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THE POLICY IMPLICATIONS OF POSSIBLE NEW ZEALAND WHEAT PRICING SCHEMES*

M. M. RICH
Lincoln College, Canterbury, New Zealand

An empirical policy simulation analysis that was performed prior to the adoption of the revised N.Z. wheat pricing arrangements is reported. The analysis was particularly timely as it coincided with, and made an input to, discussions between the various parties attempting to derive an improved wheat pricing scheme. The implications of making N.Z. farm-gate wheat pricing more responsive to world market prices were assessed using a simulation model to distill information on the impact of alternative pricing schemes on those criteria thought to be of interest to policymakers. The results also indicated how the recently announced new scheme would have performed. This information aided public decision making, particularly in clarifying some of the trade-offs that are necessary in choosing a pricing scheme.

Introduction

Up until 1980, direct negotiation between grower representatives with the N.Z. Wheat Board and the N.Z. Government determined the farm-gate price (i.e. the free-on-rail price for domestically produced milling grade wheat). This price was announced prior to sowing and was subject to a maximum 10 per cent Wheat Board levy to offset any losses when wheat was exported. The factors considered by the negotiating parties included:

(a) the effect of alternative product prices, particularly wool and lamb, on area sown to wheat;
(b) the import price defined as the free on board (f.o.b.) cost, in N.Z. dollars, of importing Australian wheat;
(c) the conservation of overseas funds; and
(d) the movement in wheatgrowers' production costs.

There was increasing dissatisfaction with this scheme. Some government representatives believed that the pricing decision should be removed from the realm of politics. Growers were concerned that the farm-gate price was lagging too far behind the world market price. This general dissatisfaction resulted in several alternative pricing schemes and policy criteria being suggested by growers, the Wheat Board and the Government. These suggested schemes were analysed in this study.

The method of evaluation was similar to that suggested by Naylor (1970). Information was generated on the value that the policy criteria could have taken in past years in response to different possible schemes. This approach was incorporated into a study by Zwart (1978). He used a theoretical policy simulation approach to compare different schemes in

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terms of their effects on several measures of benefits and costs to the N.Z. wheat industry. An area of uncertainty in his analysis was the subjective parameter estimates used and he concluded that a more realistic model was needed. Therefore, in this empirical study, a theoretically simple model is used with realistic parameter values.

The aim in this study was to generate information in order to clarify some of the trade-offs that are involved in any decision to change the N.Z. wheat pricing arrangements to some alternative scheme. The implications of making the N.Z. farm wheat price more responsive to world market prices were assessed with a simulation model using historical data. The model generated information on the effect that different schemes would have had on policy criteria (i.e. those criteria thought to be of interest to policymakers). The findings also provided guidelines as to how the new scheme would have performed.

The new scheme begins as from the 1981 harvest. It relates the N.Z. farm-gate price to a three-year moving average of world market prices for Australian standard white wheat. The moving average includes prices for the past year, the current year and the year ahead. The price for the past year is the average over the months of January to December, inclusive. The price calculation for the current year omits the month of December because the price is announced in the first week of that month. For the year ahead, the price is the average of those future monthly prices published by the Australian Wheat Board in November. In addition, the scheme provides for a minimum farm-gate price set at 90 per cent of the price paid to growers in the previous season.

The information-generating framework consisted of seven alternative schemes for determining the farm price, a behavioural equation which explained the potential wheat area supply response to farm product prices and several identities which linked the remaining policy criteria to the wheat area.

Alternative Schemes

A general description is given concerning how the farm-gate price is determined in the alternative schemes analysed. A more detailed account is found in the Appendix. The alternative schemes included do not cover the whole spectrum of possible schemes, but reflect the interest of the two organisations which requested the study.

All schemes except 6 and 7 linked the farm-gate price to the Australian price[1]; that is, a world market price for Australian standard white wheat. This linking allowed N.Z. farm-gate prices to respond more quickly to world market prices and was achieved using different combinations of past, current and future Australian prices. These combinations resulted in different degrees of price stability. Scheme 1 was taken to be an average of the Australian price in the current year and past two years. The current Australian price was directly linked to the farm-gate price in scheme 2. Scheme 3 was similar to the new scheme, and consisted of a three-year moving average of Australian prices in the year ahead, the current year and the past year.

Compensation for movements in wheatgrowing costs was the key

[1] Defined as the N.Z. equivalent of the average Australian standard white wheat export price f.o.b. for the months September, October and November.

feature of the linkage between the Australian price and the farm-gate price in schemes 4 and 5. In addition, a high level of self-sufficiency was aimed for in scheme 4.

