SUPPLY RESPONSE IN THE WHEAT-BELT OF SOUTH-EASTERN AUSTRALIA: THE IMPACT OF DELIVERY QUOTAS ON WHEAT PLANTINGS*

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Supply response equations were estimated for a number of regions in south-eastern Australia using the area sown to wheat as the response variable. These equations were used to determine the effect of delivery quotas on the area of wheat sown in those regions. Results from this study indicate that delivery quotas were only effective in reducing wheat plantings in the south-eastern Australian wheat-belt in the 1970-71 season. Plantings in other seasons in which delivery quotas were applied could be explained using variables such as wheat prices and a time trend.

Several studies of supply response in the Australian grain industries have been conducted in recent years.[1] However, no attempts have been made to assess the direct effect of wheat delivery quotas on wheat plantings. In a study of supply response in the coarse-grain industries, Traill [17] used wheat plantings as an exogenous variable in equations explaining the area sown to coarse grains. He suggested that a knowledge of the size of wheat quotas in any year could be used to predict the area sown to wheat, and that these predictions could be used in equations designed to forecast the plantings of coarse grains in that year.

The main aim of this study was to estimate a number of regional supply response equations for the south-eastern Australian wheat-belt, and to use these to establish whether the wheat delivery quotas introduced in 1969 were effective in restricting the area sown to wheat during the seasons 1969-70 to 1971-72. If delivery quotas were effective in restricting wheat plantings, then a knowledge of the size of the quota for a particular season would provide a basis for forecasting plantings in that season. Data for the period 1949-50 to 1971-72 were employed in the analysis of supply response in two regions in southern New South Wales and three regions in Victoria. A similar analysis using aggregate data from the period 1949-50 to 1973-74 for Victoria was also undertaken and the results compared with those of the regional analysis.

The Methodology

The marketing quotas imposed on the wheat industry in 1969 restricted the amount of the commodity that could be delivered to the Australian Wheat Board.[2] As such the quotas had only an indirect effect on the area of wheat sown. The effect of the introduction of wheat quotas is unclear, partly because the payments to farmers from wheat pools fell between the period 1967-68 and 1969-70. The prices received for the principal alternative commodity, wool, and for barley, were also

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[1] See, for example, the studies by Anderson [2 and 3], Traill [17], Powell and Gruen [15] and Duloy and Watson [6].

[2] For a summary of the regulations governing delivery quotas see Hellier [9].

trending downwards during this period. Depending on the relative significance of these price changes and the effect of time lags, the area sown to wheat in the seasons following 1969-70 may have fallen even in the absence of wheat quotas. In an attempt to disentangle these separate effects, the following steps were taken.

(1) Supply response equations were estimated for five regions in the south-eastern Australian wheat-belt using data for the period 1949-50 to 1968-69. Watson and Duloy [18] have shown that successful estimates of supply response relationships can be made at a regional level. For this study two regions were chosen in southern New South Wales and three were selected to include the major wheat growing areas in Victoria.

(2) Forecasts of the area sown to wheat in these regions were then made for the three seasons 1969-70 to 1971-72 using observed values for the independent variables, and a test was performed to ascertain whether there was a significant difference between the actual and forecast levels of plantings.

(3) The supply response equations were then re-estimated for the period 1949-50 to 1971-72, and estimates of the effect of the quota on areas sown were obtained using dummy variables. The respective differences between the actual and forecast plantings obtained in step two were compared with the estimated quota effects for the various seasons, and conclusions were drawn about the impact of the delivery quotas on wheat plantings and on the structure of the response to wheat price.

The Selection of Regions

The area sown to wheat is dependent on a number of factors, including product prices and the presence or absence of quotas, as well as climatic conditions. For this study an attempt was made to limit the effect of weather variability by selecting regions in the southern wheat-belt. Plantings in northern New South Wales and Queensland are heavily dependent on soil moisture stored during the preceding summer months. Plantings in southern New South Wales and Victoria are much more likely to be made in anticipation of adequate rainfall. The regions chosen in southern New South Wales and Victoria are essentially the same as those used by Watson and Duloy [18]. For this study a correlation analysis of wheat yield data for local government areas in New South Wales and counties in Victoria was conducted on the assumption that yield was a proxy for climatic effect. It was found that there was no reason to reject the traditional disaggregation of the Victorian wheat-belt into the statistical districts Mallee, Wimmera and Northern. Southern New South Wales was divided into two regions, Southern Slopes and the Riverina.[3]

Some indication of the product mix on wheat farms in these regions can be obtained from the Australian Bureau of Agricultural Economics' regular surveys of the wheat-growing industry. An examination of relevant statistics indicated that wool production was the most important alternative enterprise, in terms of percentage of receipts, on farms growing significant quantities of wheat. The main alternative cropping enterprises were barley and oats. For the three-year period 1969-70 to

[3] See Appendix for a list of the local government areas in these regions.

