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SOME ESTIMATES OF THE PRICE ELASTICITY OF DEMAND FOR FEED GRAINS IN AUSTRALIA

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In this paper, up-to-date estimates for the price elasticities of feed demand for wheat, barley and sorghum for both Australia and New South Wales are presented. For feed wheat, the estimates for the price elasticities of demand are consistent with those obtained for earlier periods. No evidence could be found for a structural change in feed wheat demand due to the introduction of the permit scheme. For feed demand for barley and sorghum, the estimates for the own-price elasticities are markedly higher than those based on less recent data, and only a little lower than that for feed wheat. The price of cattle - reflecting the demand for cattle - markedly influences the feed demand for barley and sorghum. The estimates for New South Wales indicate consistency with those for the nation as a whole.

Introduction

The Australian feed grains market forms an important outlet for domestic grain production, particularly for coarse grains. It accounts, on average, for around 5 per cent of wheat disposal and around 30 per cent of disposal of coarse grains. The importance of the domestic feed grains market has increased in recent years. An increase in intensive livestock numbers, including a large increase in feedlot cattle, has stimulated demand for feed grains. Further impacts on the market are expected from the recent deregulation of the domestic feed wheat market and from the liberalisation of the Japanese beef market. The former may result in cheaper feed wheat for buyers, and the latter may push up domestic cattle prices, and hence indu an increase in feed grain demand.

To analyse the effects of these changes on the domestic feed grains market, an insight into the demand for feed grains is essential. As regards feed wheat deregulation, the extent of the effects on the grain and livestock industries will depend on the responsiveness of feed grain demand to changes in the relative prices of feed grains. If demand for feed grains is price responsive, and if deregulation leads to a lower price of feed wheat for buyers, the changed price relativity among feed grains could markedly influence the pattern of feed grain consumption, increasing feed wheat consumption by substitution for other feed grains. Liberalisation of the Japanese beef market can be expected to have significant effects on the domestic feed grains market if demand for feed grains is responsive to their price and the price of cattle.

Estimates obtained from previous studies for the price elasticities of demand for feed grains vary significantly (Table 1). Estimates for the own-price elasticity of demand for feed wheat in similar data periods ranged from a low of -0.72 (Spriggs 1978) to as high as -2.86 (Austin 1977) and -2.76 (Ryan 1981). The most recent measures of the own-price elasticities of feed demand for barley and sorghum are low relative to that for feed wheat, although wheat, barley and sorghum are highly substitutable in feed. The large variation in the estimates for the price elasticities of feed grain demand creates confusion in analysing the effects of policy changes on the domestic feed grains market. Moreover, the marked expansion in the livestock sector - especially in the poultry and cattle industries - in the past decade, and the changes in the marketing arrangements for feed wheat, may have affected the underlying market structure and resulted in changes in the price elasticities of demand for feed grains since the above measurements were made. (The sample period in the latest estimation for feed grain demand was only up to 1978-79.)

Another limitation of previous estimations of feed grain demand is that they have all been for Australia as a whole: no study was undertaken for a state or a region. Since transporting grain over a long distance is very costly, grain types produced close to local feed markets would have a comparative advantage over those produced at a distance. For example, sorghum is mainly grown in New South Wales and Queensland, and is little used outside these two states because of transport costs. Consequently, the relative importance of each factor affecting feed grain demand, particularly the price responsiveness of demand, could differ between the nation as a whole and states or regions. In this study, the price elasticities of demand for feed grains are estimated using more recent data, for both Australia as a whole and New South Wales. The two sets of estimates are compared to examine how the price elasticities of feed grain demand in New

TABLE 1

Previous Estimates for the Price Elasticities of Demand for Feed Grai[illegible]

Study	Product	Wheat	Barley	Oats	Sorghum	Pig	Poultry	Eggs	Beef	Data period
		Price elasticities								
Bain (1973)(a)	Wheat	0.14	0.13	0.22						1947/48-69/70
	Barley	-0.43	-1.92	1.02						
	Oats	-0.38	1.53	-4.95						
Austin (1977)(b)	Wheat	-2.86								1960/61-75/76
	Barley		-1.20							
	Sorghum				-0.78					
Spriggs (1978)	Wheat	-0.72(c)								1949/50-72/73
	Barley		-0.85(d)							1955/56-74/75
	Sorghum				-1.10(d)					1960/61-73/74
Fisher (1978)	Wheat	-1.03(e)								1949/50-72/73
Ryan (1981)(b)	Wheat	-2.76	1.[illegible]6			0.71	0.30	1.40	0.34	1950/51-78/79
Ryan (1982a)(b)	Barley	0.77	-0.94						1.52	1949/50-78/79
Ryan (1982b)(b)	Sorghum	1.18(f)			-1.27				1.39	1960/61-78/79

(a) Al[illegible] prices were deflated by the index of prices paid by farmer. (b) Nominal prices were used in the st[illegible] (c) Deflated by the barley price. (d) Deflated by the price of feed wheat. (e) Deflated by a composit[illegible] price of other feed grains. (f) A composite price of feed wheat and barley.

