C_t + dP_t$$

where:

$Q_t$ = the quantity demanded in year t;
$C_t$ = the intercept for year t, calculated to allow a schedule of slope d to pass through the observed price:quantity point for that year;
d = the slope, calculated so that the specified elasticity applies at the average price and quantity observed over the 18 years under analysis; and
$P_t$ = price in year t.

The choice of functional form is critical to the analysis. The potential impact of the degree of non-linearity in demand has been demonstrated analytically (Moir 1989). As demand becomes more curvilinear, a buffer-fund becomes more attractive relative to the buffer-stock.

Although Figure 1 incorporates shifting demand and stable supply schedules, it is not assumed in this analysis that price instability results from demand shifts. No assumption is made about the nature of the supply schedules. The alternative policies considered here all result in the same prices to producers, and it is assumed that the quantity produced would be the same under each alternative. The only point on the supply schedule for each year required is that point on which the recorded price and quantity lie.

It is assumed that administrative costs are the same under each alternative scheme, and they are not explicitly included in the analysis.

Physical handling and storage costs were modelled by Foster (1988). This model includes a number of equations, and requires much data. Separate data are required, for example, on wool held in stocks overseas and in Australia, and on sales of ex-stock wool by treaty and by auction. Such disaggregated data cannot be generated from the models of alternative schemes described in this paper. Furthermore, the relationships between costs and explanatory variables under the Reserve Price Scheme need not hold under the alternatives involving only partial emphasis on stockholding. The simpler approach used in this study was to estimate an equation with aggregate handling, storage and selling costs as a function of the average level of stockholding (the mean of opening and closing stocks) and time. A log-linear form was used to allow any economies of scale to be represented and to preclude the prediction of negative costs. The result was:

$$(3) \qquad \underset{}{Log(STCST_t)} = \underset{(10.9)}{5.09} + \underset{(8.6)}{0.54}*Log(STOCK_t) + \underset{(5.2)}{0.60}*Log(TIME_t)$$

$\bar{R}^2 = 0.86$, D-W statistic = 1.91, and 't' statistics are given in parentheses,

where:

$STCST_t$ = storage, handling and selling costs in year t, in \$'000;
$STOCK_t$ = mean of opening and closing stocks in million kg; and
$TIME_t$ = 1 in 1969-70, ..., 19 in 1987-88.

This function was used to calculate handling, storage and selling costs. In the final year of the estimation period (1987-88), for example, actual costs were \$6.7m, while the prediction was \$5.9m, equivalent to \$35 per bale.

## *Results*

The results are summarised in Figure 2. In general, the difference in outcomes between the pure buffer-stock, under which the actual data used in the analysis were observed, and the simulated effects of a pure buffer-fund and combinations of the two instruments, were found to be greater with less elastic demand. This is not surprising, as the price gap implied by a given change in stocks is greater at smaller elasticities of demand. This result is consistent with the *a priori* reasoning of Moir (1989).

