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QUALITY PREMIUMS FOR AUSTRALIAN WHEAT IN THE GROWING ASIAN MARKETS

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An hedonic price function is applied to Australia's wheat exports to the growing Asian markets. The values for the quality characteristics in the wheat markets of Indonesia, Malaysia, Singapore, South Korea, and Thailand are estimated. The data base for the study is from the Australian Wheat Board shipments over the period 1984 to 1991. The sample is divided into two separate time periods to test the consistency in demand for export wheat and to trace recent trends in quality premiums. The implications of the results for wheat marketing and trade are explored.

Introduction

The Australian agricultural economy relies heavily on the international market for its sustainability and growth. One segment of the international market, the Asian countries, has recently emerged as a significant destination for Agricultural exports. The wheat market is a prime example, as wheat exports to Asian markets in 1986/87 amounted to just over 38 per cent of the total wheat exports, while in 1992/93 they represented nearly 60 per cent of total wheat exports (Australian Wheat Board (AWB) various). The Asian markets yield a wide variety of end-uses from Australian wheat. These different end-uses result in demanding various quality characteristics of the wheat. Determining the premiums/discounts associated with these characteristics is of significance to the grains industry for production, marketing and trade decisions.

The main objective of this paper is to measure the premiums/discounts for Australian wheat characteristics in the growing Asian markets. An

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hedonic price function is applied to the actual wheat export shipments over the period 1984 to 1991 to test the extent to which various wheat characteristics explain price. The paper is set out in the following manner. Background information on the growing Asian markets studied is provided first followed by an outline of the model and data for the analysis. The results are then presented and interpreted. An attempt is made to explore the policy implications for the Australian wheat industry prior to concluding comments.

Background

Australia has always exported significant volumes of wheat to major Asian markets, such as, Japan and China. Recently, there has been a rise in exports to smaller countries of this region including Indonesia, Malaysia, Singapore, South Korea and Thailand. These five markets accounted for over a quarter of Australia's exports in 1992/93 (AWB various) which is more than double what they accounted for in 1986/87. Generally speaking, Australia's wheat exports are mainly used for flat breads (45 per cent), noodles (31 per cent) and pan bread (11 per cent), while steamed bread, chappaties and cakes/biscuits account for four per cent each (Wrigley 1994). Unlike the Middle East where most of the wheat has flat bread as its end-product, there are various end-uses in Asia with the importance of each varying from one country to another.

Noodles are the major end-product in both Indonesia and Malaysia having been estimated to represent up to 70 per cent and 40 per cent of wheat usage respectively. In Indonesia the remaining end-uses are pan breads (15 to 20 per cent) and cakes and biscuits (10 to 15 per cent) (Miskelly 1988). The major classes of wheat sold to Indonesia are Australian Standard White (ASW) and ASW soft varieties which account for nearly 80 per cent, while Australian Hard (AH) and Australian Prime Hard (APH) make up the remainder. In Malaysia pan bread and biscuits represent up to 30 and 25 per cent respectively of flour usage with the remaining flour used for cakes, pastries and steamed buns (Miskelly 1988). ASW is the major class of wheat sold to Malaysia representing around 59 per cent of Australian wheat exports over the period 1984 to 1991. The APH category (24 per cent) also represents a significant share with AH (7 per cent), Soft, General Purpose and Feed making up the remainder.

Singapore purchases a wide variety of wheats from Australia including APH, AH and ASW which are used mainly for noodle and bread production. In South Korea, noodles are the major end-use with bread and confectionary products also produced in significant quantities (Miskelly 1988). South Korea purchases mainly ASW and Soft wheat from Australia as well as significant quantities of AH and some General Purpose and Feed. Thailand usually imports high protein wheats for bread manufacture, although noodles and biscuits are also produced. Thailand imports a wide variety of wheats from Australia including APH and AH, but ASW is the largest grade imported.

Overall, although noodles are the major end-product in Asian markets, there exist many other end-uses of wheat in this region. To meet the quality requirements of these end-uses, the majority of wheat purchased by Asia comes from the ASW category, while there is also significant quantities of AH and APH in some markets.

