MODELS FOR THE ANALYSIS OF BARLEY MARKETING

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Abstract

Barley marketing, like a number of other commodities in Australia, is subject to the requirements of the Hilmer reforms. Approaches to the analysis of the possible deregulation of barley marketing are considered. Emphasis is placed on the use of a spatial equilibrium model designed to assess the consequences of different degrees of market power exerted over the export and domestic markets and econometric techniques designed to assess the extent that prices in different export markets differ from what might be expected without exerting market power. Results are obtained which illustrate the fact that rents can be extracted from markets if market power can be exerted and they also provide information on the distribution of the rents. It is also observed that the Japanese import policy has a significant impact on the ability of Australia to extract price premiums.

Keywords: barley, marketing, spatial equilibrium, market power, price discrimination

In this paper some approaches to assessing the effects of deregulating the Australian barley industry are considered and then an analysis, using spatial equilibrium modelling, is provided of some of the consequences of changing from a marketing board with oligopolistic control over barley marketing to a more competitive environment.

The Australian Barley Industry in a World Context[1]

In Australia the area planted to barley is about 3 million hectares which produces about 5.5 to 6.5 million tonnes. South Australia is the largest producing state with 1.8 million tonnes, followed by Victoria producing about 1 million tonnes. In Australia, barley is used for feed and malting with very small amounts used directly for human consumption. Of Australia's malting barley, approximately 60 per cent is exported and the remaining 40 per cent is processed in Australia into malt. About two-thirds of the Australian produced malt is exported, accounting for 24 per cent of the total malting barley crop. Thus, around 84 per cent of the total Australian malting barley crop is exported, either in the form of malt or malting barley. Many of the markets into which Australian barley or malt is sold are characterised by single-desk buyers, for example, Japan, China (this is being freed) and several of the Middle East countries.

† The help of Chris de Mestre in parts of the quantitative analsysis for the paper is gratefully acknowledged.

[1] This section, as well as other parts of the paper, are based on the report by the Myers Strategy Group (1996).

World barley trade in 1994/95 was about 15 million tonnes. This trade was concentrated among six major exporters and eight major importers. For Australia, China is the most important market for malting barley and Japan and Saudi Arabia the most important markets for feed barley. Australia is a relatively small exporter in a world context. However, Australia is a significant exporter in the malting barley market accounting for over 50 per cent of malting barley exports in 1993/94 and 1995/96. The major competitors for Australian malting barley are Canada and the European Union. Australia accounts for about 15 per cent of feed barley exports.

Government intervention is a characteristic of many agricultural markets and barley is no exception. Japanese imports are controlled by the Japanese food agency which allocates fixed market shares to exporting countries. China has a central buying agency but its control is likely to diminish over time. Taiwan has a market which is tightly controlled through the political system. Korea uses a system of quotas for feed barley and the malting barley imports are managed by the three brewing companies. In the Middle East, many countries have single-desk buyers. Saudi Arabia is the world's largest feed barley market and is controlled by a central purchasing agency which imports primarily through traders. The European Union has a high internal price system encouraging production. Surpluses are sold onto the world markets through a system of restitutions. The United States has a farm program which provides for subsidies on production and trade (the Export Enhancement Program). Canada has had a number of support schemes, in particular, a freight subsidy and also has a single-desk seller for barley exports.

The Australian malting market is dominated by two malting companies and barley marketing is essentially controlled by marketing boards (the NSW Grains Board, the Australian Barley Board and the Grain Pool of Western Australia). Marketing boards must supply the needs of the maltsters before supplying export markets. The major market for malt is beer but barley only represents about 2 per cent of the final cost of beer. Growth in the beer market has been slow. However, the Australian feed grains market has grown rapidly in recent years. Barley dominates in the beef feedlot, pigmeat and dairy industries where it commanded shares of 37, 31 and 27 per cent respectively in 1993/94. This is a very competitive sector where there is flexibility to use a whole range of feed alternatives.

From this brief overview it is clear that government intervention in the barley markets of the world is significant. Arguments relating to the role of such intervention and the common instrument of a single-desk seller or buyer are common. The Hilmer report (Hilmer, Rayner and Taperell 1993, pp. 143-4 and p. 206) focuses on such boards and recommends their dismantling on the basis that 'There should be no regulatory restrictions on competition unless clearly demonstrated to be in the public interest.' Thus, assessment of the nature of the effects of single-desk selling arrangements becomes important given the broad ranging adoption of the Hilmer reforms.

Price Premia

The nature of the prices obtained for a particular product and how it is priced in a given market is made up of a complex set of factors. In relation to marketing performance, price premiums are frequently referred to in a general fashion. However, a more precise definition of the concept of price premia in an international trading environment is needed when considering the market performance of a firm or marketing board. One of the key arguments supporting single-desk selling arrangements, such as those in Australia, is the strengthening of the ability of the seller to extract a price premium. To help clarify the situation three different premia/discounts are defined as follows.

A ***competitor price premium or discount*** can be defined as the difference in price between two suppliers of the same product into the same market at the same time. Such a price difference reflects the normal pricing activities of suppliers attempting to achieve the highest price possible in a market and/or gain a sale over a competitor. It is likely there will be a number of non-price factors which determine such price premia or discounts such as favourable

credit terms, service associated with the product, loyalty, security of supply and so on. These non-price factors may be present or absent. These are all normal business operating processes and normally have no connection to market power. Such premia or discounts can be measured as the difference between prices offered for a product by two or more suppliers at the same time, same place, in the same currency and for the same quality product. There may be direct costs associated with provision of some of the non-price factors not included in the premium or discount. In most circumstances it will be appropriate to measure the premium or discount as the difference related to the next best competitor.

