PRICING EFFICIENCY AT SOUTH EAST QUEENSLAND CATTLE AUCTIONS*

by

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1 Introduction

Historically the public auction has played a major role in the marketing of cattle in Queensland. Over the last decade at least half of the slaughter cattle sold each year in Queensland have been sold at saleyards by public auction. Further, price quotations from these auctions have always provided a yardstick by which producers negotiate direct sales to processors. Despite new developments in the area of sight-unseen selling, the public auction is likely to remain the major price discovery mechanism for slaughter cattle in the near future. It is important therefore that this mechanism generates efficient prices.

In the 1970s, there was widespread concern within the industry that the auction may be ineffective in this role. In particular, a major gap was seen in the availability of information to market participants. In response to this, statewide livestock market reporting services (LMRS) were developed throughout Australia.

This study examines the pricing efficiency of the auction system in South East Queensland, with particular reference to the ability of the information contained in LMRS reports to explain price variation.

2 Efficiency and the Price Discovery Mechanism

2.1 Pricing Efficiency

Pricing efficiency is one aspect of marketing efficiency, the other being operational efficiency. While operational efficiency refers to the cost effectiveness of assembly, transportation and processing techniques in alternative marketing channels, pricing efficiency refers to the accuracy with which markets reflect the true demand and supply conditions in the

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* A paper to be presented at the 33rd Annual Conference of the Australian Agricultural Economics Society, Lincoln College, Christchurch, New Zealand, 7-9 February 1989. Research for this paper was funded by a grant from the Rural Credit Development Corporation and with the cooperation of the Livestock and Meat Authority of Queensland.

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market. Thus an efficient price will contain all the necessary information about preferences of buyers and the availability of the product to enable market participants to make optimal buying and selling decisions, both at that point in time and in the future, given the market situation. An efficient pricing system will, therefore, accurately reflect perceived quality differences over time and space. A pricing system which fails to do this is inefficient in that producers will not be paid the true value of their product and, consequently, the market system will be unable to carry out its role of efficient resource allocation. The theme of this project has been captured by Johnson(1972, p14)

> A pricing system which does not accurately communicate the quality preferences of the buyer by rewarding or penalizing the producer impedes quality improvement and reduces industry efficiency.

Of particular interest to this study is the changing efficiency over time of one specific marketing channel, the auction. Operational efficiency can be considered to be relatively constant for the auction system over the period examined. For the remainder of this paper, the term 'efficiency' will refer to pricing efficiency only.

2.2 The Price Discovery Process

The price discovery process, as defined by Thomsen and Foote(1952), is the arrival of buyers and sellers at a transaction price for a specific quantity and quality of a commodity at a specific time and place.

This is a two stage process. In stage one, the general level of prices around which specific transaction prices vary is determined. This is equivalent to the traditional determination of the market equilibrium price. However, with a heterogeneous product, there will be no one equilibrium price. A second stage of price discovery is required where buyers (and sellers) can arrive at the value, and consequently the price of the specific product or lot being offered for sale (Ward,1981,1983).

The second stage of the price discovery process, the evaluation of a specific lot offered, involves the assessment of the lot's characteristics and the calculation of the appropriate premiums or discounts. The characteristics of the lot may include qualities of the commodity being sold but also characteristics which relate to the conditions of sale, for example, the time and place of the sale, the conditions of settlement, the quantity being sold and the total offering

for a specific lot of, in this instance, cattle will be the expected equilibrium price plus or minus a number of premiums or discounts for the variation in the characteristics of that specific lot compared to the average.

3 The Role of the Livestock Market Reporting Service (LMRS) in the Price Discovery Process

Information is central to the efficient operation of the livestock auction market. Phillips(1968) considered 'information-getting' to be an important, if not fundamental part of the marketing process. Adamowicz, Baah and Hawkins(1984, p462) also indicated the essential role of information:

> One of the main functions of an efficient market is to facilitate the flow of information. The prices resulting from this flow should accurately represent the supply and demand situation.

This was recognised by the Australian livestock industry in the late 1970s with the introduction of Livestock Market Reporting Services throughout most States. The aim was to provide free, accurate and up-to-date information for the major auction centres. The view was that such information was necessary for the efficient discovery of prices. As McCallister(1950, p958) stated:

> The role of market news in marketing, quite simply, is to aid the free competitive marketing system to do its job better and at lower cost.

3.1 The Livestock Market Reporting Service

The livestock Market Reporting Service (LMRS) began in Queensland in 1980 with coverage of only a few saleyards. The LMRS is responsible for reporting the essential performance of livestock sales throughout the State. It does this by collecting, analysing and then disseminating critical livestock sale performance data. Sale data collected include the price paid for each lot sold, the estimated or actual average weight of the cattle, the estimated average fat depth, whether grain-fed or not and the number of cattle in the lot. Currently there are fifteen fully operational market reporting centres for slaughter cattle. An example of a typical market report is shown in Table 1. It is important to note that while the cattle are assessed in terms of weight in kilograms and fat depth in millimetres, in the reports the animals are grouped in weight ranges and fat scores. Table 2 shows the currently-used LMRS

This transformation of supposedly continuous data into categorical groups for the purposes of the reports is expected to have an impact on the kind of data generated by the market reporters. This impact is discussed further below.

3.2 The Potential Usefulness of Market Reports

The information supplied by the LMRS reports should aid the better discovery of prices at both stages of the price discovery process. In stage one, where the general level of prices is discovered, market participants can examine the most recent market reports both for their closest market and more distant ones to get an overall indication of market movements. This would include a quantitative view on what is happening to prices of different types of cattle around the state and also to the overall level of prices via the Queensland Cattle Market Index, published in each report.[1] Both buyers and producers may benefit from this information.

At the second stage of the price discovery process, producers should be able to use the LMRS reports to obtain a clearer picture of the relative strength of various sectors of the markets. It is here that buyer preferences should be reflected in the differing prices for different quality of animals in different parts of the State.