Extreme self-sufficiency measures were used to determine the farm-gate price in schemes 6 and 7. In scheme 6, the price was set at a level such that all of the country's wheat requirements were grown domestically. Such a scheme would be impractical; however, it was included in order to gain understanding about policy criteria implications that would result if N.Z. adopted a scheme which encouraged total wheat self-sufficiency. In scheme 7, it was assumed that the price was zero and that all wheat requirements were imported.

The announcement of the farm-gate price was an important characteristic of all schemes except 6 and 7. The price was announced before sowing in the case of schemes 5 and 3 and immediately prior to harvest in the case of all other schemes.

Potential Wheat Area Supply Response

Surveys of N.Z. wheatgrowing farms undertaken by the Agricultural Economics Research Unit indicate that the main alternative activity to wheatgrowing is sheep production. In addition, farm product prices have been more volatile than farm input prices. These two characteristics influenced the choice of variables to explain movements in actual wheat area. The area of wheat harvested was equated with the area in the previous year plus the change in area, $\triangle A_t$. The factors affecting this change were the expected farm-gate wheat price, EP_t, relative to the expected fat lamb price and expected wool price. This specification of relative, rather than absolute, prices conforms with that which would be derived under assumptions of fixed resource supplies and constant technology. That is, the technologies of wheat and sheep farming were thought to change at similar rates.

The expected fat lamb price was taken to be last season's actual price, PL_{t-1}. It was thought that farmers' expectations toward wool prices were not only affected by the actual price in the previous season, PWO_{t-1}, but also by the quantity of wool stocks held in the previous season, WO_{t-1}. This is because, in many years, farm-gate wool prices have been influenced by the buying and selling activities of wool marketing authorities, especially the N.Z. Wool Commission.

The explanatory power of this initial model was disappointing and an examination of the graph of residuals showed that the power of the model could be improved if two outliers were dropped. However, the two particular years of concern had excessively wet conditions at sowing time, to the extent that some growers were forced to abandon attempts to sow wheat in these two years. Therefore, allowance was made for these adverse weather conditions by specifying two dummy variables, D_1 and D_2. The estimated equation (with standard errors in parenthesis) was:

$$\triangle A_t = \underset{(2.481)}{3.742} - \underset{(8.523)}{29.330}\,D_1 - \underset{(8.255)}{14.970}\,D_2 + \underset{(0.146)}{0.601}\triangle(EP_t/PL_{t-1}) + \underset{(0.134)}{0.212}\triangle(EP_t/PWO_{t-1}) + \underset{(0.011)}{0.031}\triangle(WO_{t-1}),$$

$$\bar{R}^2 = 0.79 \quad d = 1.76$$

where $D_1 = 1$ in 1975 and 0 in other years; and
$D_2 = 1$ in 1979 and 0 in other years.

The area of potential wheatgrowing land was, for the purpose of this analysis, taken to be fixed.[2] The amount of this land available for sheep production was simply those residual hectares not employed in actual wheat production. By using information from the surveys of N.Z. wheatgrowing farms, it was assumed that a hectare of wheat caused 0.5 hectares of land to be unavailable for sheep production. Clearly this is a simplification of reality and some sort of nonlinear function, of the type reported by McKay et al. (1981) in which wheat and sheep became more competitive for land as more wheat was grown, would give an improved representation of product substitution.

Policy Criteria

The distributional implications regarding the economic welfare of wheat consumers and producers were gauged. That is, the consumer welfare was represented by the cost to consumers while producer welfare was indicated by farm-gate price and revenue. For food security reasons, a measure of self-sufficiency was included to indicate the proportion of N.Z. wheat requirements that would be grown domestically. A foreign exchange measure was required, because the health of the N.Z. economy depends heavily on agricultural exports. The structural specification of these five policy criteria and the main associated assumptions are discussed below. A complete listing of the various equations and identities are to be found in Rich and Foulds (1980).

Farm-gate price

The announced farm-gate price was also the price received by growers except for those years when wheat was exported. In the latter situation, the price received by growers was taken to be a weighted average of the announced farm-gate price and the export price, where the respective weights were the proportion of domestically produced wheat consumed and the proportion exported. The export price was subjectively taken to be 90 per cent of the import price, because it was thought that N.Z. export wheat would probably be of inferior quality to imported Australian wheat.