South Wales differ from those for the nation as a whole. The grain and livestock industries in New South Wales are the largest in the nation.

The Domestic Feed Grains Market

Feed grains are a major input into the production of livestock, contributing around 60 per cent of total costs in intensive production (Australian Bureau of Statistics 1987). The price of feed grains is a major determinant of the profitabilty of intensive livestock production, while the demand for intensive livestock products determines the demand for feeds, including feed grains.

Grain for feed can be sold either directly to livestock producers (both intensive and extensive) or to stockfeed manufacturers. Feed rations produced by stockfeed manufacturers are sold mainly to intensive livestock producers. Grain is also utilised directly on the farms for feeding sheep and cattle. By-products of the production of human food from grains, such as pollard and bran, are also used in feed and are largely sold to the domestic feed grains market. By-products of meat processing and vegetable oil production are used as protein sources in feed rations.

The location of feed grain markets reflects the cost of transporting grain, the availability of feed and meat processing facilities, the availability of other inputs into intensive livestock production, and the location of livestock markets. Pigs and feedlot cattle enterprises tend to be concentrated in grain growing regions, because of the availability of land and the relative economies in transporting cattle and pigs rather than transporting the large quantities of grains required to feed them (Australian Pork Producers Federation 1986). Availability of store cattle also influences the location of feedlot operations. Poultry farms are located close to major urban markets because the lower prices and per-animal feed requirements of poultry make it more economical to transport grain than poultry over large distances (Australian Chicken Meat Federation 1988). Transporting poultry over long distances is difficult and can be costly as a result. Availability of electricity and labour also makes urban fringes good locations for poultry plants.

Domestic feed grain prices are usually determined by price developments on world feed grain markets, because export markets are the most important outlet for Australian grains (Foster and Geldard 1985): developments in the domestic livestock feed market normally have little influence on domestic feed grain prices. Only infrequently, in periods when there is temporary excess demand such as during severe droughts, do domestic prices rise above export parity. Nor will developments in the domestic livestock feed economy influence Australian export prices, because Australia is essentially a price taker on world grain markets.

Consequently, unit export returns, after deductions for distribution and marketing, provide a floor for the price at which farmers will sell grain on their local feed market. Grain producers would divert grain supplies to export markets (or other domestic outlets) if regional feed grain prices were lower than the equivalent unit export market return. On the other hand, grain farmers might, locally and temporarily, seek a price higher than the equivalent unit export return, but regional feed users could then buy in supplies from nearby grain growing regions. It is in this way that regional feed markets are linked to national and international feed grain markets. Developments in export and other domestic grain markets would be transferred to a regional feed market via this price mechanism.

Feed grain prices are closely related because of the high substitutability between feed grains as food energy sources. End users are able to switch grain types quickly as relative prices of feed grains change. The degree of substitutability is not perfect, because grain types differ in their nutrient characteristics, and toxic substances in some grains restrict the amount that can be fed to some classes of livestock. The relationships among feed grain prices depend largely on developments in feed grain markets in the United States, because of the dominance of the United States in world feed grain markets (Foster and Geldard 1985). The availability of each feed grain in the United States and the structure of the US livestock industries are important determinants of the relationships among feed grain prices.

Changes in government policy have also had effects on the domestic price structure of feed grains. Prior to 1979-80, domestic wheat prices were set administratively at the commencement of each five-year wheat plan, independently of local supply and demand conditions. Between 1979-80 and 1984-85, the Australian Wheat Board used its commercial judgment in determining feed wheat prices. Between 1984-85 and the recent deregulation of the domestic feed wheat market, a permit scheme was implemented for feed wheat, whereby feed wheat could be purchased directly from growers instead of through the bulk handling authorities. Since the introduction of the permit scheme, feed wheat prices have been determined by domestic demand and supply of feed wheat (BAE 1987), and have fallen markedly.