> Efficient prices should provide signals about resource scarcity and reflect consumer preferences.(Adamowicz et al., 1984, p462)

The LMRS reports include information on the prices paid for all the combinations of sex/age/weight/fat-scores sold at the auction. From this, producers can assess whether it is likely to be more profitable to sell animals now, at their current weight, or whether to fatten them further to meet the criteria of a different segment of the market.

Producers must form some price expectation in deciding whether to send their livestock to auction or not. With the advantage of the information available in LMRS reports, these expectations may be more accurate and may allow better decisions as to the place, time and form in which to sell their cattle.Of course, not all the information required to make these decisions is contained in the LMRS reports - views would also have

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[1] The Queensland cattle market index is a Laspeyres price index, based on price movements of a broad spectr of cattle

Table 1

LIVESTOCK AND MEAT AUTHORITY OF QUEENSLAND

CATTLE MARKET REPORT DALBY CATTLE 14-Dec-88

YARDING : 2009

In the last sale of the year there was a yarding of 2009 head at Dalby which made a total of 177000 sold through Dalby for the year. This number is 28500 more than last year. At todays sale values rose for all descriptions. Bullocks sold to 122.6 cents and were 4 cents dearer, prime trade steers were up to 11 cents dearer, cows sold 5 to 9 cents dearer, heifers rose 7 to 5 cents and yearlings were 2 to 4 cents dearer. Competition was strong throughout - store cattle met much stronger competition after isolated rain in the district. Dalby resumes normal weekly cattle sales on the 4th January 1989.

DESCRIPTION LIVEWEIGHT	FAT SCORE	LIVEWEIGHT PRICE (CENTS/KG) LOWEST	HIGHEST	AVERAGE	CHANGE	NUMBER RECORDED
VEALERS						
76 to 130 Kg	1	140.0 to	167.2	151	NQ	2
131 to 210 Kg	1	105.6 to	105.6	106	NQ	4
	2	113.0 to	132.2	123	NQ	4
YEARLINGS						
0 to 280 Kg	1	99.2 to	121.4	110	NQ	38
	2	96.6 to	123.6	111	4	169
	3	114.0 to	122.0	120	NQ	6
281 to 370 Kg	2	104.8 to	111.8	108	-1	30
	3	114.8 to	129.8	118	2	40
	GF	124.2 to	127.2	126	2	73
HEIFERS						
0 to 370 Kg	2	96.2 to	109.0	104	2	156
	3	103.2 to	123.6	115	5	44
	GF	107.2 to	124.0	118	4	62
371 to 450 Kg	3	93.2 to	111.2	99	NQ	11
	4	105.0 to	110.4	105	NQ	12
	GF	118.4 to	123.2	121	NQ	5
Over 450 Kg	4	105.0 to	105.0	105	NQ	4
COWS						
321 to 420 Kg	1	64.0 to	64.0	64	NQ	4
	2	77.6 to	90.4	87	9	46
	3	88.4 to	99.8	93	5	29
	4	96.6 to	100.0	98	NQ	2
421 to 520 Kg	2	77.6 to	89.6	87	7	24
	3	88.8 to	94.0	92	5	26
	4	90.8 to	98.2	93	1	24
	5	88.8 to	93.0	90	NQ	13
Over 520 Kg	5	85.2 to	86.6	86	NQ	6
STEERS						
0 to 370 Kg	2	99.2 to	116.8	114	8	68
	3	116.8 to	121.0	118	NQ	15
	GF	130.2 to	132.6	131	NQ	6
371 to 450 Kg	2	104.2 to	114.0	108	3	48
	3	108.4 to	124.6	115	4	39
	4	117.4 to	123.0	120	NQ	15
	GF	126.0 to	130.4	129	11	56
451 to 500 Kg	3	105.0 to	112.0	107	NC	30
	4	113.2 to	117.0	116	4	35
	GF	117.8 to	122.2	121	NQ	13
501 to 550 Kg	4	114.0 to	115.6	115	3	35
	GF	115.2 to	117.8	116	2	63
Over 550 Kg	4	112.0 to	117.8	115	NQ	15
	GF	118.0 to	122.6	120	4	53
BULLS						
0 to 350 Kg		86.2 to	99.2	93	10	9
351 to 540 Kg		90.0 to	104.2	99	11	10
	GF	94.6 to	94.6	95	NQ	6
Over 540 Kg		100.0 to	105.6	104	6	13

A detailed Grainfed Report is available if required

Table 2

Current LMRS reporting categories

(i) Sex and Liveweight Categories (1985 - current)

Category	Description	Liveweight Ranges (kg)
Vealers	Calves and mother raised vealers (male and female)	to 75 76 - 130 131 - 210 211 - 280 over 280
Yearlings/Young Cattle	Milk or 2 permanent teeth (up to approx 2 years) male and female	to 280 280 - 370 over 370
Steers/Bullocks	Steers, 3 or more permanent teeth (approx 2 years and older)	to 370 371 - 450 451 - 500 501 - 550 over 550
Heifers	Females, 3 - 7 permanent teeth (approx 2-4 years)	to 370 371 - 450 over 450
Cows	Females, 8 permanent teeth (over 4 years approx)	to 320 321 - 420 421 - 520 over 520
Bulls	Entire male showing bull characteristics	to 350 351 - 540 over 540

(ii) Fat Scores (1985 - current)

Fat Score	Rump Fat Depth(mm)
1	0-2
2	3-6
3	7-12
4	13-22
5	23-32
6	over 32

to be formulated about the likely strength of future demand and supply in particular sectors of the market.

For buyers, the information in the IMPS reports will give them an insight into the range of premiums and discounts applying to different segments of the market. Some degree of substitutability exists within segments of the market and information about price differences can aid buyers to form more precisely their views on relative prices.

The mere availability of market information will not guarantee the efficient operation of the price system.

> One thing, of course, that market news cannot do is to insure that the information will be used with equal intelligence and skill by both the buyers and sellers who receive it. (McCallister, 1950, p959)

4 Hedonic Price Analysis

The central theme of this research is the extent to which price variations can be explained by variations in the lot characteristics.

Hedonic price analysis is seen to be a useful approach: here the price of a specific lot of cattle is related to the characteristics of the lot for sale. The value of the cattle is directly related to the value of the meat obtained from the carcasses of the lot.