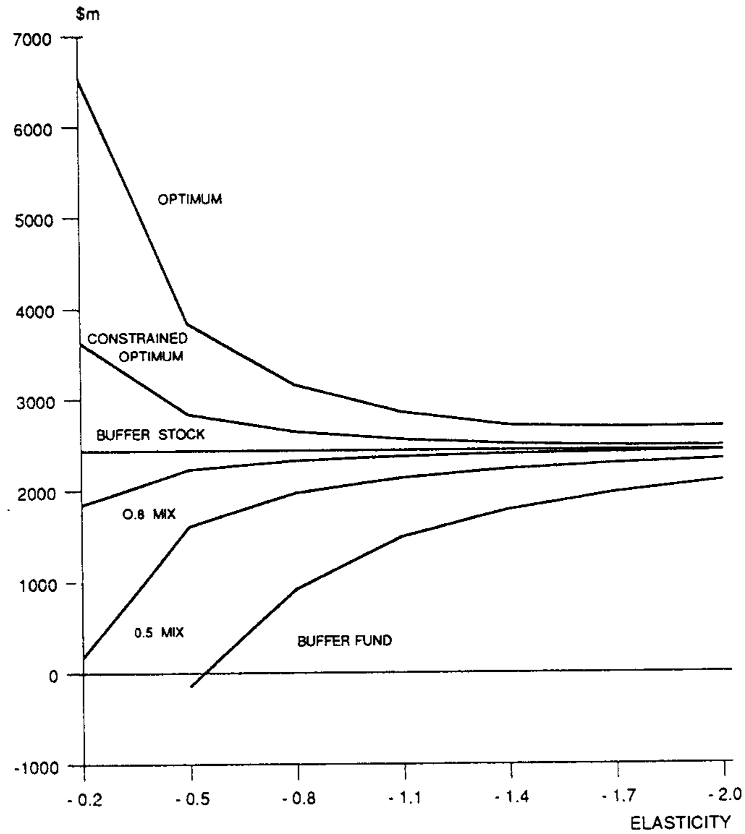
The balance of the fund at the end of the period is higher with the pure buffer-stock than with either the pure buffer-fund or with the x = 0.5 or x = 0.8 combinations. However, Moir (1989) showed that results are different if the demand function is non-linear or if shifts in demand are not parallel. In particular, with a constant elasticity of demand, the pure buffer-fund is preferred to fixed combinations of buffer-fund and buffer-stock, which in turn are preferred to the pure buffer-stock.

The conclusion that a pure buffer-stock provides stability at a lower cost than the buffer-fund is contrary to the prediction of Simmons (1988). His assumptions on supply and demand functions would result in price:quantity relationships which differ from those used in this analysis. Simmons assumes that the expected price in one period is the level at which prices will be stabilised in the next. This is not the rule followed by the AWC over the period of this analysis.

Non-linear programming was used to determine the optimal fixed combination of instruments (where x is constant over the 18 years). With elasticities of demand from –0.2 to –1.7, the pure buffer-stock is optimal. Only at the high elasticity of –2.0 does a buffer-fund enter the

FIGURE 2

*Worth at End of 18 Years with Fixed and Optimal Combinations*




optimal combination, and then only negligibly. A combination of x = 0.97 (3 per cent buffer-fund) is optimal.

A higher closing balance of the fund was achieved by allowing the combination of instruments to change from year to year. Then, for each elasticity, the optimal set of combinations is considerably better than the pure buffer-stock, the pure buffer-fund and fixed combinations (see figure 2). However, the differences decrease as demand becomes more elastic.

The optimal set of policies derived, shown in Table 1, includes nine years of pure buffer-stock operations, eight years of pure buffer-fund, and one year when a combination is used. There are five changes from one extreme to the other. Such erratic behaviour by the stabilising authority may be unacceptable.

Another optimal solution was generated, this time constraining the year-to-year changes in the policy mix to a maximum of 10 percentage points, ie:

$$x_{t-1} - 0.1 \leq x_t \leq x_{t-1} + 0.1.$$

The results of this constrained optimisation are also shown in Figure 2. With this constraint there is still potential for a flexible mix of policy instruments to yield better results than either a single instrument or any fixed combination of instruments.

TABLE 1
*Optimal Set of Stabilisation Policies, 1970/71 to 1987/88*

| Year | No constraint on year-to-year changes ($x_t$) | Annual change constrained to ≤ 0.1 ($x_t$) |
|---|---|---|
| 1970/71 | 1.0 | 1.0 |
| 1971/72 | 0 | 0.9 |
| 1972/73 | 0 | 0.9 |
| 1973/74 | 1.0 | 1.0 |
| 1974/75 | 1.0 | 1.0 |
| 1976/76 | 0 | 0.9 |
| 1976/77 | 0 | 0.8 |
| 1977/78 | 0 | 0.7 |
| 1978/79 | 0.18 | 0.6 |
| 1979/80 | 1.0 | 0.52 |
| 1980/81 | 1.0 | 0.5 |
| 1981/82 | 0 | 0.4 |
| 1982/83 | 0 | 0.5 |
| 1983/84 | 0 | 0.6 |
| 1984/85 | 1.0 | 0.7 |
| 1985/86 | 1.0 | 0.8 |
| 1986/87 | 1.0 | 0.9 |
| 1987/88 | 1.0 | 1.0 |

$x_t$ is the proportion of buffer-stock in the policy mix in year t; $x_t = 1$ indicates buffer-stock operation, $x_t = 0$ indicates buffer-fund.
Slope of linear demand functions derived using elasticity = –0.8.