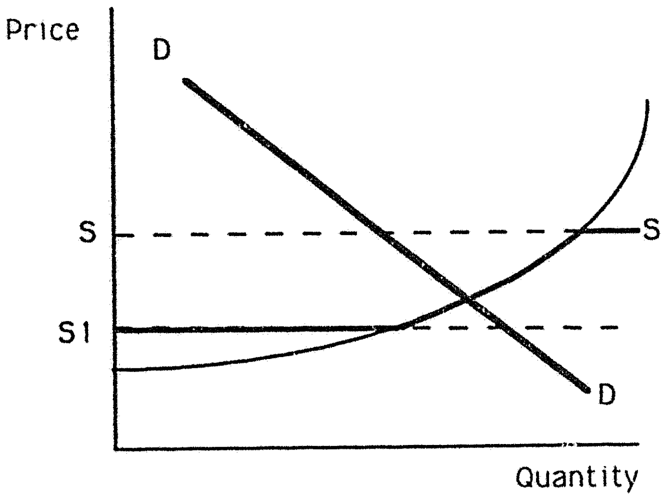
The main consequence of the permit scheme has been a change in the nature of wheat supply. Under the previous administrative arrangements, supply of wheat was in effect perfectly elastic at the Australian Wheat Board administered sale price level (SS in Figure 1). In the deregulated market, grain producers can either deliver their wheat to the Board, obtaining a pool price S_1, or sell it to local feed users at a negotiated price. Feed users would source their wheat from farmers for prices up to the Board's sale prices. Thus the Board's sale price provides a ceiling for local feed wheat prices (curve S_1S in Figure 1), and the expected pool return for feed wheat acts as a floor price, above which farmers will supply local markets rather than deliver wheat to the Board. (When feed quality is in short supply, the expected pool return for Australian Standard White wheat would act as the floor price.) The nature of the demand relationship will not be affected by deregulation.

For coarse grains, the marketing boards (unlike the Australian Wheat Board) have had little opportunity to exercise discriminatory pricing policies for domestic sales for feed because their marketing powers are limited to a state or regional basis. Interstate trading of coarse grains is not prohibited by the state-based regulations, and there is a large interstate trade supplying feed grains to local markets. The marketing boards handle only a very small proportion of total domestic feed sales.

Grain is the most important input in feed because of its high energy content and low prices relative to other ingredients of equivalent feed value. In 1983-84, around 1620 kt of unmilled grain was purchased by stockfeed manufacturers, as against 179 kt of oilseed meals, 173 kt of blood, liver and meat and bone meals, and around 258 kt of wheat bran, pollard and screenings.

In the production of human food from grains there are by-products, whose quantity is simply determined by the amount of grain milled and is unresponsive to changes in by-product or feed grain prices. Demand for these by-products, on the other hand, is fairly responsive to feed grain prices,

Figure 1–Feed Wheat Supply and Demand



because of the high degree of substitutability between by-products and feed grains. The prices of by-products are therefore largely determined by their nutritive value relative to feed grains.

Although grains form a cheap energy base for feeds they lack adequate protein, and protein meals are required to make up the shortfall. Meat meals are the main source of protein utilised for animal feed, but oilseed meals have increased in importance over the last two decades. Recently, the use of grain legumes as protein sources has been increasing due to their low prices relative to oilseeds meals. Feed grain prices rose sharply in 1988 relative to grain legume prices, making legumes a potentially important competitor for cereals in the domestic feed grains market.

The major users of feed grains are the intensive broiler, egg, pig and feedlot cattle sectors. Extensive livestock industries are minor users except in years when there is a pasture shortage or when livestock prices are high.

The largest user of feed grains is the broiler industry. While the egg industry has been declining in importance as a feed consumer, changes in consumer tastes and the relatively low price of poultry meats compared to other meats have led to a substantial expansion in the broiler industry. Annual poultry slaughter increased from 83 million in 1968-69 to an estimated 289 million in 1987-88.

The size of the pig industry has fluctuated since 1968-69, although improved prospects for pigmeats have resulted in an increase in pig numbers in recent years. Pig numbers rose from 2.43 million in 1980-81 to 2.70 million in 1987-88. After broilers, the pig industry is now the second largest consumer of feed grains in the domestic market.

The cattle feedlot industry expanded markedly in the late 1960s and early 1970s to meet the Japanese demand for prime quality chilled beef. The industry collapsed in 1974 when the Japanese government banned imports of beef, but expanded again in the late 1970s in response to an improvement in trade with Japan. Since 1983-84 there has been a substantial increase in the number of cattle being fed in feedlots, in response to lower grain prices and lower store cattle prices. Total cattle throughput increased from 130 000 in 1983-84 to 590 000 in 1987-88. Grain provides around 80 per cent of the feed utilised by feedlots, sorghum and barley being the main grains used. Sorghum is likely to be the more important feed grain because of the large proportion of cattle feedlots located in southern Queensland and northern New South Wales where sorghum is largely produced.