1971-72 the Bureau of Agricultural Economics' statistics show that approximately 30 per cent of the area under crops was sown to either barley or oats. Approximately 64 per cent of the crop area was sown to wheat. Between the mid-60s and the three-year period ending in 1971-72, there was a significant increase in the proportion of the cropped area planted to barley. The increase in barley plantings appears to have been associated with a fall in the area sown to wheat and oats during the years when wheat quotas were in existence.

The Approach to Supply Response and Time Lags

Economic theory suggests that the product price, relative to the prices of alternatives and input costs, is important in determining the amount of a commodity produced. The price variables may be incorporated in a supply response equation as single variables or as ratios, and usually operate with some time lag. The simplest models used in supply response analysis incorporate price variables with one or two period lags. More complex equations may incorporate, either implicitly or explicitly, a distributed lag on the price variables.

Probably the most widely employed justifications for using a distributed lag on prices in agricultural supply response analysis are the adaptive expectations and partial adjustment hypotheses due to Cagan [4] and Nerlove [12 and 13] respectively. Some theoretical basis has been established for these models, particularly the adaptive expectations hypothesis. Griliches [7, p. 42] suggests that the adaptive expectations hypothesis is closely related to the theory of optimal prediction where it has been shown that, under many circumstances, moving averages with exponentially declining weights are optimal predictors for certain types of random walk series.[4] It has been suggested by others, however, that response to a price change might be delayed if the change is felt to be temporary.[5] Such a response might lead to a lag structure with weights that rise and then fall, rather than a set of weights that decline geometrically. The simplest way to provide for such a possibility is to estimate the lag weights using a polynomial distributed lag technique.[6] Suitable portions of a degree two polynomial can give rise to a 'humped' type of distribution or one which approximates a lag structure with geometrically declining weights.

The use of a distributed lag on price variables has important implications for the form in which these variables should be included in the supply response equation. In many studies, for example those of Anderson [2] and Duloy and Watson [6], ratios of product prices are used. This has the advantage that it may save some degrees of freedom. However, the use of a ratio of product prices may lead to a specification error in a distributed lag model because its use implicitly assumes that

[4] It is a point of conjecture whether in fact any price series is a random walk.

[5] For example, see Anderson [3, p. 121].

[6] Anderson [2] and Chen *et al.* [5] have used a polynomial distributed lag in agricultural supply analysis. However, these studies use a method of estimation due to Hall and Sutch [8] which assumes, *a priori*, that the lag weight at the far end of the lag distribution is equal to zero. As there was no reason to believe that such a constraint existed before the estimation was performed the more general procedure due to Almon [1] was used in this study.

the lag effect has the same duration for both price variables.[7] This may not be so, especially when a livestock price is included with a crop price in the ratio. Because of the enterprise mix on wheat farms in the regions under study, it was felt that both wool and barley prices might be relevant alternative product price variables to include in the supply response equations. In an attempt to gauge the effect of a possible specification error caused by including these price variables in the ratio form, the price variables were included in equations both as ratios and separately.

In this study no attempt has been made to take account of changes in input costs. Nerlove [13, p. 83] has suggested that while the inclusion of input prices is useful, such prices may be omitted without serious difficulties arising. The aggregate time-series data on input prices that are available indicate that farm costs have been trending upwards over the period 1949-50 to 1971-72, while prices received for wheat have been almost stationary and those for wool have been trending downwards. Profit maximizing firms facing these circumstances would reduce output if the production techniques remained unchanged. However, some technical changes have occurred during the sample period. Without detailed knowledge of the effects of these changes on outputs, the inclusion of input prices in time series analysis of supply response is likely to result in misleading conclusions.