The various end-uses require different quality wheats. There are many types of noodles, the major end-use in Asia, which can be grouped into three broad categories: white salted noodles, yellow alkaline noodles and instant noodles (salted or alkaline). White salted noodles require a relatively soft grained white wheat with a protein content of 9 to 10 per cent, while flour colour is also of prime importance. The protein content in yellow alkaline noodles varies from type to type with egg noodles requiring 12 per cent, and Hokkein style 10.5 per cent (Miskelly 1988). Instant noodles are generally made from flour with a protein content of 10.5 to 11 per cent.

The quality requirements for the other major end-use in Asia of pan bread depend on how leavened the bread is desired. For leavened breads, wheat which is reasonably hard (particle size index 12 to 19) with a medium to high protein content (11.5 to 14.5 per cent) is the most desirable. For lightly leavened and unleavened breads, protein content does not need to be as high, and medium to soft grained wheats are satisfactory (Simmonds 1989, p22-23).

In summary, the ASW category is very well suited to noodles, while APH is used for the noodles requiring higher protein with the cleanliness of Australian wheats also being an advantage. AH and APH which have higher protein contents are the most appropriate for pan bread production.

Model

To estimate the premiums/discounts associated with the various quality characteristics the hedonic pricing approach is utilised. This approach has been applied to wheat by Ahmadi-Esfahani and Stanmore (1994), Larue (1991), Goodwin and Espinosa (1991), Wilson (1989) and Veeman (1987) previously. The hedonic price approach postulates that the price of a heterogeneous product is a function of the characteristics of the product.

Hedonic theory can take two different approaches. Firstly, the product can be considered to be a final product, where the characteristics provide utility in a consumer's optimisation problem. Alternatively, in the case of products that can be considered inputs, the characteristics constitute input arguments in a production function. Therefore, a consumer maximising utility subject to a budget constraint or a firm maximising profit subject to an input characteristics production function can be postulated. The former approach is taken here following the work of Ladd and Suvannut (1976).

The consumer's utility function can be expressed as $U = U(X_{01}, X_{02}, \ldots . X_{0m})$

where X_{oj} = the total amount of the jth characteristic provided by consumption of all products $j = 1$ to m, and X_{ij} = the quantity of the jth characteristic provided by one unit of product i, $i = 1$ to n. The consumer's utility is constrained by the budget constraint $\sum_i p_i q_i = I$ where p_i = price paid for the ith product, qi = the quantity of the ith product, and I = income. The Lagrangian can then be formed as $L = U(X_{01}, X_{02}, \ldots X_{0m}) - \lambda(\sum_i p_i q_i - I)$ yielding

$$(1) \qquad \frac{\partial l}{\partial q_i} = \sum_j \left(\frac{\partial u}{\partial x_{oj}}\right)\left(\frac{\partial x_{oj}}{\partial q_i}\right) - \lambda p_i$$

Given that the marginal utility of income $\frac{\partial u}{\partial I}$ is λ, equation (1) becomes equivalent to

$$(2) \qquad p_i = \sum_j \left(\frac{\partial x_{oj}}{\partial q_i}\right)\left(\frac{\partial u}{\partial x_{oj}}\right) \Big/ \frac{\partial u}{\partial I}$$

The ratio $\frac{\partial u / \partial x_{oj}}{\partial u / \partial I}$ is the marginal rate of substitution between income and the jth product characteristic. Thus, $\frac{\partial u / \partial x_{oj}}{\partial u / \partial I}$ can be written as $\frac{\partial I}{\partial x_{oj}}$. Assuming all income is spent, $\frac{\partial u}{\partial I} = \frac{\partial u}{\partial E}$, where E = expenditure on all products. Thus, equation (2) reduces to

$$(3) \qquad Pi = \sum_j \left(\frac{\partial x_{oj}}{\partial q_i}\right)\left(\frac{\partial E}{\partial x_{oj}}\right)$$

where $\frac{\partial x_{oj}}{\partial q_i}$ = marginal yield of the jth characteristic by the ith product and $\frac{\partial E}{\partial x_{oj}}$ = marginal rate of substitution between expenditure and the jth characteristic which is the marginal or implicit (hedonic) price paid for the jth characteristic.

The model is based on the assumption that consumers derive utility from the intrinsic characteristics of the product. This assumption together with that of perfect competition allows the price of the product to be decomposed into parts expressing the contribution of specific characteristics to the overall utility gained from consuming the product.