Methodology

In this section, the demand model postulated to capture the relationships between demand for each type of feed grain and relevant prices and livestock production is described. The demand for feed grains is a derived demand as feed grains are used as inputs into livestock production.

The livestock producers are assumed to maximise profits, given input and output prices, subject to their production technique. Under this assumption, the demand for the ith feed grain can be specified as a function of its own price, the prices of substitute grains, and the prices of outputs. Specifically, demand for the ith grain is postulated to be a function of its own price, the prices of substitute grains, the price of cattle, an index of production of eggs, poultry and pigmeats and a weather index:

$$(1) \qquad D_i = f(P_i, P_s, P_f, I, W)$$

where D_i is feed demand for the ith grain, P_i is domestic price of the ith grain (own-price), P_s is domestic price of grains that substitute for the ith grain, P_f is price of cattle received by farmers, I is an index of production of eggs, poultry and pigmeats, and W is a weather index.

This formulation takes into account the fact that feed grains are mainly used in intensive livestock production, including cattle feedlots, and in extensive livestock production as supplements. An index (see Appendix) of production of eggs, poultry and pigmeats, instead of their prices, is used as a measure of those demand components because the prices of eggs, poultry and pigmeats are highly correlated with the prices of feed grain.[1] A combined production index was adopted when it was found that use of the individual production variables resulted in high multicollinearity in the estimation. High multicollinearity between time and the production index precludes the use of a time trend to capture the effect of technical changes. A national-scale aggregate weather index (Flavel, Collins and Menz 1987) is used to approximate pasture conditions. When pasture supply is sufficient, extensive livestock industries would consume less feed grains, so the relationship between the consumption of feed grains and the weather index was expected to be negative. Pasture supply can also be improved by using other farm inputs such as fertilisers and irrigation, but because such substitution can occur only slowly it is not included in the model.

By-products from human food production such as bran, pollard and screenings are omitted from the demand specification because their prices are highly correlated with feed grain prices. (The Pearson correlation coefficient between the price of wheat by-products and that of feed wheat in the period 1968-69 to 1983-84 is 0.99.) Moreover, the use of by-products is

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1 In the case of feed wheat, the Pearson correlation coefficients between the prices of eggs, poultry and pigmeats and the price of feed wheat in the period of 1968-69 to 1986-87 are respectively 0.95, 0.92, and 0.90. For the definition of the Pearson correlation coefficient, see Johnston (1984), 23-25.

small relative to that of feed grains. The influence of by-product supply on demand for feed grains is unlikely to be significant. The use of protein supplements such as oilseed meals is also relatively small, and these were omitted from the demand specification when their prices were found not to improve the explanatory power of the model.

Assuming linear homogeneity in the livestock production function and homogeneity of degree zero in prices in the input demand function, equation (1) can be written as:

$$D_1 = f(P_i/P_s,\ P_f/P_s,\ I,\ W)$$

A double-log specification is used, mainly to capture the non-linearity resulting from the imperfect substitutability between feed grains. The estimating model for the demand for the ith grain can be expressed as follows.

$$(2) \qquad \ln(D_i) = a_0 + a_1 \ln(P_i/P_s) + a_2 \ln(P_f/P_s) + a_3 \ln(I) + a_4 \ln(W) + e_i$$

In equation (2), the price of each feed grain is postulated to be exogenous. This is reasonable, since domestic prices generally move closely with export prices. Although the domestic feed grain prices could sometimes exceed export parity, this occurs only in times of severe drought. The exogeneity of feed grain prices in equation (2) is supported by the exogeneity test proposed by Hausman (1978). The test was applied to all estimations undertaken in this study, and the results indicate that, except for feed wheat prices under the permit scheme, the exogeneity of feed grain prices is statistically acceptable.

The compatibility of the restriction of homogeneity in prices with the data was also examined by using an F test on all the estimations. The results indicate that this assumption is statistically acceptable for the feed grain demand at the 5 per cent level.

Estimation and Results

The model was estimated for the period 1968-69 to 1986-87 (with exceptions explained below). The OLS technique was used for the estimations. Feed demand Australia-wide for wheat and for barley were also jointly estimated using Zellner's Seemingly Unrelated Regression method over the period 1968-69 to 1983-84. However, no significant improvements could be obtained in this way.