The price of wheat used in this study is the total amount (per tonne) paid to growers from each wheat pool. This price variable has some defects even though, compared with other wheat price variables such as the guaranteed price, it most closely represents the returns to growers from a particular crop. Because of the operation of the wheat price stabilization scheme, the Australian Wheat Board makes a number of payments, over an extended period, for wheat received during any one season. Consequently, when a crop is sown, the only payment that has been received by growers for the wheat delivered in the previous season is the first advance.[8] As Watson and Duloy [18, p. 44] indicated, farmers have some information on the likely final payment because both the state of the international grain market and the proportion of the crop that will be sold at the guaranteed price is known. Even if this information is not particularly accurate, the importance of any unknown payments for a single crop is reduced in supply response

[7] For example, consider the response function

(1) $Y_t = f(PR^*_t)$

where PR^*_t is the expected price ratio of wheat to wool prices and assume the expected prices are a weighted sum of past prices. If PR^*_t is in fact a ratio of expected wheat prices, say

(2) $PWh^*_t = \sum_{i=0}^{j} a_i PWh_{t-i}$

to expected wool prices, say

(3) $PWo^*_t = \sum_{i=0}^{k} b_i PWo_{t-i}$

rather than a weighted sum of wheat to wool prices, say

(4) $\frac{(PWh)^*}{(PWo)_t} = \sum_{i=0}^{h} c_i \frac{(PWh)}{(PWo)_{t-i}}$

then estimation of a function containing (4) will amount to a specification error.

[8] On average over the period considered the first advance constituted approximately 80 per cent of the final pool payment for any one season.

equations containing an expected price variable which is specified as a function of a number of past prices.

Over the period studied there was a strong upward trend in the area sown to wheat in most regions in the Australian wheat-belt. To take account of this linear time trend variable was included in the models.

In response functions estimated for the period 1949-50 to 1971-72, it was necessary to include a measure of the effect of delivery quotas on the area sown. Because the response equations were estimated on a regional basis, it was not possible to develop a quantitative measure of this effect based on the size of the quota allocated to each State. As an alternative, dummy variables were used. A different dummy variable was used for each year in which a quota restriction was imposed because the magnitude of the quota restriction changed from year to year.[9]

The Estimated Response Functions for the Period 1949-50 to 1968-69

The response equations finally accepted are given in Table 1. Equations containing a distributed lag on the price ratio variables performed badly. No instance was found where the estimated coefficient on the barley price variable, included either separately or in the wheat to barley price ratio, was significantly different from zero. In all equations where a distributed lag on the wheat to wool price ratio was estimated, all the coefficients on the price variables were insignificant. In equations containing the wheat to wool price ratio lagged one year and a time trend, there was strong evidence to suggest the existence of positive serial correlation among the estimated residuals. Re-estimation of these equations with a first order autoregressive structure fitted to the residuals resulted in the coefficients on both the price ratio and trend variables becoming insignificant.[10]

The only equations in which the coefficients on an alternative product price variable were statistically significant were those containing a distributed lag on wheat prices and a wool price variable lagged one year. However, the explanatory power of these equations was much lower than for those presented in Table 1. For example, the $\bar{R}^2$ values for equations estimated for the Southern Slopes and the Riverina were 0·8042 and 0·7795 respectively. The root mean squared errors for the forecasts of the areas sown, for the three years 1969-70 to 1971-72, obtained from these equations were also larger than those obtained using the equations presented in Table 1. This suggested that the wool price

[9] It was assumed that the correct model was of the form:

$A_t = a_1 + b_1X_1 + \ldots\ldots + b_kX_k$ before 1969-70
$A_t = a_2 + b_1X_1 + \ldots\ldots + b_kX_k$ in 1969-70
$A_t = a_3 + b_1X_1 + \ldots\ldots + b_kX_k$ in 1970-71
$A_t = a_4 + b_1X_1 + \ldots\ldots + b_kX_k$ in 1971-72

Then in the case where the data from the period 1949-50 to 1971-72 were used the regression equation:

$$A_t = c_1 + c_2Q2 + c_3Q3 + c_4Q4 + b_1X_1 + \ldots\ldots + b_kX_k$$

was estimated, where $Q2$, $Q3$, $Q4$ are the quota dummy variables. Comparison of these equations reveals that:

$a_1 = c_1$
$a_2 = c_1 + c_2$
$a_3 = c_1 + c_3$
$a_4 = c_1 + c_4$

The conventional test of significance on c_2, c_3 or c_4 tests whether there was a significant change in the size of the intercept term, a_1, in any quota year.