The competitor price premium can be represented as in Figure 1.

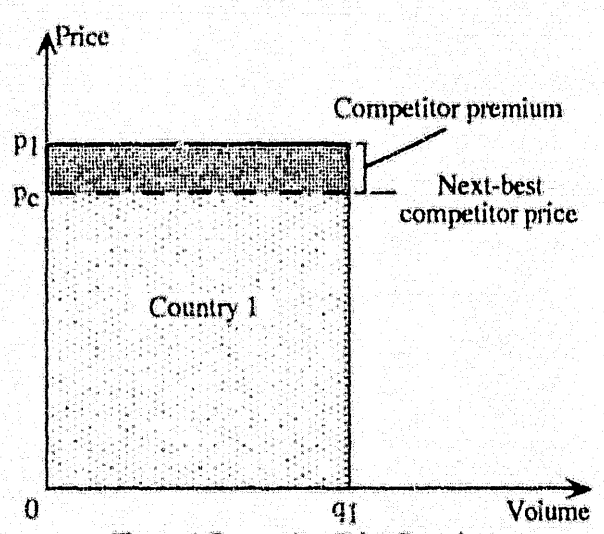

Figure 1 Competitor Price Premium

Price discrimination premia or discounts are defined as price differences for the same or similar product supplied by a single supplier to different markets (over time, space or customers). Such premia or discounts must be calculated on a comparable basis such as at the point of export and in the same currency. Normally such premia and discounts would be associated with price discrimination as a result of an ability by a supplier to price discriminate by customer, by place or over time. This will imply some form of market power. It is necessary to be able to separate the markets and the discrimination is only worthwhile if the different markets have different elasticities of demand. One way of assessing such premia or discounts, discussed below, has been proposed by Knetter (1989) and applied by Carter (1993) in Canada for barley and Griffith, Mullen, Fagan and Jones (1995) for rice in Australia.

Market restriction premia or discounts may be generated as a result of intervention in a market such as with quotas, tariffs, subsidies and taxes. These premia or discounts are not easily measured since generally prices without the restriction in place are not available to use for comparison. However, where restrictions such as a quota is in place the domestic price is likely to be raised relative to prices in unrestricted markets. Thus there is the opportunity for a supplier with sufficient bargaining power to extract some of the quota rent. This might be measured approximately by comparing the fob price to a similar country. If tariffs or taxes are used on imports a similar situation can be expected, while for domestic subsidies it may be necessary to discount the products to achieve a sale.

Market mix gains or losses have also been recently used in attempts to analyse the benefits of single-desk sellers (Booz, Allen and Hamilton 1995, p. 44) and are proposed as a measure of the ability of a firm or organisation to sell a higher percentage or share of a product into the higher priced markets than would be expected on an equitable sharing of the markets available. Thus the market mix effect is a measure of the inequity with which the available

markets are shared. If a country, firm or organisation can sell more than its proportional share into the higher priced markets then there is a gain relative to the equitable or proportionate share. However, this is not a measure of the ability of a firm to achieve gains by the use of market power since the proportionate share is not an outcome which will exist if there is not market power. The notion of market mix can be represented as in Figure 2.

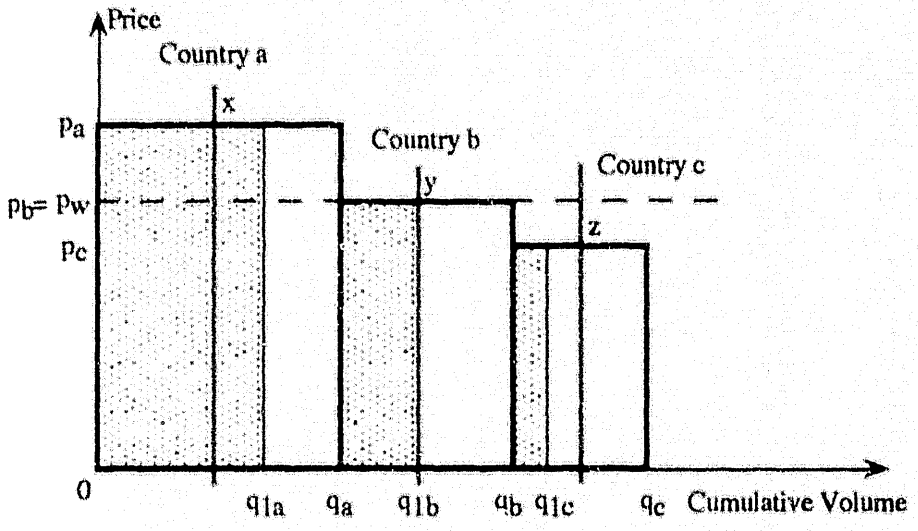

Figure 2 Representation of Market Mix

For country 1 it is assumed that there are three countries a, b and c to which it exports. Country 1 has different shares of the trade going to each of the countries but overall has 50 per cent of the trade to the three countries. For an equitable share in each country it thus could be supposed that the share should be 50 per cent for each of the countries to which country 1 exports (indicated by vertical shaded lines x, y, and z). In Figure 2 the value of trade (price by quantity) shipped to each of the countries is represented by a rectangle outlined by heavy black lines. The countries are ranked in order of price paid to country 1 and the horizontal axis represents the cumulative volume. Thus, the trade from country 1 to country a is q_{1a} and the total imports of country a are q_a. If also, it is assumed that a 'fair' price for country 1's exports is the overall average price of imports, given as p_w and that by construction this is made equal to p_b to simplify the illustration, then an evaluation can be made of the extent to which country 1 receives a 'fair' value. This can be done by accumulating up the areas in which value exceeds the average and subtracting the amounts by which value is less than the average. The net value can then be expressed per unit of the tots' exports of region 1. This has been referred to as the market mix premium.