A regression of equation (3) assists in testing the null hypothesis that the price of the product is not related to quality characteristics. That is,

the regression determines the direction and magnitude of the characteristics impacting on the price of the product. Thus, the price of wheat is determined by a linear summation of the marginal implicit prices multiplied by the quantity or quality level of each characteristic. The implicit prices are, in turn, exactly the same as premiums/discounts paid for wheat by end-users.

Data

The database for the study is from the AWB which granted us access to information from previous Australian wheat export shipments to the Asian markets. To our knowledge, this is the first study to utilise contract data to estimate the premiums for wheat quality characteristics as the previous studies by Ahmadi-Esfahani and Stanmore (1994), Larue (1991), Goodwin and Espinosa (1991), Wilson (1989), and Veeman (1987) all used annual average data. Annual average data may not tell as much about the individual characteristics because of their aggregated nature and, as such, reduce the accuracy of the relationship among the variables. The contract data reflect the actual market conditions more precisely and are thus more likely to result in the implicit prices estimated for the quality characteristics being closer to their true values.

The data include the prices for and the size of shipments of wheat to the five markets, as well as quality characteristics tested for in those shipments. These characteristics are test weight, protein, moisture, unmillable material, foreign material and falling number. Hardness is not a characteristic reported in AWB contracts. Test weight and protein are both desirable characteristics and would expect to yield a premium as they increase in magnitude. Moisture, unmillable and foreign material are undesirable and should result in discounts as their content rises. Falling number is a test that indicates amylase activity with an inverse relationship. Amylase activity is undesirable and therefore a discount would be expected which is indicated by a premium for falling number. The data size varies with particular markets but is quite large in most cases, covering the period 1984 to 1991. All data were obtained in US dollars but have been converted at A$1.00 = US$0.75 with the results reported in Australian dollars with 1990 the base year.

Results

The demand of each market for Australian wheat is analysed by estimating the implicit values of the six quality characteristics and testing the consistency of demand over two time periods. Implicit values are the changes in the price of a tonne of wheat, when there is a marginal change in the level of a characteristic; changes that can be interpreted as premiums or discounts. The results are presented in the Tables 1-3 with the t statistics reported in parentheses below the implicit values. Both linear and non-linear functional forms were estimated; however, the linear form yielded the more consistent results. The linearity of the model implies that the premiums/discounts remain constant across the range of the charac-

teristics. However, it is quite likely that non-linear relationships exist at the extremities, particularly in the case of falling number. The results for the whole data sample are interpreted first followed by a comparison of the results for the different time periods.

The results for the individual markets over the period 1984 to 1991 are displayed in Table 1. The results for Indonesia indicate that three variables — protein, unmillable material and falling number — consistently influence the price. The coefficients imply that a premium of $3.16 per tonne of wheat is paid for each additional per cent of protein. On the other hand, a discount of $1.31 is the result of a one per cent increase in unmillable material. The discount for amylase activity, as represented by a premium for falling number, is $0.57 for every ten seconds that falling number increases.

TABLE 1
Implicit Prices of Quality Characteristics for 1984-91[a]

	Implicit Price ($A per tonne)			
Characteristic	Indonesia	Malaysia	Singapore	Thailand
Test Weight (kg/hl)		1.15 (2.03)	2.55 (1.93)	
Protein (%)	3.16 (3.99)	3.65 (4.82)	9.44 (4.63)	9.99 (5.03)
Unmillable Material (%)	−1.31 (−1.91)			
Foreign Material (%)		−17.69 (−2.37)		
Falling Number (10 seconds)	0.57 (3.75)	0.25 (2.14)	0.80 (2.89)	0.61 (2.52)
R^2 adjusted	0.48	0.31	0.65	0.42
Durbin-Watson	1.86	2.03	2.08	2.00
Degrees of Freedom	168	465	87	56

[a] Moisture was an insignificant characteristic for all markets, while there were no characteristics significant in South Korea.