[10] The procedure used in the estimation of this equation is due to Pagan [14].

variable was acting as nothing more than an imperfect trend variable. This was later confirmed when equations were estimated for Victoria as a whole using the sample period 1949-50 to 1973-74. Over this period the wool price series does not have a strong negative trend as it did for the shorter period 1949-50 to 1968-69. When the lagged wool price variable was included in equations estimated for the longer period, its coefficient became insignificant. Consequently, equations without alternative product price variables were accepted.

Because it was originally suggested that the lag weights were likely to rise and then fall or to decline steadily, the degree of the polynomial used in the estimation of the distributed lag on wheat prices was initially

TABLE 1

The Estimated Supply Response Equations for Five Regions in South-eastern Australia: Sample Period 1949-50 to 1968-69[a]

Information on Variables in the Regression	Southern Slopes Region 1	Riverina Region 2	North-eastern Victoria Region 3	Wimmera Region 4	Mallee Region 5
Constant	—102·845	—150·471	—62·674	—76·431	—68·156
	(—6·405)	(—6·419)	(—5·317)	(—4·918)	(—3·166)
Time Trend	1·676	2·237	0·550	0·669	1·160
	(9·212)	(9·963)	(4·281)	(3·945)	(4·942)
Wheat Price $\sum_{i=0}^{3} w_i P_{t-i-1}$					
Degree of Polynomial	1	1	2	2	2
w_0	0·5904	0·6683	0·2515	0·3531	0·3583
	(6·6482)	(6·5127)	(2·9526)	(3·1444)	(2·3030)
w_1	0·3936	0·5016	0·3067	0·4104	0·4273
	(6·6482)	(7·0841)	(5·4448)	(5·5264)	(4·1539)
w_2	0·1968	0·3349	0·2229	0·2927	0·3079
	(6·6482)	(4·7707)	(3·6617)	(3·6478)	(2·7700)
w_3	0·0000	0·1681	0·0000	0·0000	0·0000
	(0·0000)	(1·6590)	(0·0000)	(0·0000)	(0·0000)
R^2	0·9413	0·9565	0·8688	0·8654	0·8493
F	129·2584	118·3843	36·3060	35·2949	31·0583
$D.W.$	1·7729	1·6722	1·9298	1·7463	1·8781
Average Lag (years)	1·67	2·00	1·96	1·94	1·95
Estimated Response Elasticity at the Data Means:					
Short run	1·86	1·77	1·30	1·04	0·68
Long run	3·73	4·43	4·03	3·12	2·09

[a] The numbers appearing in parentheses are values for Student's t statistic. The response variable is in units of 10,000 hectares.

two.[11] However, the estimated lag weights declined almost linearly in the response equations for the two regions in southern New South Wales. Equations in which the lag weights were constrained to lie along a straight line performed slightly better in terms of $\overline{R^2}$ and the root mean squared forecast error than those containing a second degree polynomial constraint. On this basis the equations containing the linear constraint were accepted for the regions in New South Wales. Equations containing a second degree polynomial constraint were satisfactory for regions in Victoria.

The lag on the wheat price variable begins at time period $(t - 1)$ and is four periods long. Duloy and Watson [6, p. 39] suggested that the effect of a change in the wheat to wool price ratio could be expected to last four or five years. For regions in this study the duration of the lag effect for a change in the wheat price alone is three or four years. This result is broadly consistent with Duloy and Watson's finding. For all regions except the Riverina, the estimated weight on the wheat price variable lagged four periods was highly insignificant. Constraining this weight to zero during estimation increased the $\overline{R^2}$ for these equations. For this reason, the equations estimated with an *a priori* zero constraint were accepted and are shown in Table 1.

The equations in Table 1 were used to make forecasts of the area sown to wheat in the three seasons following 1968-69. The predictions are given in Table 2. These equations consistently over-estimated the area sown in 1970-71 but were accurate for the 1969-70 and 1971-72 seasons.[12] From this it would appear that 1970-71 was the only season in which quotas caused wheat plantings to fall below the level already established by lower wheat prices.[13]

When the response functions were re-estimated for the period 1949-50 to 1971-72, it was found that the dummy variable for 1970-71 was the only quota variable with a significant coefficient except for the response function for the Southern Slopes. In the latter case no quota variable had a significant coefficient. These equations are given in Table 3. The lag weights on the wheat price variable and the estimates of response elasticity did not change markedly in the re-estimated equations suggesting that the introduction of delivery quotas did not change the way in which farmers reacted to price. For the extended period the shape of

[11] As suggested by Schmidt and Waud [16, p. 13] and Mackrell *et al.* [11, p. 10], a number of specifications were tested in an attempt to find the appropriate degree of the polynomial and the correct lag length.