In Figure 3 the value of the market mix is the areas (abcd - efgd) less the area (hijk -lmnk). The value is then divided by the total quantity q_1 exported from country 1 to obtain a per unit measure of the net return per unit above or below the average return.

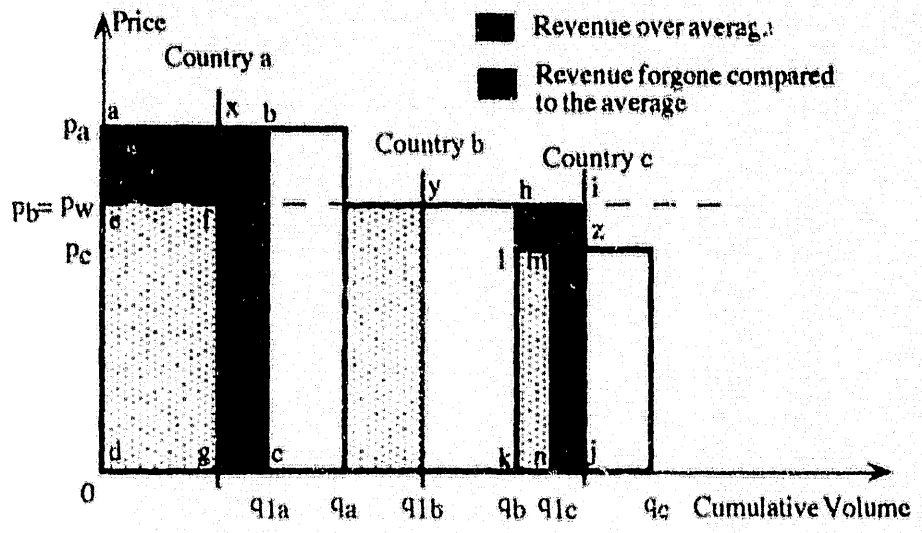

Figure 3 Market Mix as a Revenue Measure

From basic trade theory there is no reason to presume that an equitable share of the markets is optimal or even likely in an undistorted world. Also, there is no reason why an exporter should choose to distribute sales across different countries so they are equally shared. A competitive trading system does not necessarily generate an equitable share of trade. The outcome depends on the supply and demand for the commodity concerned, the transport costs, exchange rates, etc. There is therefore no economic basis for assuming an equitable distribution of trade across importing countries. Although the measure of the nature of the inequity in the market mix may be of interest, it is arbitrarily defined in terms of a proportional sharing of the trade. There may be a number of other ways in which a basis for the measure could be formed to assess this inequity. One possibility is to evaluate the trade of one country against the distribution of shares of a competitor country. Another possibility is to use the average market shares. One way in which the measure of market mix might be effectively used is to observe trends over time. In this way it can be detected if the firm or organisation is, over time, gaining a greater or smaller share of the high revenue importing markets. This may be a reflection of performance but need not have any necessary connection to market power. It may simply reflect a more efficient trading and supply system than competitor countries.

It should also be noted that the competitor price premium is a measure of a price difference while the market mix measure is a measure of inequity. Since they both measure different dimensions of trade patterns it is not valid to add the two together.

Finally, the measure of market mix has no specific connection to market power or price discrimination and therefore no connection to what can be achieved by a single-desk marketing board. It would be expected that an efficient commercial firm may choose to maximise profits by selling a higher proportion of exports into the higher valued markets than the lower valued markets. However, depending on the elasticities of excess demand for the country's commodity it may be profit maximising to sell a larger share into the lower valued markets.

Pooling and Return and Cost Averaging

One of the consequences of a single-desk seller is the pooling of returns and costs. The pooling of grains and then the averaging of returns from those pools across growers of the grain is a common procedure for the handling of grain within a regulated system. There are arguments that relate to the equity of this approach and significant problems with the economic efficiency of it. The net effect is that the return that any particular grower receives is made up

of the growers own contribution and the effect on the average per unit return of the actions of all other growers within the pool. In addition, the pooling of charges associated with the handling storage and transport of grain leads to significant inefficiencies as shown by the Royal Commission into Grain Storage, Handling and Transport (Quiggan and Fisher 1988). The use of pooled charges for handling storage and transport is a consequence of the physical need for the pooling of the grain in the marketing system.

The marginal return, which is the appropriate return to consider in economic decisions by a producer, and reflects the price signal to a grower, is confounded in a complex way by the actions of all the other growers contributing to the pool.[2] In simple terms, a grower who produces a high-priced component as a contribution to the pool receives a lower per unit average return than might otherwise be the case while the grower contributing the lower-valued component to the pool receives a higher price than would otherwise be the case. Thus, the high value producer is in effect subsidising the low value producer. Also, income is transferred among growers because of the pooling and pricing mechanism used. The downstream consequence is that too much low valued grain will be produced and too little high valued grain will be grown. This then leads to an inefficient use of agricultural resources and a poor ability to meet market needs. In an agricultural system in which there are a number of crops grown, distortions can also result when crops are subject to different pools and when some crops are pooled and some not.

The basic economic problem with pooling is indicated above, however, in practice there are a number of practical issues involved which modify this basic economic problem. In brief, these are listed below.

(1) In many cases there is a number of pools used for different types of grain and also different regions and time periods. This means that different prices are determined for different pools. Clearly there is an economic problem in determining the optimal levels of segregation for grain commodities. Payments may also be adjusted for quality.