The use of product characteristics to examine price variation in non-homogeous products is not new. Quality factors have been used to analyse such price variations since 1928. Waugh(1928,1929) examined the impact of quality variation on the prices of vegetables, while Clarke and Bressler(1938) looked at the relationship between the price of strawberries and their quality. However, their empirical analysis was not given any strong theoretical framework until much later. Houthakker (52) began to formalise the theory of characteristics demand, although Lancaster is often taken to be the founder of this extremely useful branch of demand/price theory. Subsequently this analysis has been developed by Ladd in conjunction with others [Ladd(1978, 1982), Ladd and Suvannunt, Ladd and Martin].

Many studies which have used the hedonic price methodology have been concerned with the evaluation of various quality factors to improve the ability of producers/sellers to make the correct production and marketing decisions (O'Connell,1986, Jarratt,1987, Wilson,1984). Knowledge of the implicit value of certain quality characteristics of his product may allow the producer to change his production and/or marketing techniques to improve his returns. These quality characteristics may take on

different values in different segments of the market. The producer can then offer the most appropriate product for specific sections of the market.

Multiple regression analysis has been used exclusively to estimate hedonic price functions in published empirical studies.

A hedonic price function is a reduced form equation, which shows how the endogenous variable, price, is determined by exogenous variables. A reduced form equation does not directly describe economic agents' behaviour but instead reports the results of their behaviour on price. No specific functional form is suggested by theory and this is therefore a matter for empirical determination.

The general form of the equations estimated is:

$$P_i = \Sigma X_{ij} p_j + \varepsilon_i$$

where P_i is the price of the heterogeneous product i

X_{ij} is the quantity of the jth characteristic (homogeneous) contained in one unit of product i

p_j is the marginal implicit price of characteristic j

and ε_i is a random disturbance term.

The addition of a constant term to the above relationship can be justified if the characteristics are measured relative to some standard. Thus the constant term becomes the price for that standard product, with the implicit prices being interpreted as premiums and/or discounts around this standard.

The estimated equation then becomes:

$$P_i = p_o + \Sigma p_j X_{ij} + \varepsilon_i$$

with P_i and ε_i as defined above,

X_{ij} being the difference in the quantity of the jth characteristic provided by the ith product compared to the quantity of that characteristic provided by the standard product,

p_o being the price of the 'standard' product

and the p_j being the premiums and/or discounts associated with a unit change in the amount of characteristic provided compared with the standard.

The characteristics which could be expected to have an effect on the price of a lot of cattle pertain to the quality and amount of meat yielded by the animals in that lot as well as conditions surrounding the sale. These are numerous. For the purposes of this study, concerned

primarily with the information contained in LMRS reports, the characteristics used in the hedonic price function are restricted to those reported by LMRS, age/sex type, average weight and fat of the animals in the lot, whether grain-fed, the number of animals in the lot and the date and place of the sale.

The primary questions this section of the analysis addresses is whether the valuations of the characteristics are uniform throughout South-East Queensland; how these valuations vary between sex/age categories; and whether they have been relatively constant over time.

This analysis may also be of use to individual producers insofar as it estimates the specific valuation of the characteristics of the cattle. For example, the analysis may find the implicit value to the producer of an extra millimetre of fat cover or an extra kilogram of weight on his cattle.

5 Measures of Market Efficiency

In theoretical economic analysis, the efficiency of a given market is measured against the benchmark of the perfectly competitive market and prices are compared with those unobservable equilibrium prices. This analysis is not useful for any applied analysis. Efficiency in the real world will be revealed instead as a relative measure, considering one market's efficiency against that of another. So it is here.

Stigler (1961) saw the variation or dispersion of prices as a measure of inefficiency. However, because of the heterogeneous nature of the cattle market, there will always be a range of prices traded, not just one single price. Thus variations in prices cannot be taken on their own as a measure of inefficiency.

For the purposes of this analysis, an indicator of efficiency used is the unexplained variation in prices, that is, the portion of price variation which cannot be explained by variation in the characteristics of the lot. The percentage of total variation explained by the estimated equations for the different sex/age categories, auction centres and time periods is interpreted as indicating the relative pricing efficiency of these sectors of the market. However, because not all factors which could be relevant are included in the estimated relationship, some care must be taken in interpreting these results. For example, by using the incomplete model and using the explained variation as indicative of pricing efficiency, the assumption is that the omitted characteristics would explain a similar proportion of price variation throughout time.

across the state and for different sex/age categories. Caution must also be used in interpreting the adjusted coefficient of determination as the true variation in prices explained by the variables considered. Variation may also be caused by the abilities of market reporters to estimate liveweight and fat depth accurately.

6 Data

The data on which this project is based have been supplied by the Livestock and Meat Authority of Queensland (LMAQ). Some problems are anticipated with the data because of the way in which they are collected.

Liveweight, in kilograms, is estimated by market reporters at all the centres analysed. There may be differences, as noted above, between the auction centres caused by differing estimation abilities among the market reporters. One of the main assumptions of ordinary least squares regression analysis is that the data for the independent or explanatory variables are without error. This assumption is obviously violated in the present study. A consequence of this is that the estimates obtained for the coefficients of the characteristics, that is, the implicit marginal prices may be biased.

Bias, stemming from errors in measurement of the amount of each characteristic possessed by the lot of cattle may be reduced by treating the independent variables for weight and fat, where measurement errors are anticipated, as categorical rather than continuous variables. As shown in Table 2, weight and fat are reported as a weight range and fat score. From discussion with LMAQ personnel, it seems likely that, for some market reporters, each lot will be appraised with these ranges in mind. Rather than estimating weight and fat depth to the nearest kilogram and millimetre, they may instead choose the appropriate weight range and fat score into which they judge the animals to fall and record a weight and fat depth which lies in that range.

If this is the practice, large errors will exist in the data when the continuous variables are used for estimation purposes. However even if this is not common practice, the use of categorical variables may still be preferred. From the viewpoint of minimising measurement error, the reporters are believed to be accurate in allocating the animals to the correct range or score. Errors in measurement would therefore be reduced.