[12] A *t*-test was used to test the hypothesis that the predictions came from the same structure or population as that presumed to have generated the sample observations. For a description of this test see Johnston [10, pp. 154-155]. The statistical evidence indicated that predictions for 1970-71 for the regions Riverina, North-eastern Victoria, Wimmera and Mallee were the only ones that were likely to have come from a different population. The *t* statistics for the four regions for the 1970-71 forecasts were 2·425, 2·170, 3·001 and 4·159 respectively. There are twelve degrees of freedom for the forecast for Riverina and thirteen degrees of freedom for the remaining forecasts.

[13] The fall in wheat plantings is unlikely to have been caused by poor seasonal conditions because the weather was generally favourable in the 1970-71 season during the sowing period in the regions considered in this study. For a summary of seasonal conditions in these regions see the Bureau of Agricultural Economics' *The Australian Wheat Growing Industry: An Economic Survey*, 1969-70 to 1971-72, p. 89.

TABLE 2

Forecasts of the Area Sown to Wheat in the Various Regions Using Response Equations Estimated for the Period 1949-50 to 1968-69 (expressed as 10,000 hectares)

Regions	1969-70		1970-71		1971-72	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
Southern Slopes	47·0	45·8	35·7	39·6	42·0	39·8
Riverina	58·6	59·1	40·5	52·0	50·9	51·2
North-Eastern Victoria	25·7	25·9	14·8	21·3	17·4	18·5
Wimmera	40·1	41·6	23·2	35·3	33·1	31·5
Mallee	59·7	63·9	34·7	57·9	48·7	54·4

TABLE 3

The Estimated Supply Response Equations for Five Regions in South-eastern Australia: Sample Period 1949-50 to 1971-72[a]

Information on Variables in the Regression	Southern Slopes Region 1	Riverina Region 2	North-eastern Victoria Region 3	Wimmera Region 4	Mallee Region 5
Constant	—98·693	—150·916	—64·714	—72·985	—78·476
	(—7·535)	(—7·716)	(—6·918)	(—5·861)	(—4·385)
Time Trend	1·741	2·224	0·525	0·686	0·979
	(13·666)	(13·560)	(5·862)	(5·763)	(5·722)
Quota Variable (1970-71)	—5·046	—11·344	—6·260	—12·090	—20·109
	(—1·461)	(—2·904)	(—2·497)	(—3·622)	(—4·192)
Wheat Price $\sum_{i=0}^{3} w_i P_{t-i-1}$					
Degree of Polynomial	1	1	2	2	2
w_0	0·5652	0·6727	0·2589	0·3613	0·4366
	(8·0545)	(8·3076)	(3·6530)	(3·8302)	(3·2208)
w_1	0·3768	0·5041	0·3164	0·3883	0·4649
	(8·0545)	(9·0772)	(7·2642)	(6·6989)	(5·5795)
w_2	0·1884	0·3354	0·2301	0·2679	0·3193
	(8·0545)	(5·4723)	(4·7141)	(4·1239)	(3·4199)
w_3	0·0000	0·1667	0·0000	0·0000	0·0000
	(0·0000)	(1·8005)	(0·0000)	(0·0000)	(0·0000)
$\bar{R}^2$	0·9453	0·9605	0·8774	0·8754	0·8559
F	110·3792	116·4892	35·0063	34·3625	29·2128
$D.W.$	1·9754	1·9181	2·1119	2·3870	2·2742
Average Lag (years)	1·67	2·00	1·96	1·91	1·90
Estimated Response Elasticity at the Data Means:					
Short run	1·67	1·67	1·31	1·05	0·83
Long run	3·34	4·16	4·08	2·97	2·32

[a] Numbers appearing in parentheses are values for Student's t statistic. The response variable is in units of 10,000 hectares.

the estimated lag structures remained the same in every case.[14] If the estimate of the quota effect for the 1970-71 season is subtracted from the original predictions in Table 2, the revised predictions appear quite accurate.