While there is potential for a policy of variable combinations of instruments to offer benefits relative to fixed alternatives, these results do not indicate what might be achieved in practice by a stabilising authority. These results were derived with the benefit of hindsight, using data from the past. A stabilising authority determining its policy relies on forecasts. The success of flexible combinations of instruments will depend on accurate forecasts and good management. The results from the optimal policy presented here are only the upper limit. Inadequate forecasts or bad management might produce results worse than those expected under the buffer-stock scheme.

The effect of choice of policy on variability of market prices and quantities is shown in Table 2. Variability of market price is greatest with the pure buffer-fund, while variability of quantity is greatest with the pure buffer-stock. The coefficients of variation of market price and quantity with both the optimal and constrained optimal policies lie between the extremes of the buffer-stock and buffer-fund. The impact which differences in variability of price and quantity have on the market could, in principle, be important (see, for example, Watson 1980 and Quiggin 1983), but these differences seem small over the sample period used in this study.

TABLE 2
*Coefficient of Variation of Market Price and Quantity Under Alternative Policies*

| Policy | Price (Coefficient of variation) | Quantity (Coefficient of variation) |
|---|---|---|
| Buffer-stock | 0.526 | 0.146 |
| Constrained Optimum | 0.529 | 0.138 |
| Optimum | 0.541 | 0.138 |
| Buffer-fund | 0.573 | 0.102 |

Slope of linear demand functions derived using elasticity = –0.8.

### *Limitations of the Study*

The study reported here is not a complete analysis of the benefits and costs of the alternative policies. Only the costs of achieving a given degree of price stability to producers are considered. It is assumed that neither supply nor demand schedules would shift if one policy was substituted for another. While the first of these appears reasonable, there is reason to expect demand to be affected by policy changes. There clearly are inherent differences between buffer-stock and buffer-fund mechanisms. In designing alternative schemes in such a way that producer prices are the same under each alternative, the differences between these instruments are concentrated on the demand side. If a buffer-fund were substituted for the buffer-stock, market prices would become less stable, while the quantity sold to the trade would become more stable. There is a possibility that demand would shift in response to a change in policy. This would affect prices and quantities traded.

The conclusions also take no account of possible changes in private stockholding. A move away from a buffer-stock scheme might be expected to result in an increase in private stockholding. This would have some stabilising effect on the market, and would leave a smaller price gap to be closed by the buffer-fund operation. Thus, a buffer-fund, and combinations of policy instruments which include a buffer-fund, may be more attractive than is indicated by the results presented here.

Wool has been treated as an homogeneous commodity in this analysis. Data on annual production and annual average prices have been used. There are many different types of wool, and interactions between the supply of, and demand for, different types may be an important factor in this type of analysis. The use of annual data precludes consideration of what could be important seasonal effects. Use of the buffer-fund, which has been shown here to increase price variability between years, would also increase price variability within years. Consumer welfare has not been considered. A plausible argument is that wool price stabilisation is the 'property' of producers, set up by producers for their benefit. The analysis here has been conducted on that basis.

The assumptions on the nature of demand and demand shifts are important. Assuming non-linear demand would have made a buffer-fund more attractive. It is not clear, however, that this has any bearing on the conclusion that flexible combinations of policy instruments can be superior to either instrument alone.

## *Concluding Comments*

The operation of a buffer-fund as an alternative to the buffer-stock scheme for wool price stabilisation has been analysed. The analysis includes combinations of the two instruments. Empirical results indicate that, under the assumptions made, the buffer-stock provides price stability at a lower cost than the buffer-fund considered as an alternative. Combinations of a buffer-fund and buffer-stock, where the combination is held constant through the 18 year period, are more costly than the pure buffer-stock. However, it has been shown that there is potential for costs to be reduced by allowing a different combination of buffer-fund and buffer-stock to be used each year. This conclusion holds when year-to-year changes in the combination are constrained.

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