Australia as a whole

(a) Wheat

As has been mentioned, endogeneity of the price of feed wheat was encountered when equation (2) was used to estimate the price elasticities of feed wheat demand over the data period including the permit wheat period. Before the introduction of the permit scheme for feed wheat in 1984-85, prices of feed wheat were set administratively by the Wheat Board. Under the permit scheme they were determined by domestic demand and supply. Since the data from the permit scheme period are insufficient for an estimation using a simultaneous equations model, equation (2) was initially fitted using feed wheat data before the introduction of the permit scheme (1968-69 to 1983-84)

TABLE 2

Parameter Estimates of Demand for Feed Grains in Australia

Dependent demand variable	Constant	Own price $\ln(P_i/P_s)$	Cattle price $\ln(P_f/P_s)$	Production of egg, poultry and pigmeats $\ln(I)$	Weather $\ln(W)$	R^2	DW	Cond.
Wheat(a)	14.16 (0.25)	-2.21 (0.61)	0.35 (0.18)	0.77 (0.39)	-0.83 (0.55)	0.72	1.98	8.02
Wheat(b)	14.03 (0.24)	-1.95 (0.57)	0.31 (0.18)	0.64 (0.35)	-0.80 (0.56)	0.70	1.89	7.21
Barley(c)	13.27 (0.35)	-1.51 (0.72)	0.65 (0.27)	0.69 (0.57)	-	0.63	2.40	7.71
Barley(d)	13.71 (0.47)	-1.60 (0.63)	0.55 (0.22)	0.53 (0.38)	-	0.65	2.40	14.04
Sorghum	12.88 (0.28)	-2.13 (0.75)	1.29 (0.21)	-	-	0.81	1.97	6.59

(a) Model with barley, oats and sorghum as substitutes for wheat. (b) Model with only barley and oats as substitutes for wheat. (c) Model with wheat and sorghum as substitutes for barley. (d) Model with only wheat as a substitute for barley.
Standard errors in parentheses. DW, Durbin-Watson statistic. Cond., condition number, which indicates the degree of multicollinearity. -, omitted from final model.

to estimate the price elasticities of feed wheat demand. The remainder of the data were subsequently used as explained below.

All the data used for the estimation for feed wheat were constructed according to the marketing season for feed wheat (October - September). A composite of the prices of barley, oats and sorghum was used for the price of substitutes (see Appendix). The estimation results are presented in Table 2.

The results of the estimation appear to be economically meaningful. All the coefficient estimates have the expected signs. The estimate for the own-price elasticity is statistically significant and indicates that a 1 per cent fall in the price of feed wheat leads to a 2.2 per cent increase in the demand for feed wheat.

The estimate for the elasticity with respect to changes in the price of cattle is low, 0.35. This is not surprising given that the main grains used in cattle feed rations are barley and sorghum. The estimate for the elasticity with respect to changes in the production of eggs, poultry and pigmeats is 0.77. No improvements could be found when the prices of wool, dairy products and oilseed meals were included in the estimation.

The coefficient on the weather index, though of the expected sign, is not statistically significant in explaining the variation in the demand for feed wheat. This could be due to failure of the annual, nationwide index to accurately reflect the adequacy of suitable pasture per grazing animal at particular times of the year. Also, since feed grain prices surge in times of drought, the movements in the prices of feed grains would partly reflect the weather effect on feed grain demand, which may contribute to an insignificant separate estimate for the weather index. No improvement was evident in the estimation when the weather index was replaced by the lambing percentage (the ratio of lambs marked to ewes mated).

An alternative estimation was also performed with only barley and oats as substitutes for wheat, because the substitution between wheat and sorghum could be limited by the difference in their marketing periods. (The marketing period for sorghum starts in April and that for wheat in October. Moreover, while wheat is available around the nation, sorghum is mainly grown and used in New South Wales and Queensland; little substitution can be found in other states). The alternative estimation yielded similar results, to the first (see Table 2), with an estimate of -1.95 for the own-price elasticity.