A possibly more convincing argument in favour of the use of categorical variables is found in the behaviour of buyers: they purchase cattle with a specific end-market in mind. For example, they have contracts to fill for export markets which specify the type of meat and cuts required. These specifications are generally stated in broad weight and fat range terms and the live cattle are bought accordingly. The units in which buyers pay is cents per kilogram liveweight. The price received for the end-product is in cents per kilogram carcass weight or weight of cuts. So, assuming away any differences in dressing percentage or meat yield between animals in the same weight/fat class, the price that the buyers are willing to pay, on a cents per kg basis, should be relatively constant for animals in the same weight range (Diagram 1).

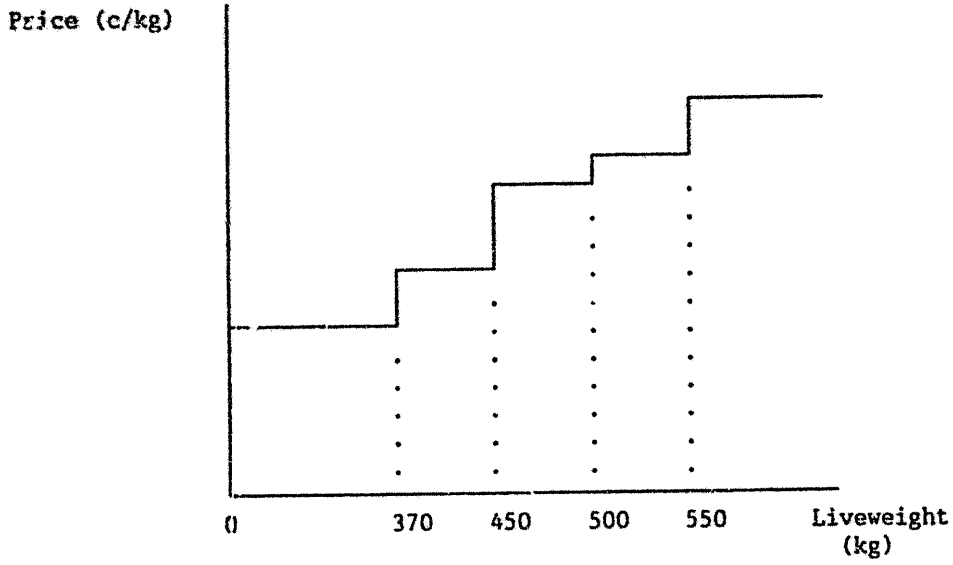

Diagram 1 Possible price/weight relationship for steers

This assumes, however, that the weight ranges used in the market reports correspond to the weight ranges used by the buyers. As the weight ranges used by LMRS correspond closely to those used by AUS-MEAT, and AUS-MEAT have chosen their ranges following discussions with all sectors of the industry, it would be hoped that this assumption is valid.[2]

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[2] Discussions with processors suggest that the ranges used for price reporting are similar to those used for their buying purposes.

The weight and fat variables used in the analysis below, therefore, will take the form of categorical variables, with a different variable representing each weight class or fat score.

7 Methodology

The empirical section of this study deals with the analysis of individual lot data and the explanation of variation in prices by variation in the characteristics of the lots of cattle. The analysis will be by necessity at a fairly disaggregate level.

7.1 Disaggregation across form

Careful attention has been paid to the extent of disaggregation across forms of slaughter cattle.

As Muellbauer (1974, p980) warns:

> careful attention should be paid to cross-sectional disaggregation. As far as possible, markets should be broken into segments based on commodity groupings which make it likely that their consumers have similar MRS and these segments should be studied separately.

Extending this to the current context, it will be necessary to split the commodity groupings in such a way that the marginal rates of technical substitution for the different types of animal are similar for meat processors. For example, an extra millimetre of fat on a yearling may be worth a lot more than an extra millimetre of fat on a heavy steer. The proper disaggregation will allow the correct identification of the implicit marginal prices of the important characteristics. Failure to disaggreagate may lead to biases in the estimates found for the implicit prices.

The broad division in the slaughter cattle market is on the basis of whether the animal is primarily for export or domestic consumption. The most important determinants in this division are the age and weight of the cattle. Domestic tastes, as confirmed by Kingston et al (1988), favour meat coming from young cattle, less than two years old. The market for vealers, yearlings and light steers and heifers is therefore dominated by local demand. The export market is primarily concerned with heavier and/or older animals. The sectors dominated by exports are bull meat, cow meat and high quality heavy steers, the Jap-Ox market.

However there are carcass types in the middle ranges of weight and age which can be used to satisfy either export or local demand. These include the heavier heifers which may be consumed here or exported to the

US, young cows which can be used similarly and medium weight steers which can go to satisfy local or export demand. Individual carcasses may even be used for both markets. For example, heavy steers (450 550kg liveweight) provide several cuts, some of which are suitable for domestic consumption and some for export.

Despite the danger in considering the different sectors of the market as distinct markets (Cochrane 1957), the following groupings, as defined by LMRS categories, were used for the analysis[3]:

- yearlings
- heifers
- cows
- steers

It is recognised that there is a high degree of substitutability (or end-use overlap) between certain of these groups. For this reason, tests for equality will be carried out on the estimated coefficients for these categories.

7.2 Disaggregation across time

A hedonic price function is a reduced form equation. That is, both supply and demand factors are implicit in any relationship estimated. Thus any change in these supply or demand factors may lead to a shift in the coefficients of the characteristics included in the price function. These implicit prices can be interpreted as grade price differentials which change with shifts in the supply and demand for different grades (Tomek and Robinson, p138).

Thus the aggregation of several years of data, during which time there may have been significant shifts in supply and/or demand, may lead to aggregation bias. In most applied work, hedonic functions are estimated for a number of discrete time periods, allowing for a change in the marginal implicit prices between periods (Jordan et al, Wilson, O'Connor). Estimation of one function for all time periods is to constrain these implicit prices to be constant over time. This is a hypothesis which must be tested.

Hedonic price functions are estimated for three sub-periods, each covering four weeks in October of 1986, 1987 and 1988.