(2) With commodities such as wheat, barley and other grains exported by ship there are logistical reasons for accumulating large quantities of grain in one location. Ship sizes range from 35,000 tonnes to 50,0000 or more tonnes. Some form of pooling of the grain is eventually required to load the ship. By establishing pooling mechanisms, the assembly of grain for a ship may be done more efficiently and the ability to fill ships is likely to be enhanced.

[2] Under a system of pooling, the basic marginal rule for a producer changes from marginal cost equals the product price to the marginal product multiplied by a weighted average price for the product plus the average return from all growers weighted by the share of output.

Let the revenue for a single producer be indicated as R_1 and written as:

$$R_1 = y_1 AR$$
$$= y_1 (p_1 y_1 + p_2 y_2)/(y_1 + y_2)$$

The marginal revenue can be derived by differentiating with respect to y_1 and equating to marginal cost and rearranging, then:

$$MC = MP (p_1 y_1 + AR y_2)/(y_1 + y_2)$$

where MC = marginal cost, MP = marginal product for the producer, AR = average return from all growers, p_1 = product price and y_1 = sales by the individual producer, y_2 = sales by all other producers. Without pooling and under standard conditions

$$MC = MP\ p = VMP$$

where VMP is the value of the marginal product.

(3) As there is a high degree of substitution between grains in both production and uses the pricing of pools must be reasonably competitive with the pricing for other grains. However, when other grains are also pooled the effect of the competition between grains may be masked.

(4) Pools are a means of sharing price risk across the producers in a pool. In effect, producers join a pool and implicitly pay a price for the sharing of the price risk among pool members.

(5) By pooling quantities of grain as an agreed strategy the transactions costs for marketing, assembly and information collection can be shared across a much larger volume of grain.

It is apparent that these various effects do not remove the resource misallocation problem but provide an indication that to evaluate the economic consequences of pooling there is a set of trade-offs that should be evaluated between the direct economic costs of pooling and some of the benefits of aggregation. Although the consequences of pooling are not directly measured in the analysis discusses below they should be recognised as a possible resource costs of single-desk marketing. The trade-off between the benefits and costs of pooling needs recognition.

The 'Pricing to Market' Test

The basic economic principle behind the 'pricing to market' test is an assessment of the ability to price discriminate. If a single-desk seller has the ability to price discriminate between markets then returns over and above those of a competitive market are likely to be made by the single-desk seller. The technique involves the assumption that in a competitive market all Australian barley export prices should be the same for all importing countries and thus there should be no country effect or bilateral exchange rate effects.

The model developed by Carter (1993) based on the work of Knetter (1989) is as follows:

$$(1) \qquad \text{Ln } P_{it} = \sum_{i=1}^{n-1} \alpha_i D_i + \sum_{t=1}^{k} \delta_t T_t + \sum_{i=1}^{n} \beta_i \text{ Ln } X_{it} + u_{it}$$

where Ln P_{it} is the natural logarithm of the Australia barley export price to country i and at time t; D_i is a set of dummy variables designed to capture the country effects for n countries; T_t is a set of annual time dummies with one variable for each of k years and designed to capture the between year differences resulting from different crop years and different costs of production; Ln X_{it} is the ith country's bilateral exchange rate (foreign currency in Australian dollars); u_{it} is a well-behaved error term.

In a competitive market it can be expected that $\alpha_i = 0$. It is then reasonable to argue that there is no country effect and so pricing is seen as not discriminating between countries. Also in a competitive market, changes in exchange rates should not affect bilateral export prices thus $\delta_t = 0$ would be expected.

In an imperfect market either $\alpha \neq 0$ or $\beta \neq 0$. If $\alpha \neq 0$ and $\beta = 0$ it is assumed that there is a constant elasticity of demand with respect to the importer's currency, but that the exporter's markup over different destinations varies, thus implying price discrimination. For $\alpha = 0$ and $\beta \neq 0$ it is assumed that the demand elasticities vary with changes in exchange rates, implying price discrimination.

Work with the Australian Barley Board made it possible to obtain detailed confidential data on sales and contract prices to different export markets over the period 1986 to 1995. Exchange rate data was obtained from the Reserve Bank of Australia and a variety of other financial institutions. All prices were expressed in $US. In using the model by Knetter (1989) and

Carter (1993) it should be recognised that the Australian Barley Board negotiated many of its contracts in US dollar terms so that consideration of the exchange rate effects may not be as clear as had all contracts been negotiated in Australian dollar terms. As there were different numbers of observations across, and within, time periods and across countries the data set was unbalanced. Thus the data set was constructed as a set of panels by country and then by time.

One of the difficulties with many models, the Carter model included, is that it is not possible to directly impute causality. It is possible that factors other than the ability to price discriminate may cause differences in prices between markets to be observed. The capture of rents from trade distortions, such as import quotas in the case of Japan, is an example. Other factors such as differences in quality and services may also have an impact.

The choice of countries to include in the regressions was rather arbitrary and based on a ranking of the sales volumes over the ten years provided there was a sufficient number of observations. The countries chosen for the feed barley analysis were Iran, Japan, Kuwait, New Zealand, Oman, Qatar, Saudi Arabia, Taiwan and the United Arab Emirates. For the malting barley analysis the countries were China, Japan, Peru, Taiwan, South Korea and Zimbabwe. Two sets of estimates were made for feed barley by first including and then excluding the domestic sales in Australia. Results are given in Tables 1 to 3 with the identity of the countries indicated by A to J or K to Q because of the confidential nature of the data (ER indicates exchange rate).