Feed wheat demand was also estimated over the period 1968-69 to 1986-87, assuming exogeneity of feed wheat prices under the permit scheme. A statistically significant estimate of -1.9 was obtained for the own-price elasticity of feed wheat demand, but estimates for the other variables became statistically insignificant and the R^2 fell markedly (from 0.72 to 0.50). These unsatisfactory results could be due mainly to the misspecification that results from the endogeneity of feed wheat prices under the permit scheme. To improve the estimation, a dummy variable was used to examine the possibility that structural demand change has been induced by the permit scheme. Although a statistically significant estimate (-2.2) was still obtained for the own-price elasticity of feed wheat demand and some improvements were found in the other estimates and the R^2, the sign of the coefficient estimate for the dummy variable was negative, contrary to a priori expectations. An attempt was also made, by using two slope dummies on the price variable of feed wheat, to examine the possibility that the own-price elasticity of feed wheat demand had changed due to the introduction of the permit scheme. Although the test results may be biased due to the misspecification, an hypothesis of no change was found to be statistically acceptable. The possible effect of the permit scheme on the own-price elasticity of feed wheat demand was also examined by recursively estimating equation (2), starting with the period 1968-69 to 1983-84 and then adding one subsequent observation at a time. No significant changes in the elasticity estimate were found.

(b) Barley

For feed barley, equation (2) was fitted with annual data over the period 1968-69 to 1986-87. A composite price of wheat and sorghum was used for the price of substitutes. The initial estimation yielded an insignificant coefficient estimate of unexpected sign for the weather index. Consequently, the weather index was omitted from the estimation. No improvement could be obtained by using the lambing percentage to replace the weather index. The estimation results are presented in Table 2.

The estimate for the own-price elasticity of feed demand for barley is statistically significant. It appears higher than those reported in previous studies (-0.85, Spriggs 1978; -0.94, Ryan 1982a), and closer to the estimated own-price elasticity of feed wheat demand. Again, a significant factor in explaining demand is the price of cattle. The importance of barley in cattle feed rations is highlighted by the fact that its estimated demand elasticity with respect to changes in the price of cattle is greater than that for feed wheat. However, it is significantly less than the previous estimate of 1.52 (Ryan 1982a). Given the fact that barley is widely used in feeding all livestock classes, and that the estimate for the short run own-price elasticity of beef supply is low (0.3: Dewbre, Shaw, Corra and Harris 1985), an increase of 0.65 per cent in the total consumption of feed barley induced by a one per cent increase in the price of cattle appears more plausible than the much higher previous estimate.

Feed demand Australia-wide for barley was also estimated with only wheat as the substitute. Similar results were obtained (see Table 2).

(c) Sorghum

For sorghum, equation (2) was fitted with annual data over the period 1973-74 to 1986-87, due to lack of livestock data for New South Wales prior to this period. Since the use of sorghum tends to be concentrated in New South Wales and Queensland, the price of feed barley in the Sydney Alexandria market was used for the price of substitutes.

The index of intensive livestock production and the cattle price were reconstructed according to the marketing period for sorghum (April - March) and using only data for the above two states. The lambing percentage for New South Wales and Queensland was used to approximate the weather conditions, since a state-scale weather index series was not then available. The initial estimation yielded insignificant estimates (with signs inconsistent with a priori expectations) for the coefficients on intensive livestock production and lambing percentage. No improvements could be obtained by replacing the production index by egg, poultry and pigmeat prices. The estimation was improved when both indexes were omitted. The estimation results are presented in Table 2.

The estimate for the own-price elasticity of demand indicates that a 1 per cent fall in the price of sorghum leads to an increase of 2.1 per cent in feed use of sorghum. The estimated elasticity of feed demand for sorghum with respect to changes in the price of cattle is 1.3, reflecting the importance of sorghum in the cattle industry in New South Wales and Queensland.

The estimate for the own-price elasticity of feed demand for sorghum is much higher than those presented in previous studies (-0.78, Austin 1977; -1.10, Spriggs 1978; and -1.27, Ryan 1982b). This result could be due mainly to the fast expansion in the cattle industry in New South Wales and Queensland. Also, the price variables used in this study are for these two states only, whereas in the previous studies data for Australia as a whole were used.

(d) Oats and other grains

An attempt to use equation (2) to estimate the demand for oats was unsuccessful. This could be due mainly to the facts that oats are largely used to supplement pasture in sheep raising, and that their substitutability with other feed grains in intensive livestock production is low because of their high fibre content. To estimate the demand for oats, a more complex model of the Australian sheep industry is needed, in which oats are treated as one of the inputs. For some new varieties of feed grains such as grain legumes, demand estimation was not performed due to lack of data.

<u>New South Wales</u>

Feed demands for wheat and for barley in New South Wales were estimated using equation (2) over the periods 1973-74 to 1983-84 and 1973-74 to 1986-87 respectively. In the estimation for feed wheat, the price of feed barley was used to approximate the price of substitutes; in the estimation for feed barley, the price of feed wheat was used. (Other grain sales series could not easily be obtained for New South Wales, but this was not considered a serious limitation because of the high correlation among feed grain prices).