TABLE 4

Estimated Supply Response Equations for Victoria: Sample Periods 1949-50 to 1968-69 and 1949-50 to 1972-73[a]

Information on Variables in the Regression	Victoria Sample Period: 1949-50 to 1968-69	Victoria Sample Period 1949-50 to 1972-73
Constant	—229·671	—246·639
	(—6·740)	(—9·557)
Time Trend	2·638	2·341
	(7·101)	(10·130)
Quota Variable (1970-71)		—40·255
		(—5·615)
Wheat Price $\sum_{i=0}^{3} w_i P_{t-i-1}$		
Degree of Polynomial	2	2
w_0	1·0673	1·1820
	(4·3347)	(5·7383)
w_1	1·2383	1·3048
	(7·6049)	(11·0724)
w_2	0·8825	0·9108
	(5·0161)	(6·6871)
w_3	0·0000	0·0000
	(0·0000)	(0·0000)
$\bar{R}^2$	0·9389	0·9411
F	82·9208	80·8254
$D.W.$	1·9784	2·3481
Average Lag (years)	1·94	1·92
Response Elasticity at the Data Means:		
Short run	0·96	1·05
Long run	2·87	3·02

[a] Numbers appearing in parentheses are values for Student's t statistic. The response variable is in units of 10,000 hectares.

[14] The estimated lag weights decline linearly for the two regions in New South Wales, whereas they rise and then fall for regions in Victoria. Watson and Duloy [18, p. 52] suggest that because a high proportion of total farm income is derived from wheat production in Victoria, farm practices are likely to be strongly oriented towards agronomic techniques, such as fallowing, designed to support a continuous cropping enterprise. Under a strict fallowing regime, adjustments to the area sown will occur more slowly than would otherwise be expected. To take account of this in their models, Watson and Duloy included a price ratio lagged two periods in response equations estimated for regions in Victoria. A similar argument may explain the shape of the lag weight distributions for Victorian regions found in this study.

As a check on the consistency of the regional response functions aggregate wheat plantings data for Victoria were collected for the period 1949-50 to 1973-74 and a similar analysis performed. A response function was estimated for the period 1949-50 to 1968-69 and used to forecast the area sown to wheat in the seasons 1969-70 to 1973-74. Equations were also estimated to allow forecasts with a lead time of one year to be made (see Tables 4 and 5). These forecasts, based on changes in wheat prices and a time trend, appear to be quite accurate in all cases except 1970-71. This is consistent with the earlier findings and for the years 1971-72 to 1973-74 suggests that the delivery quotas applied were not restrictive enough to reduce wheat plantings in Victoria below the level established by wheat prices.

TABLE 5

Predicted Wheat Plantings for Victoria for the Seasons 1969-70 to 1973-74

Season	Wheat plantings (10,000 hectares)	Predicted wheat plantings[a] (10,000 hectares)	Absolute percentage error of forecast	Predicted wheat plantings: one year lead time (10,000 hectares)	Absolute percentage error of forecast
1969-70	133·5	139·5	4·5	139·5	4·5
1970-71	76·0	121·2	59·5	118·7	56·2
1971-72	104·2	110·5	6·0	109·1	4·7
1972-73	108·7	117·2	7·8	113·4	4·3
1973-74	126·2	131·6	4·3	126·9	0·6

[a] These predictions are based on an equation estimated using data for the period 1949-50 to 1968-69.

Conclusions

The delivery quotas set for New South Wales and Victorian growers in the 1969-70 season were very similar in magnitude to the average production over the preceding seven seasons (see Table 6).[15] The base delivery quota for New South Wales was reduced by approximately 25 per cent for the 1970-71 season. The reduction for Victoria was approximately 20 per cent. The quota restriction was less severe in 1971-72. From the analysis using regional supply response functions for the period 1949-50 to 1971-72, it appears that the only season in which the major proportion of the change in wheat plantings could not be explained by changes in wheat prices was 1970-71. In that season the quota was restrictive enough to have had an effect on the area sown to wheat in all regions except the Southern Slopes. The estimated percentage reductions in wheat plantings between 1969-70 and 1970-71

[15] The announcement that delivery quotas were to be imposed was made in April, 1969. However, the actual quota allocations for New South Wales and Victorian growers for the 1969-70 season were not made until late in 1969. Because of the timing of the announcements the effect of the delivery quotas on plantings in 1969-70 could be expected to be somewhat different from the effect in later years.