7.3 Disaggregation across space

In addition,it may not be valid to aggregate the data across auction centres. It is possible that the value of different characteristics varies across the region. This is more likely for the categories of animal which can either be exported or consumed locally (eg. heifers). Some saleyards may be identified as selling to predominantly domestic works while others may be more oriented to export works. If such a difference in valuation were found to exist, this itself could be taken as a sign of inefficiency. If the valuation were higher at one yard, then market forces should cause a change in the price to equalise these valuations.

Again this is a hypothesis which must be tested. If the value of characteristics is found to be constant throughout the region, then the data can be aggregated to allow further analysis, for example, of the effect of auction centre size on pricing efficiency.

The major saleyards of Toowoomba, Brisbane, Warwick and Dalby in the south-east region were used for the analysis, with a hedonic price function estimated for each auction centre.[3]

8 Analysis and Results

Two functional forms were estimated initially to find the most appropriate form for these data: linear and semi-log linear.

That is: $P_i = \beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots$

and $\log P_i = \beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots$

The advantage of the second form is the β_j coefficients can be readily identified as percentage premiums or discounts. However this interpretation is less clear when the variables are, as in this case, dummy variables (Halverson and Palmquist). Preliminary analysis suggested that the linear form is slightly better in explaining the price relationship and this is used throughout.

The model estimated for all four types of cattle, for all three periods, for all eight saleyards is as follows:

$$P_i = \alpha + \Sigma\beta_j W_{ij} + \Sigma\Phi_k F_{ik} + \Omega G_i + \Gamma NLOT_i + \Sigma\eta_m T_m$$

where P_i is the price paid for the ith lot (c/kg);

α is the estimated price (c/kg) paid for a lot of cattle of the 'standard' form;

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[3] [illegible]

W_{ij} are the j dummy variables used for the j 'non-standard' weight classes;

β_j are the premiums or discounts associated with these weight classes as compared with the 'standard';

F_{ik} are the k dummy variables used for the k 'non-standard' fat scores;

Φ_k are the premiums or discounts associated with these fat scores as compared with the 'standard';

G_i is the grain-fed dummy;

Ω is the premium associated with a lot being grain-fed;

$NLOT_i$ is the number of animals in lot i;

Γ is the average premium associated with an incremental increase in the number of cattle in the lot;

T_m are the three time dummy variables associated with the 2nd, 3rd and 4th week of each period;

π_m are the average change in the price of the 'standard' animal in the 1th week as compared to the first week.

The standards used are:

for yearlings, weight class 1 and fat score 3

for heifers, weight class 1 and fat score 3

for cows, weight class 3 and fat score 4

for steers, weight class 5 and fat score 4.

8.1 Relative efficiency of the reported saleyards

The variation in prices explained by the above relationship, as measured by the coefficient of determination, is generally greater in the three Toowoomba saleyards and at Cannon Hill in Brisbane (see Table 3). These are the four largest of the yards examined and appear to be the most price efficient on the basis of price variability explained.[4]

This finding is consistent with a priori reasoning and with the results of earlier work, such as McPherson(1956), who have found that price discovery tends to be more efficient at larger centres.

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[4] The higher coefficients of determination at Toowoomba and Brisbane could also be related to the experience of the market

It should be noted that, although the coefficient of determination is higher at these yards than elsewhere, the degree of explanation is not high: in 1988, over 20 per cent of price variation is unexplained.
A factor which may explain the low explanatory power of the relationship at Dalby and Warwick, particularly for yearlings, is the larger element of store cattle trading at these yards.

8.2 Relative efficiency of different sectors of the cattle market
Yearlings, the only sector exclusively domestic in nature, has by far the lowest explained variation in prices, with less than half of price variation explained in most yards by the relationship (see Table 3). In the domestic market, other factors, not incorporated in the analysis, such as the breed of the animal may be important.[5] Again, the purchase of yearlings for store purposes may be confusing this sector, as indicated in the reduced discount on low fat-score yearlings at the 'store' yards of Dalby and Warwick in some periods.
The best explanation of price variation is found in the export-dominated sectors, cows and steers. It would appear that the export sector is more price efficient than the domestic sector, at least in terms of the characteristics recorded by the LMRS.

8.3 Relative efficiency over time
There is a general tendency for the explained variation in prices to decline over time, particularly between October 1987 and 1988 (see Table 3). This apparent decline in efficiency may be attributable to an increase in lot-size with a likely associated increase in the heterogeneity of lots offered for sale over that period This was caused by an increased requirement for residue testing, following the pesticide scare in July 1987. An increase in lot-size has the effect of lowering total testing costs, but this appears to be at the expense of reduced pricing efficiency.

8.4 Impact of individual characteristics on price
8.4.1 Weight
The effect of weight on price varies across the four types of cattle considered, with weight being a more consistently significant factor in price determination in the market for steers and heifers (see Tables 4-

7). Weight appears to have some effect on the price of cows (Table 6), with lighter cows suffering a discount. However, this effect is not consistent across yards. Weight has only become significant for heifers in 1988. This change, with a premium paid for low weight heifers, may be partly explained by the importance of the Korean market in this sector in 1988 (see Table 5).

For steers, there is a clear pattern of preference for very heavy animals with discounts associated with the lighter classes. These are most pronounced in 1986 and 1987 (see Table 7). In 1988 the discounts were substantially less. Indeed, the weight coefficients were insignificant for steers in 1988 for all yards other than Toowoomba. Discounts have fallen over the three years, the most marked reduction being in 1988. This may be because of the weakness of the Japanese very heavy steer market during the last quarter of 1988.

This positive relationship between weight and price is at odds with the findings of Park(1979), Todd and Cowell(1981) and Hall(1981), the first two finding an inverse relationship and the latter no relationship between weight and price. Todd and Cowell (1981, p44) did note that their analysis was for predominantly domestic trade animals and if

> export buyers had entered the market strongly, then a positive (c/kg) weight-price relationship could have been established.

Park's analysis was also for primarily domestic animals while in Hall's study the range of weights studied was small.