TABLE 2
Implicit Prices of Quality Characteristics for 1984-87[a]

Characteristic	Implicit Price ($A per tonne)				
	Indonesia	Malaysia	Singapore	South Korea	Thailand
Test Weight (kg/hl)		2.07 (2.70)	3.56 (1.94)		
Protein (%)	6.11 (5.31)	4.23 (4.22)	12.01 (4.52)	5.76 (2.43)	11.85 (3.64)
Foreign Material (%)		–29.72 (–1.94)			
Falling Number (10 seconds)		0.39 (2.54)	0.68 (1.93)		1.21 (2.98)
R^2 adjusted	0.49	0.38	0.66	0.17	0.46
Durbin-Watson	1.90	1.96	1.97	1.96	2.04
Degrees of Freedom	70	234	43	40	27

[a] Moisture and unmillable material were insignificant characteristics for all markets.

TABLE 3
Implicit Prices of Quality Characteristics for 1988-91[a]

Characteristic	Implicit Price ($A per tonne)		
	Indonesia	Malaysia	Singapore
Protein (%)	3.09 (3.93)	3.19 (3.44)	7.36 (2.88)
Falling Number (10 seconds)			0.95 (2.84)
R^2 adjusted	0.41	0.24	0.47
Durbin-Watson	1.78	2.02	1.73
Degrees of Freedom	99	233	41

[a] Test weight, moisture, unmillable and foreign material were insignificant characteristics for all markets, while there were no characteristics significant in South Korea or Thailand.

The results for Malaysia indicate that it is a quality conscious market, as four characteristics have premiums or discounts, with only moisture and unmillable material being insignificant. The results suggest that a

$1.15 premium exists for each extra kg/hl of test weight. The premium for protein is $3.65 per percentage point. For foreign material, the discount of $17.69 per every per cent is large and demonstrates that Malaysian flour mills desire very clean wheat. This finding is supported by the extremely low levels of wheat purchased from the United States (a market share of only 8 per cent in 1991/92) which has a reputation for having higher dockage levels than those for other countries. Falling number is also a significant characteristic in Malaysia's decision to purchase wheat, which indicates a desire for sound wheat with low levels of amylase activity, although the premium of $0.25 is not particularly large.

Singapore also appears to be a quality conscious market given the regression results. The three significant characteristics, test weight, protein and falling number all command relatively large premiums of $2.55, $9.44 and $0.80, respectively. The insignificance of unmillable and foreign material implies that Singapore may not be concerned about the cleanliness of the wheat.

The results for South Korea indicate that it may not be a quality conscious market, as none of the characteristics is significant. The most significant characteristic is foreign material, but the discount of $10.21 is only significant at the 20 per cent level, which exhibits a rather inconsistent demand as the discount is not always assured of existing.

The results for Thailand show that protein and falling number are the characteristics to consistently affect the price paid by Thailand. The $9.99 premium for protein is substantial suggesting that protein is a key factor in the end-uses of wheat in Thailand, while the premium for falling number is $0.61.

Overall, the results for the whole data sample indicate that certain Asian markets such as Singapore and Malaysia are particularly quality conscious with 3 or 4 characteristics having significant premiums/discounts. Indonesia and Thailand are also quality conscious. Australia's market share in 1991/92 for Indonesia was 36 per cent, Malaysia (39 per cent), Singapore (37 per cent), South Korea (9 per cent) and Thailand (13 per cent) (IWC 1992) indicating that of the markets where Australia had a significant market share, Indonesia, Malaysia and Singapore received greatest reward for quality.

For the individual quality characteristics, test weight, protein and falling number are the most important, being significant in a majority of the markets. The premium for protein ranges from 3.16 to 9.99 with the largest premiums being paid by the smaller Asian markets such as Singapore and Thailand. The premium for test weight indicates that although test weight influences price in some markets, the impact is rather small with only Singapore having a premium in excess of two dollars. However, it should be noted that an increase of an extra kilogram per hectolitre may be easier to achieve than an extra per cent of protein and thus a smaller premium for test weight would be expected. This is certainly the case for falling number as an increase of ten seconds in falling number is more likely and easier to achieve than an increase of one per cent in protein.

As with protein, the largest premiums for falling number are paid by Singapore and Thailand. Unmillable material and foreign material are only significant in Indonesia and Malaysia, respectively, while moisture is insignificant in all markets.