The initial estimation for New South Wales yielded insignificant estimates (with signs inconsistent with a priori expectations). To improve the estimation, the equation was modified by dropping the weather index and the index of intensive livestock production and adding time to capture an apparent trend in feed use in New South Wales. The estimation results are presented in Table 3.

The results indicate that demand for feed wheat in New South Wales is own-price elastic. The time trend is positive, indicating a tendency toward using wheat to replace other feed grains in New South Wales. Demand for feed barley is also own-price elastic. The estimate for the elasticity of feed demand for barley with respect to changes in the price of cattle in New South Wales is 0.7. The coefficient of the time trend was negative but statistically insignificant.

The estimated own-price elasticity of feed wheat demand in New South Wales appears lower than that for Australia as a whole. However, this difference in the estimates could be due to the fact that only the feed barley price was used as a price of substitutes for feed wheat in the estimation for New South Wales. The estimated elasticity of feed barley demand with respect to changes in the price of cattle in New South Wales appears higher than that for the nation as a whole, which could be due to the large proportion of feedlot cattle in New South Wales. In general, the results are consistent.

TABLE 3

Parameter Estimates of Demand for Feed Grains in New South Wales

Dependent demand variable	Constant	Own price $\ln(P_i/P_s)$	Cattle price $\ln(P_f/P_s)$	Time(a) $\ln(t)$	R^2	DW	Cond.
Wheat	6.69	-1.60	0.28	0.13	0.79	1.92	6.82
	(0.11)	(0.38)	(0.15)	(0.06)			
Barley	5.75	-1.57	0.73	-0.12	0.73	2.19	8.08
	(0.25)	(0.73)	(0.19)	(0.12)			

(a) 1973-74 = 1.
Standard errors in parentheses. DW, Durbin-Watson statistic. Cond., condition number.

Summary

In this study, the price elasticities of feed demand for wheat, barley and sorghum are estimated using recent data. The small sample of feed wheat sales under the permit scheme has resulted in some difficulties in estimating the up-to-date price elasticities of feed wheat demand. The estimation results indicate that the demand for feed wheat is very elastic to changes in the price of feed wheat relative to other feed grain prices. Despite possible misspecification, no evidence could be found for a structural change in feed wheat demand due to the introduction of the permit scheme. For feed demand for barley and sorghum, the estimated own-price elasticities are markedly higher than the previous estimates. This could be due mainly to the expansion in the livestock sector, especially in the cattle industry, in recent years.

These results may be useful in analysing the effects of the deregulation of the domestic feed wheat market and the liberalisation of the Japanese beef market. From the estimation results, it can be concluded that if a lower price of feed wheat for buyers results from the deregulation, the demand for feed wheat should increase significantly. If domestic cattle prices are increased by the liberalisation of the Japanese beef market, the feed demand for barley and sorghum should increase markedly.

The price elasticities of feed grain demand in New South Wales were also estimated. The estimates are not significantly different from those obtained for Australia as a whole.

Appendix: The Data

Australia

Data for feed grain prices and usage in Australia are presented in Table A1.

The quantity of feed wheat consumed was obtained by adding the quantity sold by the Australian Wheat Board, the quantity sold under permit and the quantity used for feed on-farm. The series of on-farm use for feed before 1979-80 was obtained from the Australian Bureau of Statistics (ABS). Publication of this series was stopped in 1979-80, and for the period 1979-80 to 1984-85 the series was constructed by subtracting calculated seed use from the total quantity of wheat kept on-farm, assuming a seeding rate of 50 kg/ha. A problem arose in calculating the on-farm feed use for 1985-86: the total stock of wheat kept on-farm was found to be less than the required quantity for seed. In the absence of further information, the feed wheat usage for 1985-86 was obtained by adding only the quantity sold under permit and that sold by the Wheat Board.

The information for feed consumption of barley, oats and sorghum (calculated by the same procedure) was obtained from Austin (1977), BAE (1984) and ABARE (1988).

The price of feed wheat used for the 'permit' period (after 1983-84) was a weighted average of the permit price obtained from the Sydney Alexandria market and the Wheat Board price, using as weightings the ratios of the quantity of permit sales and of Wheat Board sales to the total sales of feed wheat. For the preceding period, the Wheat Board price was used.