In all schemes except 6 and 7, a simple naive price expectations model was used.[3] Where prices were announced prior to sowing, the expected price was assumed to be equal to the current announced price. In the remaining schemes, expected prices were believed to be functions of last year's prices because prices were announced after sowing.

Self-sufficiency

The self-sufficiency measure was the production of N.Z. milling grade wheat expressed as a percentage of domestic milling grade wheat consumption requirements. Milling grade wheat was taken to be area

[2] The fixed area was taken to be an arbitrary 200 000 hectares since the largest wheat area harvested in N.Z. was 162 000 hectares in 1892. The arbitrary way in which the fixed area was chosen did not affect the interpretation of results.

[3] The expected price in scheme 6 was taken to be the price which caused growers to produce the area needed for complete self-sufficiency. Under scheme 7 the expected price was taken to be zero and therefore the area response equation was not used.

harvested multiplied by the historical yield minus that wheat which was unsuitable for milling.[4]

The area harvested was calculated using the estimated behavioural response equation by assuming that the parameter estimates remained unchanged across schemes. A zero value was assumed in every year for the error term in the equation. This failure to account for the residual variation was not considered a serious omission because the alternative scheme results were assessed relative to the old scheme rather than at an absolute level. The assumption that parameter estimates were invariant with respect to the alternative schemes presented an intractable validation problem, but was an important consideration since there are differences among schemes in both the time that farm-gate prices are announced and the amount of price variation allowed. Both these points relate to the importance of risk in farm production response.

Cost to consumers

The majority of wheat is used for bread production and this tends to be an essential food item in most household budgets. This implies a price inelastic demand function and therefore consumption requirements were taken to be exogenous. That is, the demand for wheat was assumed independent of the particular pricing scheme.

The cost to consumers was defined as the cost of providing a sufficient quantity of wheat to meet milling grade wheat consumption requirements in N.Z.[5] (i.e. the consumer cost per tonne multiplied by the tonnes of wheat consumed). In any year when wheat was imported, the cost per tonne was taken to be a weighted average of the farm-gate price and the import price. The weights were determined by the proportion of consumption requirements that were produced domestically and the proportion of consumption that was imported. When wheat was exported or the country was self-sufficient in wheat, the cost per tonne was simply the farm-gate price. This definition implied that the cost of any export loss was borne by the grower rather than the consumer.

Revenue to growers

This was assumed to be the combined farm-gate wheat and sheep gross margins generated on the fixed area of wheatgrowing land. The wheat gross revenue varied according to the particular pricing scheme. Direct costs associated with wheat and sheep were calculated to be $198/ha and $73/ha, respectively, in 1979. These two figures were adjusted by indexes for the preceding years to allow for cost changes. The sheep gross revenue was taken to be $249/ha hectare in 1979, but this figure was ad-

[4] Non-milling grade wheat was thought to be grown irrespective of what pricing scheme operated because it was used mainly by growers for seed or sold either as feed or as certified seed. It was taken that no wheat stocks were carried over from year to year because growers are obliged to sell all milling grade wheat to the Wheat Board before the next harvest and the Board, more often than not, has to import wheat.

[5] The true cost of supplying sufficient wheat to meet domestic requirements in N.Z. includes not only the cost of wheat but also the cost of storage, handling and transport that is incurred when moving wheat to the flour mill. These additional costs were not formally included in this study because it was thought that they would not differ significantly across schemes. For example, the demand for imported wheat always comes from the Auckland area and is met by supplies coming from either Australia or the South Island. The transport costs from these two supplies are about equal according to N.Z. Wheat Board data.

justed in preceding years by using an export price index which included meat, wool and by-products. An export price index was used since the majority of sheep production on wheatgrowing land is geared toward the export market.

Foreign exchange

This was taken to be overseas funds earned from wheatgrowing land minus the value of any imported wheat needed to fill the gap between domestic production and consumption. The funds earned from wheatgrowing land were taken to be the value of any wheat exported plus the f.o.b. value of export sheep product earnings (the latter was defined as the residual hectares of wheatgrowing land not used for wheat production multiplied by the f.o.b. sheep gross revenue per hectare). It was assumed that all sheep products were exported. Information on past farm-gate marketing and processing charges for lamb, mutton and wool were used to calculate a sheep value-added figure from farm-gate to f.o.b. in 1979 of $183/ha.

The inputs required to grow and harvest a crop, produce lamb, mutton and wool, or to process these farm products, involve machinery and fuel which often have a significant import content. However, due to a lack of available data, the overseas funds used to purchase these imports were not considered in this foreign exchange definition. If suitable data could be found, a worthwhile extension would be to define foreign exchange net of imports.