5.4.2 Fat

In contrast to weight, fat depth as indicated by the fat score has a more consistent effect on price for all four types of animal, with discounts associated with overly thin or overly fat animals, the most desired animals being of fat score 3 or 4 (see tables 4-7).

This is consistent with the findings of Park(1979), Todd and Cowell(1981) and, particularly, Porter and Todd(1985).

The amount of discount varies between the four categories of animal, with low fat cover yearlings suffering a lesser discount than low fat cover heifers, cows or steers.

Discounts for either too lean or too fat cattle are clearest for cows (Table 6). For steers, only in some Toowoomba sales do too fat animals suffer a discount, while there is consistent disounting of animals below fat score 4 (Table 7).

8.4.3 Type of feed

This variable is not applicable for cows or for the saleyard of Warwick where there are no grain-fed animals reported.

This effect does vary, surprisingly, between yards and between cattle types (Table 8). For yearlings, the premium for grain-fed animals is low and is often insignificantly different from zero. For heifers, there is a clear premium, reflecting not only the increased price which may be obtained for the end-product but also the premium that buyers will pay as a guarantee against unexpected pregnancies.[6] For steers, the premiums estimated for different yards are highly variable. This variability may not be real - there is a high correlation between fat score, weight and type of feed which may cause estimation problems at individual yards. This potential statistical problem warrants more work.

8.4.4 Number in the lot

Generally, lot size is found to have a significant effect on price when the cattle sold are cows or steers, with this effect more pronounced at the smaller/more distant saleyards (see Table 9). The size of the coefficient varies between yards, between types and over time. Only at Dalby and Warwick was there found to be a lot size effect for yearlings and heifers and this was highly variable over time.

The size of the coefficients is in line with that found in other studies (Hogan and Todd(1979) and Todd and Cowell(1981)).

8.5 Equality of implicit prices of characteristics over space

8.5.1 Weight

The degree to which implicit weight premiums and discounts can be considered equal across space varies with the age/sex of the cattle. For steers (Table 7), the coefficients estimated for the Toowoomba yards can be taken to be approximately equal, while Dalby has consistently higher discounts for lighter cattle. For cows (Table 6), even within Toowoomba, there are significant differences in the values placed on the different weight classes. In 1988, when weight became a significant factor for heifers (Table 5), the implicit discounts for heavier animals were quite uniform throughout the region. Warwick, with its larger store market component, appears to have lower penalties on heavier yearlings (Table

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[6] If a heifer is not obviously in calf at the time of auction, the three months minimum which has been spent at the

4). Weight is not often a significant factor for yearlings but when it is, the size of the coefficients is reasonably steady across the other yards.

8.5.2 Fat

Three yards stand out as being different, at least in some periods. These are Dalby, Warwick and, to a lesser extent, Cannon Hill. It is clear that at these yards lower fat score animals attract a less severe price discount compared with Toowoomba. Fat scores seem to attract similar discounts at the three Toowoomba yards.

8.6 Equality of implicit prices of characteristics over time

8.6.1 Weight

The coefficients on the weight variables did generally change over time. For steers (Table 7), there was a decline in the discounts associated with cattle other than very heavy steers, particularly evident for the lower weight classes. For heifers (Table 5), weight was not an important determinant of price in the earlier two years but in 1988, there was a dramatic change with weight becoming highly significant. This may be because of the stronger export component coinciding with the reopening of the Korean market. The market for heavier weight yearlings is too thin to draw any conclusions (Table 4). For the medium weight yearlings, there is some evidence of a rise in the premium but this is not statistically significant. For cows (Table 6), the effect of weight on price is too variable to allow any conclusion to be reached.

8.6.2 Fat

The discounts associated with different fat scores have stayed more constant over time, with only a slight shift in favour of less fat cattle being apparent in 1988, particularly for yearlings. The extreme discounts given at some yards have obviously varied over time. These have been found mainly in the thinly traded sections of the market.

8.7 Equality of implicit prices of characteristics across form

8.7.1 Weight

It is clear from the above that the discounts and premiums associated with the four types of animal considered vary widely. For steers, light weight animals attract a price discount while, for other cattle, the

8.7.2 Fat

The effect of fat score on price is more uniform with low fat score cattle being particularly penalised. For younger cattle, yearlings and heifers, the discounts associated with low fat score animals are significantly less than those received by underfinished cows or steers. Price discounts for fat score 1 and 2 cows are generally a little higher than for equivalent steers and while, until 1988, little penalty was placed on over-finished steers, fat score 5 cows do suffer a discount. Fat score 3 and 4 are equally valued for yearlings with fat score 4 being the most highly valued fat score for heifers, cows and steers.

9 Summary and Conclusions

There is evidence to suggest that auction centres in South-East Queensland are imperfect in generating efficient prices, with larger centres appearing to be more efficient than smaller ones.

Evidence of inefficiency can also be found in the differing valuation of weight and fat characteristics across the region.

Over time, weight discounts appear to be less stable than fat discounts. While market changes, local or overseas, may affect the weight categories in greatest demand, and thus the premiums and discounts associated with different weight classes, the amount of fat which is desirable is probably subject to slower change, with a reasonable fat cover required for shelf-life, taste and other qualities.

The results suggest that such analysis must be carried out at a disaggregate level. The varying price discounts/premiums associated with different weight and fat levels for the different sex/age groups chosen mean that any more aggregate analysis would not be particularly informative. Indeed it could be argued that an even more disaggregated analysis is required.

There appears to have been changes in the implicit value placed on the different characteristics over time. There are also clear differences in the valuation of the characteristics at different yards.

The information content of the LMRS reports, as measured by the extent of price variation explained by reported factors, is particularly weak for the domestic yearlings market. Even for the other three sectors, there is a large, and possibly growing, unexplained component in price variation. While some of the increase in unexplained variation may be caused by the greater heterogeneity of lots, a side effect of the increased need for residue testing, further analysis should be undertaken

to identify the factors which may decrease this unexplained component of price variation. Possible factors to be considered include breed type, district of origin and position in sale.