Where combined prices of substitute grains were used, the price was constructed by first multiplying the sales quantities of each feed by their wholesale prices to obtain the respective sales values, adding up the sales values of the substitute grains and then dividing the result by their total sales quantity.

The annual cattle price used was constructed by averaging the Bureau's monthly index of cattle price received by farmers, with total beef production as weights. For the combined production of eggs, poultry and pigmeats, an index of their weighted sum of outputs was used, the weights being the ratios of the estimated feed consumption by type of product to total feed consumption. The feed consumption by type of product was estimated by multiplying the production volumes by conversion rates for each livestock product, obtained from Spriggs (1978) (1.65 tonnes of grain per 1000 dozen eggs, 2.5 tonnes per tonne of pigmeat and 2.7 tonnes per tonne of poultry meat). The conversion rates for livestock production vary from time to time, but because of inadequate data on the variations it was assumed that conversion rates remained constant in the sample period.

The effect of pasture supply on demand for feed grains has proven to be very difficult to capture. In previous studies, several different measures such as lambing percentage and lamb death rates were used, but results were unsatisfactory in most cases. In this study, a weather index constructed in Flavel et al. (1987) for the October-September year was used to approximate pasture conditions.

TABLE A1

Prices and Quantities Consumed of Feed Grains in Australia

Year	Wheat		Barley		Oats		Sorghum(a)	
	Price index	Quantity	Price index	Quantity	Price index	Quantity	Price index	Quantity
		Kt		Kt		Kt		Kt
1968-69	100	450	100	634	100	901	100	205
1969-70	83.93	723	90.70	440	79.41	797	93.62	240
1970-71	84.80	909	109.30	426	100	874	93.62	265
1971-72	87.14	1 025	95.35	680	85.29	808	89.36	219
1972-73	90.67	1 527	123.26	424	126.47	497	123.40	497
1973-74	113.16	1 204	183.72	513	176.47	762	161.70	296
1974-75	132.74	1 163	237.21	175	200	458	180.85	112
1975-76	158.08	837	230.23	287	200	751	180.85	69
1976-77	167.75	678	241.86	104	202.94	410	178.72	113
1977-78	176.92	665	200.00	485	205.88	741	176.60	368
1978-79	185.60	663	197.67	814	167.65	680	185.11	451
1979-80	223.62	1 374	283.72	359	211.77	874	223.40	502
1980-81	240.92	1 415	330.23	488	364.71	999	268.09	363
1981-82	238.39	809	311.63	918	282.35	1 309	225.53	462
1982-83	293.03	1 916	344.19	612	402.94	832	276.60	362
1983-84	278.91	559	348.84	402	261.76	1 264	278.72	697
1984-85	235.94	811	318.61	528	279.41	1 218	306.38	300
1985-86	212.46	858	281.40	568	305.88	1 000	272.34	267
1986-87	185.44	821	276.74	719	300.00	1 054	246.81	301

(a) Because sorghum statistics are based on a much later marketing year than other grains, the values of feed consumption of sorghum are assigned to the following year. This ensures that the values of all the variables are appropriately aligned within a time period.
Sources: Austin (1977); ABARE (1988); ABS (1988); Australian Wheat Board (1987).

New South Wales

In the estimation for New South Wales, the Australian Wheat Board price was again used for the feed wheat price before 1984-85. For the period 1984-85 to 1986-87, a weighted average of the permit price in Sydney and the Wheat Board price was used, as above, but with the weights based on the respective sales of feed wheat in New South Wales. For barley, the price of feed barley in Sydney was used.

The cattle price in New South Wales was constructed from the Bureau's monthly index of cattle price received by farmers in New South Wales weighted by beef production in New South Wales. The index of intensive livestock production in New South Wales was constructed, as above, based on the production volume of poultry and pigmeats in New South Wales.

The consumption of feed wheat in New South Wales was obtained by subtracting from the quantity of wheat production in New South Wales the quantity of wheat received by the Wheat Board and the quantity of seed use in the following season, and then adding the quantity of feed wheat sold by the Wheat Board in New South Wales. A similar procedure was applied to construct the consumption data for feed barley. However, this procedure is not entirely satisfactory. For feed wheat, the Wheat Board receival in New South Wales does not include wheat produced in New South Wales but delivered to licenced receivers in Victoria. The constructed feed wheat consumption in New South Wales may therefore be overstated.

Due to lack of information, the inter-state trade of barley was not included in the construction of feed barley consumption. However, since the main purpose of the estimation for New South Wales was to examine the consistency with the estimates for Australia as a whole, these geographic boundary effects are not a serious shortcoming.

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