The model coefficients are tested using F-tests. The F(1) test is a test for all the $\alpha_i = 0$ or the country effects, while the F(2) test is a test of all the $\beta_i = 0$ or exchange rate effects. For feed barley with the domestic data included (Table 1) the hypothesis that the country effects are zero is rejected but the hypothesis that the exchange rate effects are zero cannot be clearly rejected. When the domestic data are not included (Table 2) then both hypotheses can be rejected and thus the hypothesis that the Australian Barley Board is unable to exercise market power is rejected. It would seem that the Japanese market and the United Arab Emirates and associated markets are the markets in which the Board may be able to exercise a degree of price discrimination on the international market. It is likely, however, that the limitations on imports into the Japanese market provide an opportunity for the Australian Barley Board to capture some of the rent imputed to the quota limitations on this market. In the case of the inclusion of the domestic data there would appear to be the possibility of discrimination between domestic and the export markets.

For malting barley, the results are provided with the domestic data included and the hypothesis that the Australian Barley Board does not exercise market power cannot be rejected both in terms of different countries and different exchange rates (both F-tests). The results support the possibility of price discrimination in relation to China and also the domestic market.

Table 1

Australian Barley Board Feed Barley Estimates of the Carter Regression, 1985/86 to 1994/95 Sales Data, with Domestic Data

Variables	Coefficients	t-values
Intercept	4.94	20.65
1985/86	-0.44	-2.73
1986/87	-0.62	-15.96
1987/88	-0.58	-19.79
1988/89	-0.27	-8.89
1989/90	-0.14	-4.47
1990/91	-0.30	-10.36
1991/92	-0.36	-12.71
1992/93	-0.26	-8.41
1993/94	-0.48	-17.35
1994/95	-0.34	-13.69
ER A	-0.87	-0.66
ER B	-0.22	-0.84
ER C	0.049	0.49
ER D	-0.32	-0.22
ER E	0.98	0.42
ER F	-4.08	-2.48
ER G	1.18	1.64
ER H	0.50	0.75
ER I	-0.14	-0.31
ER J	-1.62	-11.16
A	1.03	0.59
B	0.67	0.74
C	-0.13	-0.25
D	-0.38	-0.26
E	-1.26	-0.42
F	5.26	2.44
G	-5.07	-1.66
H	0.56	0.68
I	0.54	2.24
Observations	845	
R-square	0.66	
Adjusted R-square	0.64	
Durbin-Watson	-	
Log Likelihood	391.0	
F-statistic (1)	13.28	10 and 815 df, P=0.00
F-statistic (2)	1.74	9 and 815 df, P=0.076

Table 2

Australian Barley Board Feed Barley Estimates of the Carter Regression, 1985 to 1994 Sales Data, without Domestic Data

Variables	Coefficients	t-values	
Intercept	5.08	25.19	
1985	-0.32	-2.33	
1986	-0.49	-9.48	
1987	-0.47	-10.04	
1988	-0.14	-2.91	
1989	0.030	0.63	
1990	-0.13	-2.79	
1991	-0.17	-3.66	
1992	-0.12	-2.65	
1993	-0.38	-8.38	
1994	-0.34	-7.70	
ER A	-1.37	-1.26	
ER B	-0.22	-0.56	
ER C	0.29	-2.90	
ER D	0.053	0.042	
ER E	1.06	0.55	
ER F	-3.34	-2.45	
ER G	0.88	1.46	
ER H	0.21	0.37	
ER I	-0.56	-1.45	
A	1.45	0.99	
B	0.084	0.11	
C	1.24	2.52	
D	-0.29	-0.24	
E	-1.63	-0.66	
F	4.03	2.25	
G	-4.05	-1.60	
H	-0.070	-0.10	
Observations	434		
R-square	0.73		
Adjusted R-square	0.72		
Durbin-Watson	-		
Log Likelihood	269.1		
F-statistic (1)	2.32	9 and 406 df, P=0.015	
F-statistic (2)	2.06	8 and 406 df, P=0.038	

Table 3

Australian Barley Board Malt Barley Estimates of the Carter Regression, 1986 to 1994 Sales Data, with Domestic Data

Variables	Coefficients	t-values
Intercept	5.15	117.60
1986	-0.63	-14.94
1987	-0.54	-14.93
1988	-0.39	-11.74
1989	-0.16	-4.49
1990	-0.26	-8.29
1991	-0.40	-13.51
1992	-0.24	-7.77
1993	-0.42	-12.91
1994	-0.26	-8.37
ER K	-0.0068	-0.75
ER L	-0.29	-1.53
ER M	-1.18	-1.19
ER N	-0.21	-2.97
ER O	-0.17	-0.84
ER P	-0.042	-0.17
ER Q	-1.03	-6.26
K	1.05	1.65
L	7.85	1.19
M	0.35	2.80
N	0.88	0.89
O	0.12	0.42
P	0.38	6.18
Observations	413	
R-square	0.67	
Adjusted R-square	0.65	
Durbin-Watson	-	
F-statistic (1)	6.96	7 and 390 df, P=0.000
F-statistic (2)	7.02	6 and 390 df, P=0.000

Barley Spatial Equilibrium Model

International barley trade is dominated by a few countries. A spatial equilibrium model in which the trade flows and equilibrium prices for barley trade can be generated was constructed. The model was designed to allow experiments to be carried out on the effects of oligopolistic market power with respect to Australian barley sales within Australia and to other countries. The model is designed to provide a guide to the likely direction of changes that might arise from the removal of single-desk powers for marketing boards in Australia.

Data for the construction of such a model are limited and in insufficient detail to be able to fully specify both feed and malt barley trade. Thus, both types of barley have been combined. This is an important limitation of the model since prices for the two types of barley can vary significantly.