The fact that unmillable and foreign material are not well rewarded in these markets implies either that most Asian importers are not concerned about the cleanliness of the wheat or that Australia's unmillable and foreign material levels are always below the required level and thus there is no explicit reward for delivering extra clean wheat. The latter interpretation is the more likely case given Australia's reputation for delivering clean wheat. A similar note may apply to moisture content as it is not found to be significant in any markets, yet the moisture content in Australian wheat is recognised to be amongst the best in the world and thus the benefit of this may come through continued sales rather than premiums for extra low moisture content.

Recent Trends

To test whether any factors in the market had led to a change in the premium for any quality characteristics, the data set for each market was divided into two periods; the first period ending, and the second period beginning, at the close of December 1987. These factors include technological advancement in the milling and baking industry, changes in consumer tastes which would show whether the change in demand for end-products had led to a corresponding change in the valuation of the quality characteristics, changes in income growth which shift the demand for quality or significant trade policy actions, such as the US Export Enhancement Program (EEP) and EC wheat export subsidies.

The results for the separate time periods 1984 to 1987 and 1988 to 1991 are presented in Tables 2 and 3, respectively. In Indonesia, the results indicate that protein is the only characteristic to be significant in each period. It is obvious that the significance of the variables drops over the shorter period and smaller data base, as neither unmillable material nor falling number is significant in either period. The consistent premium for protein indicates the importance of protein in wheat sales to Indonesia.

The results for the two periods suggest that the Malaysian market may be becoming less quality conscious. In the first period, four variables — test weight, protein, foreign material and falling number — had a direct impact on the price paid for the wheat, but since 1988, Malaysia's demand for Australian wheat is less influenced by the quality characteristics of the wheat. Test weight and foreign material appear to no longer have a significant impact on price and even though protein is significant in the second period, the size of the premium has dropped indicating a reduced reward for quality. The insignificance of test weight and foreign material in the most recent period reduces their importance in Australia's wheat sales to Malaysia; however, attention should still be paid to the protein and amylase activity content of the wheat.

In the Singapore market, two characteristics, protein and falling number have consistent premiums in both periods. However, test weight moves from having a significant premium in the earlier period to being insignificant in the latter. This observation implies that Singapore pays lower premium for to test weight. The high value of the *t*- statistic for protein means that the hypothesis that this market is highly concerned about the protein levels is accepted with increased confidence, but the lower premium indicates that the reward for protein has decreased. The wheat industry should be most concerned about the protein and amylase activity content in wheat exports to Singapore.

In South Korea, the results for each period suggest that the only characteristic to be significant in the earlier period 1984 to 1987 was protein. The premium obtained for protein was $5.76 per percentage point. The fact that the premium for protein does not exist for the whole period 1984 to 1991 shows the impact that the recent time period, where there is no premium for protein, has on the overall results. The insignificance of all characteristics over the whole sample and in the latest time period seems to indicate that South Korea is not a very rewarding market for quality. The surprising result for South Korea may have been influenced by the large volumes of feed wheat sold to South Korea over the period of analysis, which received little reward for quality.

In Thailand, the results for the earlier period are consistent with the results for the whole data sample, as protein and falling number are the only characteristics to have significant premiums. These premiums are larger than those for the whole data sample. The results for the latter period suggest that protein and falling number do not influence price and thus, demand is not consistent throughout. The insignificance of all the characteristics in the latter period may have been influenced by the small data sample (29 observations) which may have allowed one or two unusual contracts to distort the results. Overall, protein and falling number are the characteristics that should receive most attention in wheat marketing and trade in Thailand.

A comparison of the results across the two periods suggests that there has been a significant shift towards a lower premium for various quality characteristics. In the earlier period there are 11 characteristics significant in the five markets, whereas in the latter period there are only four. Also, the premiums in the latter period are smaller, except for falling number in Singapore, than those obtained for this market in the earlier period. The most obvious observation is that test weight is significant for two of the markets in the earlier period but insignificant for all markets in the latter period.

The difference between the two periods is also highlighted by the R^2 values which have all decreased from the earlier to the latter period. For Indonesia, the R^2 value dropped from 0.49 to 0.41, for Malaysia the decrease was from 0.38 to 0.24, while for Singapore the R^2 value fell from 0.66 to 0.47. The lower R^2 values in the latter period imply that other factors apart from quality characteristics must be explaining export wheat

price. This tendency towards lower premiums may have been influenced by a number of factors, including the recent wheat price war, increased blending technology or a change in consumer tastes.