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Table 3

Percentage of price variation explained in the four-week period studied (October) as measured by the adjusted coefficient of determination*

Saleyard		Yearlings	Heifers	Cows	Steers
		%	%	%	%
Toowoomba Monday	86	45 (161)	72 (255)	80 (458)	83 (968)
	87	44 (159)	68 (187)	86 (267)	79 (516)
	88	54 (76)	66 (160)	62 (240)	67 (510)
Toowoomba Tuesday	86	55 (208)	78 (149)	83 (261)	84 (606)
	87	41 (123)	74 (133)	79 (133)	86 (374)
	88	60 (104)	73 (92)	65 (141)	70 (436)
Toowoomba Wednesday	86	51 (147)	70 (119)	82 (184)	86 (465)
	87	22 (58)	77 (132)	60 (168)	84 (392)
	88	61 (39)	61 (111)	80 (126)	80 (392)
Brisbane	86	78 (164)	79 (116)	75 (188)	50 (595)
	87	79 (49)	75 (149)	66 (79)	72 (159)
	88	51 (37)	77 (57)	59 (86)	63 (109)
Dalby	86	36 (226)	65 (155)	64 (209)	69 (109)
	87	37 (171)	69 (187)	70 (207)	79 (415)
	88	9 (174)	43 (175)	49 (140)	36 (529)
Warwick	86	47 (386)	57 (196)	46 (496)	73 (666)
	87	30 (290)	44 (131)	59 (234)	65 (440)
	88	17 (351)	23 (114)	42 (252)	31 (327)

* Numbers in brackets are the total number of lots traded in the period.

Table 4

Yearlings:
estimated premiums and discounts associated with deviations in weight class or fat score from the 'standard' (weight class 1, fat score 3)
(c/kg)

Saleyard		Weight Class 2	Weight Class 3	Fat Score 1	Fat Score 2	Fat Score 4
Toowoomba Monday	86	3.57**	-	-12.18**	-6.15**	-
	87	1.28	-	-25.41**	-5.25**	-1.28
	88	-0.29	-	-	-5.11**	-
Toowoomba Tuesday	86	2.17*	-	-18.81**	-7.86**	-
	87	2.69*	3.24	-	-4.72**	0.16
	88	4.56**	-	-	-5.09**	-0.80
Toowoomba Wednesday	86	3.21**	-	-19.69**	-5.07**	-
	87	3.96**	-	1.69	-2.53	-
	88	0.05	-	-	-4.55**	-
Brisbane	86	3.52**	-	-14.85**	-2.63**	2.66
	87	-	-	-23.01**	-4.03**	-
	88	4.65	-	-9.59**	-4.56**	4.12
Dalby	86	2.59**	-	-5.00**	-4.02**	-0.04
	87	4.54**	-	-10.25**	-4.43**	-
	88	-1.89	-	-7.93	-3.58	-
Warwick	86	1.46**	4.88**	-16.07**	-6.06**	4.69**
	87	0.13	3.57	-9.51**	-2.98**	2.15
	88	-0.17	-3.01	-6.33**	-3.21**	3.99**

* indicates significant at 5% level
** indicates significant at 1% level

Table 5

Heifers:
estimated premiums and discounts associated with deviations in weight class or fat score from the 'standard' (weight class 1, fat score 3)
(c/kg)

Saleyard		Weight Class 2	Weight Class 3	Fat Score 1	Fat Score 2	Fat Score 4	Fat Score 5
Toowoomba Monday	86	-2.02**	0.08	-19.60**	-8.42**	4.67**	-
	87	-0.50	4.84*	-12.21**	-9.17**	1.65*	-
	88	-5.29**	-4.46*	-23.50**	-8.68**	2.21*	-8.23*
Toowoomba Tuesday	86	-0.81	5.76**	-23.59**	-9.68**	3.18**	-
	87	-1.73	0.70	-33.70**	-8.97**	1.41	-12.13*
	88	-5.72**	-7.80 *	-	-6.06**	2.98*	-4.55*
Toowoomba Wednesday	86	-0.04	6.02**	-	-6.66**	2.18	-
	87	0.56	-	-22.33**	-5.94**	1.83*	-5.16
	88	-3.80**	-17.91**	-	-8.83**	1.81	-
Brisbane	86	-0.46	-	-22.[illegible]**	-4.50**	-2.30*	-
	87	-3.42**	-	-14.47**	-4.17**	2.09*	-
	88	-5.68**	-9.13*	-15.15**	-5.97**	0.13	-
Dalby	86	-3.92**	-7.36*	-14.64**	-6.60**	6.87**	-
	87	-1.00	2.94	-15.50**	-7.54**	1.36	-
	88	-4.18**	-11.66**	-	-5.91**	3.10	-
Warwick	86	-1.12	-0.60	-17.39**	-8.83**	4.42**	-
	87	-3.60	-14.02*	-16.36**	-5.93**	1.37	-
	88	-5.59	-7.07	-20.82**	-4.25	2.72	-

* indicates significant at 5% level
** indicates significant at 1% level

Table 6

Cows:
estimated premiums and discounts associated with deviations in weight class or fat score from the 'standard' (weight class 3, fat score 4)
(c/kg)