The model consists of ten trading regions. These are: Australia, the People's Republic of China, Taiwan, Japan, Saudi Arabia, Other Middle Eastern countries, Canada, the United States, the European Union, and the rest of the world. The regions were chosen on the basis

of suitable data being available to estimate parameters the importance of the country or region for Australian barley trade and the [illegible]
Trade between these regions is assumed to occur according to the supply and demand requirements of different regions, the cost of transfer between the regions and the relative prices. Initially, a competitive trading system is assumed. In this instance, price differences between any two trading countries will be such that the price difference between the demanding region and the supplying region will be less than or equal to the transfer cost. This requirement is known as the spatially competitive arbitrage condition.

With the current regulation of barley marketing in Australia, single-desk selling powers have been given to a number of marketing boards. In effect, this provides a potential capacity for boards to gain price premiums from certain markets because of a potential ability to price discriminate. An oligopolistic market structure is one in which an individual seller can have a perceptible influence upon rivals in the market (Henderson and Quandt 1980, p. 200). This would seem to be a reasonable representation of the capacity of marketing boards in a country to influence the trade with other countries. It may also happen that other countries will reflect an oligopolistic pattern of behaviour in return. For the purposes of this study it has been initially assumed that other countries act in a competitive fashion.

One of a number of possible behaviours is for marketing boards to operate as if they are a single monopolist facing a demand for their product and to take no account of the behaviour of competitors or rivals (a Nash equilibrium) (Kolstad and Burris 1986). This assumption will be used in this case with the net effect that the marketing board is assumed to be able to extract an oligopolist's margin from each of the appropriate markets based on the nature of the demand for barley in each of these markets. For example, if a board believed that on each tonne of barley sold to a given country it could obtain a certain per unit margin then this amount could be used. However, the Nash solution assumes that the margin is based on the demand function in each of the countries with which the board or boards are trading. In the case of barley there are three marketing boards in Australia. Thus the ability of the boards to extract the full oligopoly margin was assumed to be one-third of that of a single oligopolist (a rather arbitrary assumption).

The basic structure of the spatial equilibrium model is described in Takayama and Judge (1971) and for the oligopolistic trading system in Hashimoto (1984) and as model GM5 in the quantity domain in MacAulay (1992, pp. 312-4). A version of the model in the price domain was used because of the number of variables used can be smaller than in the case of the quantity domain. The basic model was modified in this case to allow for a set of supply and demand functions in the case of Australia and for each of the other countries included in the model to be treated as net export or import demand functions (see Takayama and Judge 1971). Thus, for Australia supply and demand elasticity estimates were required while in the case of the other countries excess supply or demand elasticities were used. In the case of Australia, it was a short-term perspective which was taken with the assumption that the supply available was fixed as might be the case after harvest.

Two scenarios were considered in the analysis. These should be considered as two reasonably artificial scenarios which can be compared. The first was of a competitive trading system in which prices between the regions differed only by the transfer costs. The second was to include an oligopolist's margin for Australian exports to other countries and also for Australian domestic consumption. No other countries were assumed to act as oligopolists. The basic data are presented in Appendix Table A.1. Transfer costs were based on a set of differences between base prices in each of the countries.

Because of the difficulty of identifying representative locations as transport points for a number of countries and also the difficulty of obtaining average transfer costs for malt and barley it was found in initial experiments with estimated transfer costs that the various spatial prices were not reasonably reflected in the solutions. As a results, it was decided to calibrate the model on the observed trade flows and prices by solving for a set of imputed transfer costs. The imputed transfer costs could then be compared to the available rates.

To calibrate the model for appropriate transport costs it was assumed that the actual trade data available was determined within an oligopolistic environment. Because the prices used were for a combination of feed and malt barley, and approximate allowance was made for the different proportions of feed and malt traded. The transport costs were such as to allow the model to very closely reproduce the existing trade flows. The use of such rates means that the model results should not be viewed as a forecast or a prediction but as an analysis of alternative scenarios based on a set of rather artificial transfer costs which reflect the inter-country price differences that were observed. These prices were prices for barley as a whole which therefore represented both malting and feed barley in the proportion produced in each of the countries.

A simple example of the calibration process is given below for a two-region model. Since the direction of trade is known for the calibration process it is possible to solve the spatial model as a set of simultaneous equations. This was done using the Mathematica software system (Wolfram 1991). To illustrate the process a simple three region model expressed in terms of excess supply and demand functions is given below where the trade flows are x_{ij}, the prices are p_i and the slopes are -20, -25, -18, the intercepts are -250, -150, and -210 and the transfer costs are for the flow from region 2 to region 1 a value of 2.0 and for the flow from region 3 to region 2 a value of 1.0. The model is derived from the standard numeric model in Takayama and Judge (1971, p.165). This model is solved to obtain the trade flows and prices.

Solve the excess supply/demand model with trade flows x_{21} and x_{23}.

(1) $-x_{21} - 20\,p_1 = -250.0$
(2) $x_{21} + x_{23} - 25\,p_2 = -150$
(3) $-x_{23} - 18p_3 = -210$
(4) $p_1 - p_2 = 2$
(5) $-p_2 + p_3 = 1$

Solve for $\{x_{21}, x_{23}, p_1, p_2, p_3\}$

$\{x_{21} \to 34.7619, x_{23} \to 34.2857, p_1 \to 10.7619, p_3 \to 9.7619, p_2 \to 8.7619\}$

The results for the trade flows and prices may now be used to derive the transfer costs, t_{ij}. The new set of equations can again be solved in Mathematica.