The world wheat market has always experienced price competition, but in the early to mid-1980s the European Community began to substantially discount its export wheat price. In response the United States expanded its EEP in 1986 and the price war really took off, with world wheat prices falling dramatically in the subsequent years (Roberts and Whish-Wilson 1993). The bulk of wheat exported by the European Community is medium protein, while the largest grade exported by the United States is Hard Red Winter. Both of these wheats compete directly with Australia's ASW grade which represents around 70 per cent of Australia's total exports. The low prices for US and EC wheat exports have meant that Australia has had to drop its price to compete as the importers' power in negotiations has increased due to the availability of cheap fair average quality wheat. Thus, the premiums received for quality characteristics in Australian wheat appear to have dropped in the emerging buyers' market. The decrease in the premiums could have been greater, had there not been significant income growth in the Asian region which has generally strengthened the demand for quality food products.

The trend towards a less 'quality-rewarding' world market may also have been influenced by recent technological advancement in flour processing, milling and blending. For instance, technology may make the removal of foreign and unmillable material much less difficult or expensive than was previously the case. Therefore, low levels of these characteristics are not rewarded in the latter period. Technological advancement may allow lower quality wheat to be used to achieve end-products of the same quality as those previously achieved by higher quality wheats. Still more important is the increased potential to blend wheats, as this significantly affects the demand structure for wheats. For instance, a greater ability to blend will allow purchases of low quality wheat to be blended with higher quality wheat to achieve the desired quality. This is particularly relevant in the US-EC price war as highly subsidised low quality wheat can be purchased and even stockpiled by importers to blend with higher quality wheats when required.

The price war together with technological advancement allows importers to adapt their processing towards cheaper grades of wheat (usually of lower quality) which is reflected in the trend towards a less quality rewarding wheat market. The other factor that could reduce the reward for quality is a change in consumer tastes. That is, Asian consumers may have realised or grown to accept that the end-product from slightly lower quality wheat is not much worse than the higher quality wheat and are therefore not willing to reward the higher quality wheat.

Policy Implications

This article provides evidence rejecting the null hypothesis that there is no implicit market in Asia for Australian wheat quality characteristics.

The single most significant finding of the study is that quality attributes are important in the Asian buyers' decision and the reward for achieving satisfactory protein levels, in balance with other characteristics, is quite high because they enable the wheat to be marketed into the higher priced markets. Quality characteristics may also be critical in ensuring continued access to the current non-discerning markets as these markets become discerning due to income growth, technological advancement or decentralisation of buying arrangements enabling individual mills or other end-users to reveal their preferences. However, there may be some areas in which it may be difficult, if not impossible, to increase the protein levels and have the appropriate balance of other attributes to gain entry into these markets.

Another significant finding of the study is that there appears to be no reward for extra clean or extra dry wheat. This observation lends support for the authenticity of the reputation of Australian wheat for cleanliness and dryness, at least, in the growing Asian markets studied here. The insignificance of moisture content in all the markets analysed is consistent with the recent scientific research undertaken by the CSIRO Division of Entomology based on which the receival moisture content of wheat was raised experimentally from the current required level of 12 per cent up to 13 per cent with no significant effect on quality (see Desmarchelier and Ghaly 1993). Accordingly, the results of the study may have significant implications for the efficiency of the grading system, breeding programmes and pricing practices for wheat (see Ahmadi-Esfahani and Stanmore 1994). In addition to protein, unmillable and foreign material, and moisture content, test weight and falling number are appropriately rewarded by the industry. The estimated premiums/discounts reported in this study can potentially be used to examine whether the current reward system is indeed efficient and to determine whether prices received by various participants reflect the end-use quality of export wheat perfectly. Regression of grading requirements on end-use quality variables may provide a useful approach to this important research question.