Data Assembly and Validation

The sample period for all data was the 23 harvest years from 1957 to 1979. The starting date was constrained to 1957 due to lack of data on some variables prior to this date.

Parameter estimates of the area supply response equation did not alter significantly when re-estimated over a shorter time period. For alternative schemes it was confirmed that wheat areas in any particular year were never greater than the fixed area of potential wheatgrowing land.

Validation checks on the identity equations linking the estimated wheat area to other policy criteria were needed because any bias in the behavioural equation could be compounded as the effects feed through to other policy criteria. A subjective approach to these checks was taken by graphically comparing policy criteria results against expert judgments of what the output should be. The general consensus was that the output seemed reasonable.

Results

The effect of alternative schemes on policy criteria are summarised in Table 1. All schemes were compared against a benchmark; namely, the old scheme which was in force until 1980. The central tendency measure used was the average over the period of years considered (Ave). The degree to which annual values have fluctuated around these average figures is indicated by the coefficient of variation (CV). The smaller the CV, the less fluctuation. It was to be expected that the size of this stability measure would be understated due to the omission of the error term from the area response equation.

TABLE 1

Effect of Schemes on Policy Criteria Over 23 Years (1979 NZ$)[a]

Scheme	Farm-gate price		Self-sufficiency		Cost to consumers		Revenue to growers		Foreign exchange	
	Ave ¢/t	CV %	Ave %	CV %	Ave $m	CV %	Ave $m	CV %	Ave $m	CV %
Old	164.0	15	74	41	53.8	19	52.6	15	57.2	19
1	−7.2	−2	−0.8	+9	−0.6	−1	−0.5	+13	+0.1	+4
2	+1.2	+6	−0.5	+9	+1.5	+3	+2.0	+17	+0.3	+4
3	+2.5	−2	+2.1	+10	+1.6	0	+3.5	+19	+1.7	+6
4	+94.3	+23	+26.3	−16	+33.8	+28	+40.6	+26	+8.8	−4
5	−29.1	+3	−9.9	+2	−6.0	+3	−9.0	−1	−3.6	0
6	+12.7	+41	+26.0	−41	+41.8	+41	+47.5	+39	+8.0	−12
7	—	—	—	—	+6.7	+8	−18.7	+2	−5.7	−6

[a] The figures for schemes 1 through 7 show deviations from the results for the 'Old' scheme.

The simulations were dynamic in the sense that estimated wheat areas in past periods were carried forward and used to define the current wheat area as last period's area plus the change in wheat area. They were also deterministic in the sense that historical data were used to simulate the effect of different schemes on the policy criteria. It was assumed that future product price fluctuations would be no greater than those which have occurred in the past.

The average farm-gate price was higher than the old scheme in schemes 2, 3, 4 and 6. The lowest price occurred in scheme 5 because, in this scheme, price increases were constrained to grower cost increases in years when world market prices for Australian standard white wheat were rising rapidly. A trade-off tended to occur between the price level and associated stability. Higher average prices tended to be associated with less stable prices. This trade-off occurred because higher prices were mainly the result of schemes being linked more closely to world market prices for Australian standard white wheat. In the past, this world market price has been more volatile than the N.Z. farm-gate price.

Average wheat self-sufficiency in schemes 3, 4 and 6 was greater than that achieved under the old scheme. Greater wheat production was not always associated with higher farm-gate prices because wheat area was determined by the farm-gate price relative to prices for fat lambs and wool. A cost of achieving complete self-sufficiency as in scheme 6 was extremely unstable farm-gate prices mainly because large price fluctuations occurred for fat lambs and wool. The average level of self-sufficiency was more unstable in all alternative schemes except scheme 4 (which embodied a high self-sufficiency level) and scheme 6 (in which all wheat was domestically grown).

Average cost to consumers in schemes 2, 3, 4, 6 and 7 was higher than that achieved under the old scheme. The table shows a strong positive correlation between cost to consumers and the farm-gate price. This is because the farm price has been the greatest component of the consumer cost. The trade-off between average levels and associated stability, which occurred with the farm-gate price was also present with the cost to consumers. Higher average costs also tended to be associated with more variable costs between years.

The average revenue to growers in schemes 2, 3, 4 and 6 was higher

and more unstable than that acheived by the old scheme. Schemes with a higher revenue to growers also had a higher farm-gate price.