(6) $-34.7619 - 20\,p_1 = -250.0$
(7) $34.7619 + 34.2857 - 25\,p_2 = -150$
(8) $-34.2857 - 18\,p_3 = -210$
(9) $p_1 - p_2 = t_{21}$
(10) $-p_2 + p_3 = t_{23}$

Solve for $\{t_{21}, t_{23}, p_1, p_2, p_3\}$

$\{t_{21} \to 2., t_{23} \to 1., p_1 \to 10.7619, p_3 \to 9.76191, p_2 \to 8.7619\}$

It is thus clear that the same process can be carried out for much larger models if the volumes shipped are known as well as the nature of the supply and demand functions. The barley spatial equilibrium system was calibrated in the same way except that allowance was made for the fact that oligopolistic margins were also imposed on the trade flows from Australia to other countries.

The results for a competitive scenario and an oligopolistic scenario are presented in Table 4 using demand and supply functions and import demand functions based on the price and quantity points and the elasticity estimates provided in Appendix Table A.1. The elasticity estimates for China (malt), Japan (total), Saudi Arabia (feed), Taiwan (total) and Other Middle East were based on simple econometric equations. For feed barley the unit price for Australian imports was estimated as a function of the quantity imported from Australia, the domestic

barley production, the livestock numbers, domestic barley stocks (if available) and a lagged dependent variable. The variables included varied somewhat between countries. A similar formulation was used for malting barley except the livestock components were dropped.

Table 4

A Comparison of Oligopolistic and Competitive Market Behaviour, 1993/94

	Competitive scenario	Oligopoly scenario	Difference (Oligopoly-competitive)	% Change
		$US/t		
Australia, Demand price	92.53	104.41	-11.88	-12.84
Australia, Supply price	92.53	87.30	5.23	5.65
China	125.07	124.23	0.84	0.67
Taiwan	101.16	101.42	-0.26	-0.26
Japan	137.21	137.21	0.00	0.00
Saudi Arabia	92.93	92.58	0.35	0.38
Other Middle East	109.14	108.79	0.35	0.32
Canada	115.59	115.24	0.35	0.30
USA	116.50	116.15	0.35	0.30
EU	72.04	71.69	0.35	0.49
ROW	110.60	110.25	0.35	0.32
		(000) t		
X11. Aust consumption	3,884.32	3,029.19	855.13	22.01
X11 Aust consumption	4,697.80	3,821.61	876.19	18.65
X12 Aust to China	1,233.40	1,316.42	-83.02	-6.73
X13 Aust to Taiwan	569.40	560.58	8.82	1.55
X14 Aust to Japan*	566.00	566.00	0.00	0.00
X15 Aust to Saudi Arabia		327.08	-327.08	
X16 Aust to Oth Mid East		493.59	-493.59	
X10 Aust to ROW	629.40	610.71	18.69	2.97
X74 Canada to Japan*	897.00	897.00	0.00	0.00
X78 Canada to USA	572.75	581.70	-8.95	1.56
X70 Canada to ROW	2,478.18	2,375.96	102.22	4.12
X84 USA to Japan*	99.00	99.00	0.00	0.00
X95 EU to Saudi Arabia	3,964.91	4,007.58	-42.67	-1.08
X96 EU to Oth Mid East	1,530.01	1,089.23	440.78	28.81
X90 EU to ROW	1,579.46	1,715.02	-135.56	-8.58
X04 ROW to Japan*	157.00	157.00	0.00	0.00
Australia exports	2,998.20	3,874.38	-876.18	-29.22
Australian production	7,696.00	7,695.99	0.01	0.00
Australian consumption	4,697.80	3,821.61	876.19	18.65
		$US 000		
Australian producer revenue	712,111	671,860	40,251	5.65
Australian consumer expenditure	434,687	399,014	35,673	8.21
Australian export revenue	277,423	338,233	-60,810	-21.92
Oligopolists net revenue	0	65,388	-65,388	

[a]For both scenarios trade with Japan was subject to quotas of 566,000 tonnes for Australia, 897,000 tonnes for Canada, 99,000 tonnes for the United States and 157,000 tonnes for the rest of the world.

Note: The scenarios are artificial and should not be considered as actual or predictions.

The results of the experiment with the model clearly reflect the fact that with market power it is possible for a marketing board to discriminate against domestic consumers and other countries by reducing sales on some markets and increasing sales in other markets. In this way returns to the marketing board are increased and as a result these returns can be passed along to barley producers. In the case illustrated, increased sales were made to China, and the rest of the world and trade was opened into two new markets. In effect, part of the oligopolist's marketing power is used to sell into markets which under a competitive scenario it might not be worthwhile doing so. It would be expected that an oligopolist would wish to charge the higher price in less elastic markets. In this way revenue is increased. Other factors such as transport costs also will affect the choices.

The results obtained from the model should be considered as reflecting two scenarios. The base case is the 'oligopoly scenario' in which it is assumed that an oligopolistic marketing board or marketing boards are able to manage the flow of barley between the domestic Australian market and the world markets. In doing so an oligopolist's margin is generated. This margin is reflected in the difference between the Australian demand price and the Australian supply price which in the case considered was $US 17.11 per tonne. The second case is the 'competitive scenario' in which there is no oligopoly margin and the prices differ by the cost of transport (better termed 'transfer costs') between markets. A significant difficulty in deriving the transfer costs between the various markets was the fact that the prices in different countries represented different proportions of malting or feed barley.

The results from the model reflect a reduction in sales on the domestic market under oligopolistic conditions and an increase in sales on some overseas markets such as China and the opening of markets in Saudi Arabia and other Middle East. Within the model, however, there is a reflection of the price responsiveness of other barley exporters such as Canada and the European Union. If Australia sells more on the international market and the price tends to be somewhat lower, then other countries will respond by selling less into the markets with lower prices. There is thus a complex set of interactions built into the model.