Finally, the hypothesis postulated in the study serves to provide a test for product differentiation with the results suggesting that export wheat prices are responsive to quality variables but are becoming decreasingly so. This finding is inconsistent with the results obtained by Wilson (1989) which indicates increasing wheat price differentials reflecting the trading environment of the mid 1970s to early 1980s. As noted previously, the more recent trend seemingly stems, in part, from the emergence of the US-EC price war of the mid 1980s to early 1990s and implies that although Australia's reputation for high quality wheat constitutes a degree of product differentiation that may provide price separation from its competitors in the higher priced markets, the extent of this separation is rather limited. Large exports of subsidised 'American' or 'European' varieties, among others, would virtually eliminate any separation and would inevitably intensify competition among sellers in markets for wheat of fair average quality. Thus, commercial production of lower-qual-

ity higher-yielding wheat cultivars (white and red) for human consumption and feeding purposes should be seriously considered by the wheat industry as a potent strategy to enhance the competitive position of Australia in these markets.

Concluding Comments

The analysis suggests that the growing Asian markets are, in general, very quality conscious with significant premiums for certain characteristics and, in particular, for protein. Given the likely increased demand for grain via income growth, Australia should strive to supply the desired quality wheat to the particular Asian markets, and maintain or enhance its reputation for high quality clean white wheat which is very suitable for noodle production, the major end-use in the region. However, given the recent downward trend in the magnitude of quality premiums, it appears that Australia should take a portfolio approach to international wheat marketing and trade enhancing its comparative and competitive advantages in the production of differentiated and undifferentiated wheats (see Ahmadi-Esfahani *et al.* 1994). Obviously, a plausible set of market-specific excess demand elasticities is required to rigorously pursue such an approach (see Ahmadi-Esfahani and Stanmore 1992). However, given that quality requirements are, in general, able to explain less than a half of the variations in wheat price (see the R^2 values in Tables 1-3), other factors, such as, financial and commercial agreements, tariff and non-tariff barriers, and political preferences may also be of considerable importance in determining export price of Australian wheat and, as such, should be included in any future work in this area.

References

Ahmadi-Esfahani, F., Jensen, P. and Stanmore, R. (1994), 'Australia's Position in the International Wheat Market: An Alternative View', *Australasian Agribusiness Review* 2 (1), 20-28.

Ahmadi-Esfahani, F.Z. and Stanmore, R.G. (1994), 'Values of Australian Wheat and Flour Quality Characteristics', *Agribusiness: An International Journal* 10(6), 529-536.

Ahmadi-Esfahani, F.Z. and Stanmore, R.G. (1992), 'Is Wheat a Homogeneous Product?: A Comment', *Canadian Journal of Agricultural Economics* 40 (1), 141-146.

AWB. (various), *Annual Report*, Australian Wheat Board, Melbourne.

Desmarchelier, J.M. and Ghaly, T. (1993), 'Effects of Raising the Receival Moisture Content on the Storability of Australian Wheat', *Australian Journal of Experimental Agriculture* 33 (7), 909-914.

Goodwin, B. and Espinosa, J. (1991), 'Hedonic Price Estimation for Kansas Wheat Characteristics', *Western Journal of Agricultural Economics* 16 (1), 72-85.

IWC. (1992), *World Grain Statistics*, International Wheat Council, London.

Ladd, G. and Suvannut, V. (1976), 'A Model of Consumer Goods Characteristics', *American Journal of Agricultural Economics* 58(1), 21-30.

Larue, B. (1991), 'Is Wheat a Homogeneous Product?', *Canadian Journal of Agricultural Economics* 39 (1), 103-117.

Miskelly, D. M. (1988), 'Noodle and Soft Wheat Quality for South East Asia'. Australian Cereal Chemistry Conference, Sydney, September.

Roberts, I. and Whish-Wilson, P. (1993), 'The US Export Enhancement Program and the Australian Wheat Industry', *Agriculture and Resources Quarterly* 5 (2), 228-241.

Simmonds, D.H. (1989), *Wheat and Wheat Quality in Australia*, CSIRO, Australia.

Veeman, M. (1987), 'Hedonic Price Functions for Wheat in the World Market: Implications for Canadian Wheat Export Strategy', *Canadian Journal of Agricultural Economics* 35 (3), 535-552.

Wilson, W.W. (1989), 'Differentiation and Implicit Prices in Export Wheat Markets', *Western Journal of Agricultural Economics* 14 (1), 67-77.

Wrigley, C. W. (1994), 'Developing Better Strategies to Improve Grain Quality for Wheat', *Australian Journal of Agricultural Research* 45 (1), 1-17.