due to the change in price and the delivery quotas are shown in Table 7. In areas with a higher estimated response elasticity with respect to changes in wheat prices the estimated effect of delivery quotas in the 1970-71 season was less severe than it was for regions where the response elasticity is low. In general, this suggests that in regions where alternative products are available a reduction in the area sown to wheat will occur with a fall in wheat price, *ceteris paribus*, whereas delivery quotas may be necessary to achieve a similar reduction in the area sown

TABLE 6

Delivery Quotas (Base Quota plus Shortfall Allowance), Estimated Quota Equivalent and Plantings for New South Wales and Victoria[a]

Year	New South Wales			Victoria		
	Quota (million tonnes)	Quota Equivalent (million hectares)	Plantings (million hectares)	Quota (million tonnes)	Quota Equivalent (million hectares)	Plantings (million hectares)
1967-68	—	—	3·3	—	—	1·3
1968-69	—	—	4·0	—	—	1·6
1969-70	3·3	2·5	3·5	1·8	1·2	1·3
1970-71	2·5	1·9	2·2	1·4	1·0	0·8
1971-72	3·1	2·4	2·4	1·6	1·1	1·0
1972-73	4·0	3·1	2·6	1·8	1·3	1·1
1973-74	5·0	3·8	2·9	2·5	1·7	1·3

[a] The estimated quota equivalent is calculated by dividing the delivery quota by an average yield (ten-year average for the period ending 1971-72).

TABLE 7

Estimated Percentage Reductions in the Area Sown to Wheat between 1969-70 and 1970-71

	Southern Slopes Region 1	Riverina Region 2	North-eastern Victoria Region 3	Wimmera Region 4	Mallee Region 5
Percentage reduction in wheat plantings due to price decline	13·6	12·1	17·8	15·1	9·4
Percentage reduction in wheat plantings due to the reduction of delivery quota	—	19·4	24·3	29·1	31·5

in regions where the response elasticity is low. If restrictive quotas are to be applied in the future, and if some equity between incomes received in different regions is desired then these results suggest that some account should be taken of the enterprise mix available to farmers in various regions when quotas are allocated.

During the 1970-71 season, the quota does not appear to have been particularly effective in reducing wheat plantings in the Southern Slopes. No general conclusions can be drawn from this result because a greater part of the region lies in close proximity to the New South Wales-Victoria state border, and during this season interstate trade in wheat contrary to the provisions of the Wheat Stabilization Scheme is known to have occurred.

A number of studies, for example, Watson and Duloy [18] and Anderson [2 and 3], have made use of response equations based on the adaptive expectations or partial adjustment hypotheses which imply that the distributed lag weights on the price variables decline geometrically. Anderson [3] indicated that this specification of the distributed lag may not be appropriate. His conclusion is supported by evidence from this study. The distributed lag weights were found to decline linearly, or to rise and then fall, depending on the region being considered. The estimation of unbiased coefficients and elasticities in supply response analysis is dependent on the use of the correct model specification. Among other things, specification errors result from the exclusion of relevant variables from the equation and from the use of inappropriate assumptions about the form of the lag distributions. Some effort could be usefully devoted to a close consideration of both the theoretical and empirical aspects of the inclusion of distributed lags in supply response equations.

Appendix

The southern New South Wales Regions 1 and 2 comprised the shires in the following list.

Southern Slopes—Region 1

Bland, Boorowa, Burrangong, Demondrille, Gundagai, Holbrook, Hume, Illabo, Jindalee, Kyeamba, Mitchell, Narraburra, Weddin, and municipalities included within these.

Riverina—Region 2

Berrigan, Carrathool, Conargo, Coolamon, Corowa, Culcairn, Hay, Jerilderie, Leeton, Lockhart, Murray, Murrumbidgee, Narrandera, Urana, Wade, Wakool, Windouran, and municipalities within these.

For statistical purposes Victoria is divided into a number of districts whose boundaries are constant. The area sown to wheat in the three statistical districts, Northern, Wimmera and Mallee, amounted to 94·4 per cent of total area sown in Victoria for the ten-year period ending 1971-72. The regions three, four, and five used in this study correspond exactly to the statistical districts Northern, Wimmera and Mallee.

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