Average foreign exchange effects in schemes 2, 3, 4 and 6 were higher than that achieved under the old scheme. Under all schemes, foreign exchange tended to increase as wheat self-sufficiency increased because one hectare of wheat replaced more foreign exchange than a hectare of sheep output produced. The lowest foreign exchange effects occurred in scheme 7. This was the effect of not growing any wheat but exporting more livestock products.

An indication as to how well the new scheme would have performed in the past relative to the old scheme can be obtained from scheme 3. Higher but more unstable farm-gate wheat prices (and revenue to growers) would have been achieved. These prices would have caused higher and more unstable levels of wheat self-sufficiency, which in turn would have resulted in a higher cost to consumers and a higher foreign exchange effect.

Discussion and Conclusions

It was assumed (without great confidence) that each hectare of wheat sown resulted in 0.5 hectares of land being unavailable for sheep production. However, this fixed substitution rate should not significantly affect the sensitivity of results when compared against a benchmark. As would be expected, using different substitution rates resulted in the affected policy criterion levels (revenue to growers and foreign exchange) moving by roughly the same absolute amount in all schemes. This insignificant movement of alternative schemes relative to the old scheme implied that the relative performance of schemes was robust to this fixed substitution rate assumption.

The performance of alternative schemes relative to the old scheme was sensitive to the time period over which the model was simulated. The cause of this sensitivity was that alternative schemes were more responsive than the old scheme to movements in the world market price for Australian standard white wheat. Despite this sensitivity, some general trends evident in the results provide the basis for some comments on the implications of making the N.Z. farm wheat price more responsive to world market prices. As alternative schemes become more closely linked to world market prices for Australian standard white wheat, the fluctuating, but relatively high, world prices cause higher but more unstable domestic farm-gate prices. These higher farm-gate prices tend to cause higher levels of wheat self-sufficiency which results in cost to consumers, revenue to growers and foreign exchange also being greater. A trade-off between average levels and associated fluctuations between years was also evident in the measures of economic welfare relating to wheat consumers and growers.

Nationally, the most economically efficient scheme is the one that results in the highest aggregate measure of well-being. A crude measure of this well-being is the foreign exchange policy criterion. This is because foreign exchange for N.Z. is a major constraint on the growth of the economy and consequent standard of living and employment opportunities. The earning of further foreign exchange enhances N.Z.'s capacity to import the additional goods and services that are essential for the economy to grow. This efficiency measure provides a partial, rather than

a complete, ordering of national well-being because it ignores the distribution of these benefits within N.Z.

A simple model has been used to assess the implications of making the N.Z. farm-gate wheat price more responsive to world market prices. However, the model could be improved, particularly by allowing for risk in farm production response plus relaxing the restrictive assumptions that wheatgrowing land is used only for wheat or sheep and that substitution between these two products is linear. These improvements would probably only affect the detailed numerical results rather than the broad policy implications which have been drawn from the analysis.

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APPENDIX
Farm-Gate Prices for Alternative Schemes

Variables used in the different schemes to calculate the announced farm-gate price, FP_t, included the Australian price, AP_t; changes in wheatgrowing costs, GC_t; and last year's self-sufficiency level, SS_{t-1}. These last two variables were measured as percentages. Temporary prices, TP_t, were also defined in some schemes. The formulae used in computing the farm-gate price are listed below.

Scheme 1

$$FP_t = (AP_t + AP_{t-1} + AP_{t-2})/3.$$

Scheme 2

$$FP_t = AP_t.$$

Scheme 3

$$FP_t = (AP_{t+1} + AP_t + AP_{t-1})/3.$$

Scheme 4

$TP_{1t} = FP_{t-1}\ (1 + (GC_t/100 + (1 - SS_{t-1})/100)/2)$ and
$TP_{2t} = FP_{t-1}\ (1 + (\mathrm{GC}_t/100 + (\mathrm{AP}_{t-1} - FP_{t-1})/\mathrm{AP}_{t-1})/2)$.
$FP_t = TP_{1t}$ or TP_{2t} whichever is greater.

Scheme 5

If $AP_{t-1} > FP_{t-1}$,
then FP_t was the minimum of either:
$FP_{t-1}\ (1 + GC_t/100)$ or AP_{t-1};
otherwise $FP_t = AP_{t-1}$.

Scheme 6

$FP_t = f$(Wheat Area) such that 100 per cent self-sufficiency was achieved.

Scheme 7

$$FP_t = 0.$$