Saleyard		Weight Class 1	Weight Class 2	Weight Class 4	Fat Score 1	Fat Score 2	Fat Score 3	Fat Score 5
Toowoomba Monday	86	-11.08**	-3.96**	1.13	-23.69**	-13.64**	-7.20**	-7.95**
	87	-35.26**	-1.67**	1.48	-21.03**	-10.44**	-3.76**	-4.02**
	88	9.69**	-1.47	-2.54*	-21.61**	-9.31**	-2.67**	-4.70**
Toowoomba Tuesday	86	-12.04**	-6.24**	1.33	-21.86**	-13.35**	-7.07**	-18.03**
	87	1.84	-1.97**	-2.86	-21.83**	-10.07**	-4.22**	-8.93**
	88	4.02	0.50	1.32	-25.30**	-11.50**	-4.67**	-6.44**
Toowoomba Wednesday	86	-2.24	-3.86**	1.22	-30.59**	-15.13**	-7.79**	-22.30**
	87	-5.30	-3.17**	-3.13	-14.23**	-10.17**	-3.30**	-6.36**
	88	-3.68	-0.53	1.21	-23.63**	-12.28**	-4.94**	-10.55**
Brisbane	86	-3.39	-1.73*	-1.39	-24.70**	-13.61**	-5.64**	-
	87	-4.25	-0.61	-33.47**	-17.69**	-9.24**	-3.99	-0.32
	88	-	0.79	-	-23.31**	-14.73**	-6.56**	-10.12**
Dalby	86	-26.72**	-2.16	-11.76**	-20.23**	-14.17**	-6.66**	6.31*
	87	0.73	-2.17*	-11.34**	-26.68**	-14.39**	-5.62**	-2.82
	88	-44.85**	-0.05	-9.91**	-28.02**	-10.56**	-6.38**	3.51
Warwick	86	-7.50**	-2.87**	1.43	-16.71**	-7.99**	-4.06**	-5.96
	87	-4.57**	-1.15	0.39	-15.30**	-7.55**	-4.67**	-0.16
	88	-6.29**	-4.42**	-1.76	-10.93**	-7.04**	-2.82*	-3.10

* indicates significant at 5% level
** indicates significant at 1% level

Table 7

Steers:
estimated premiums and discounts associated with deviations in weight class or fat score from the 'standard' (weight class 5, fat score 4)
(c/kg)

Saleyard		Weight Class 1	Weight Class 2	Weight Class 3	Weight Class 4	Fat Score 1	Fat Score 2	Fat Score 3	Fat Score 5
Toowoomba Monday	86	-9.95**	-11.40**	-8.56**	-3.51**	-36.51**	-11.89**	-5.72**	-5.75
	87	-9.60**	-8.08**	-5.51**	-2.05**	-11.44**	-8.54**	-2.48**	-3.26
	88	0.67	-2.70**	-3.65**	-2.13**	-22.54**	-10.83**	-4.78**	-
Toowoomba Tuesday	86	-12.39**	-12.84**	-10.78**	-5.32**	-29.95**	-13.33**	-5.58**	-6.74
	87	-8.97**	-8.88**	-4.62**	-2.45**	-23.08**	-8.28**	-3.16**	-
	88	-0.24	-3.42**	-5.51**	-2.39**	-	-12.29**	-4.81**	-10.97**
Toowoomba Wednesday	86	-13.75**	-12.52**	-9.99**	-4.26**	-27.43**	-11.05**	-5.76**	-7.30**
	87	-10.69**	-8.92**	-4.81**	-1.79**	-18.80**	-5.40**	-2.31**	-3.77**
	88	-1.75**	-4.17**	-4.08**	-2.23**	-	-8.24**	-3.36**	-6.20**
Brisbane	86	-10.54**	-8.94**	-6.56**	-2.81**	-	-9.47**	-2.86**	-3.06
	87	-9.25**	-8.19**	-7.16**	-4.06**	-19.72**	-8.21**	-3.23**	-
	88	0.77	0.01	-0.38	-0.16	-	-13.00**	-3.33**	-1.34
Dalby	86	-17.47**	-15.03**	-11.49**	-6.10**	-10.53**	-7.56**	-3.36**	-4.18
	87	9.98**	-9.45**	-6.81**	-3.89**	-	-7.45**	-3.40**	-4.15
	88	0.13	-0.97	-1.65	-0.73	-	-8.11**	-3.64**	-0.79
Warwick	86	-15.73**	-12.05**	-7.65**	-4.67**	-15.19**	-10.02**	-4.63**	-
	87	-9.07**	-6.27**	-4.23**	-1.87**	-18.35**	-6.43**	-3.19**	-
	88	-0.98	-2.65	-3.45*	-1.44**	-12.41**	-6.91**	-2.66**	-

* indicates significant at 5% level
** indicates significant at 1% level

Table 8

Estimated premiums associated with grain-fed animals (c/kg)

Saleyard		Yearlings	Heifers	Steers
Toowoomba Monday	86	0.58	5.29**	2.09**
	87	-1.11	3.90**	-0.22
	88	2.76	6.81**	1.99**
Toowoomba Tuesday	86	1.85*	4.57**	0.76
	87	2.99*	4.80**	1.15**
	88	4.27**	5.00**	1.62**
Toowoomba Wednesday	86	1.82*	4.58**	0.78
	87	0.10	5.28**	0.46
	88	1.79	5.40**	1.22**
Brisbane	86	5.28**	5.59**	3.71**
	87	[illegible].82	1.74**	1.90**
	88	1.37	4.32**	5.54**
Dalby	86	[illegible].03**	3.40**	1.15*
	87	0.60	5.49**	-0.25
	88	-1.27	[illegible].11**	2.43**

* indicates significant at 5% level
** indicates significant at 1% level

Table 9

Estimated premiums associated with a unit increase in the number of cattle in the lot sold (c/kg)

Saleyard		Yearlings	Heifers	Cows	Steers
Toowoomba Monday	86	0.27*	0.05	0.15*	0.17**
	87	-0.15*	0.01	0.47**	0.18**
	88	0.11	0.04	0.28**	0.22**
Toowoomba Tuesday	86	-0.18	0.01	0.16**	0.15**
	87	-0.06	0.19**	0.31**	0.16**
	88	0.17	0.10	0.02	0.09**
Toowoomba Wednesday	86	-0.05	-0.01	0.25**	0.07
	87	0.12	0.16*	0.45**	0.19**
	88	-0.20	0.09	0.17	0.19**
Brisbane	86	0.26**	0.30*	0.21	0.19**
	87	-0.08	-0.03	0.62**	0.17**
	88	-0.07	0.10	0.33	0.29**
Dalby	86	0.23**	0.16*	-0.02	0.10*
	87	0.02	0.21**	0.33**	0.14**
	88	0.40**	-0.11	0.15	0.05
Warwick	86	0.52**	0.83**	0.64**	0.64**
	87	0.45**	0.28	0.51**	0.57**
	88	0.17	-0.11	0.54**	0.71**

* indicates significant at 5% level
** indicates significant at 1% level