Considering the results in Table 4 more specifically, it is clear that with the removal of oligopoly power the price in Australia falls (from $US104 to $US92.5 per tonne). This is a result of the higher quantity (876,000 tonnes) which would be sold on the domestic market. This amount should not be seen as the precise amount by which sales would rise in Australia if single-desk selling of barley were abandoned. Rather it should be seen as indicative of the direction of the change. There are many qualifications and uncertainties in relation to the data used in the model so that it is difficult to be sure of the amount that would result. However, it is clear that it could be a significant amount.

In the case of the increased sales to China it was apparent after a number of experiments with the model that sales of barley to China were very sensitive to the transport costs between Australia and China and between Canada and China. With a very small change it was possible for Canada to capture the Chinese market and Australia would sell more to the rest of the world. This would seem to be indicative of the fact that small changes in production and transport costs can potentially make a lot of difference to the shares and directions of world trade.

Within the model, imports into Japan from Australia, Canada, the United States and rest of the world are constrained to quota levels. This means that in moving to a competitive scenario there is no change in the Japanese market.

Saudi Arabia is a very large importer of barley and was the lowest price importing market. With the European Union as the lowest price exporting market large amounts were supplied from the European Union to Saudi Arabia. With appropriate transfer costs Australia was able to supply the Other Middle East countries. Since the elasticity of demand for the Other Middle East countries was taken to be lower than for Saudi Arabia the preferred alternative for Australia in the competitive scenario was to increase sales under the oligopoly scenario.

Overall, the results reflect a significant drop in Australian exports and an increase in domestic consumer expenditure. If the oligopolist were to be a private trader then it could be assumed that the oligopolist's margin would go as profit to shareholders. If the oligopolist were a set of producer marketing boards then it is reasonable to assume that the oligopolist's margin will be largely returned to producers. There may be some losses in returning the full margin but if it were fully returned to producers then the marketing boards would return in the order of $US65 million to producers compared to a private oligopolist in the particular scenario indicated.

The difference in producer revenue between the competitive scenario and the oligopoly scenario could also be significant. In the case of a marketing board or boards passing the revenue onto producers there is a $11.88 per tonne gain for producers compared to the competitive case but at the expense of domestic grain consumers who pay the $11.88 as a higher price for grain.

One of the major uses for barley domestically is in the production of malt for the production of beer. To assess the impact on final consumers of such a margin, consideration needs to be given to the value of barley used in the production of beer. Since barley represents only about 2 per cent of the cost of beer then the above margin would reflect a very small change in the overall cost of beer production.

Concluding Comments

Within the context of the Australian barley industry it seems reasonable to conclude that with market power it is possible for a marketing board as a single seller to discriminate against domestic consumers by reducing sales on the domestic market and increasing sales in certain of the export markets. In this way returns to the marketing board may be increased.

The actual extent of such discrimination as reflected in the Carter model estimates are reasonably small. The possibility of price discrimination for feed barley destined to Japan and the United Arab Emirates was not rejected. In the case of Japan this is likely to be due to the import limitations imposed by Japan. The possibility of discrimination between the domestic market and export markets could also not be rejected when domestic data were included in the sales data for the Australian Barley Board.

For malt barley, evidence of discrimination between the domestic and export markets was not rejected. This may be influenced by the timing of malt sales. The domestic maltsters tend to price their sales over a relatively short window in the year and thus look to lock in their supplies preceding the Australian harvest and thereby minimise risk. The possibility of price discrimination in the case of China in later years was also not clearly rejected

By using an oligopolistic form of the spatial equilibrium model it is possible to clearly show that revenue to the oligopolist is increased as the oligopolist supplies more to the most price sensitive markets and reduces sales in the less price sensitive markets. A result that would be expected from basic price discrimination theory. By removing the ability to express market power both producer revenue and consumer expenditure increase. At the same time, with a marketing board as an oligopolist much of the oligopolist's margin will be returned to growers. In the scenario examined this amounted to $A 59.3 million. If the oligopolist were a private trader this may go as profits to the shareholders in the oligopolistic firm. In the scenario illustrated, about half the gains are made in export revenue and about half from the domestic market.

Finally, it is clear that the techniques illustrated in this paper provide one set of means of analysing some of the consequences of providing single-desk seller status to marketing boards. It is also apparent that a number of difficulties still remain and that a mix of approaches is likely to be preferable. Focus on very partial measures, which do not fully recognise the significance of the basic theory of price discrimination, such as the market-mix premium, will be likely to provide little help in clarifying the public benefit test required by the Hilmer reforms.

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Appendix A

Table A.1

Spatial Equilibrium Model Data

Country	Exports[a] (000 t)	Imports[a] (000 t)	Net Imports	Price[c] ($US/t)	Elasticity of demand[d]
Australia	3856[b]		-3856	104.16	2
China		1239	1239	125.01	-10
Taiwan		569	569	101.17	-6
Japan		1719	1719	137.21	-4
Saudi Arabia		4595	4595	92.33	-21
Other Middle East		1620	1620	108.54	-10
Canada	3789		-3789	114.99	8
United States	1553	2042	489	115.90	-6
European Union	6680	53	-6627	71.44	8
Rest of the World	2702	6743	4041	110.00	-1

[a]USDA, *Grains: World Markets and Trade and ABARE data*

[b]Net exports based on data collected from the three barley boards.

[c]Price estimates are indicative of in-country prices from various sources and should currently be treated as a scenario rather than actual prices.

[d]Excess demand elasticity estimates were based on regression estimates using trade data provided by the Australian Barley Board. For Canada, the United States, the European Union and the Rest of the World values are judgement-based estimates after considering a range of literature. The elasticities and the price and net import data were used to calculate linear excess supply and demand functions.