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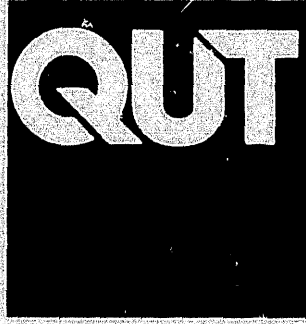
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**PRICING ACCURACY AND PRICE AVERAGING
AT CATTLE AUCTIONS**

by

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Queensland University of Technology

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Pricing accuracy is a fundamental requirement for the efficient operation of a market. This paper investigates pricing accuracy at cattle auctions over a six year period at seven major saleyards in Queensland by examining the extent to which prices paid reflect the quality differences between the lots of cattle for sale. The traditional practise of price averaging of slaughter cattle, where an overall single price is offered for a lot of mixed quality, appears to have an adverse effect on the accuracy of these prices. In addition, pricing accuracy is shown to be related to the volume of transactions occurring at these saleyards.

1 INTRODUCTION

Pricing accuracy relates to the extent to which the price system reflects the final value of a product to the producer of that product. Accurate prices are essential for pricing efficiency. If product values are reflected accurately in prices paid to producers, then producers will be able to allocate their resources more effectively. The question of whether prices are accurate or not is most often raised in the context of heterogeneous products. Quality differences between products result in different prices being offered by buyers and asked by sellers. The extent to which quality differences are fully reflected in these prices affects the extent to which these prices are accurate.

In the context of this paper, prices for slaughter cattle will vary with the perceived quality of the animals for sale. For prices of slaughter cattle to be accurate, the price differences must fully reflect the difference in the value of the cattle to the meat processor. Price averaging, where an overall single price is offered for a lot of mixed quality of a commodity, is a common practice in many commodity markets. Such price averaging has been often said to apply to slaughter cattle, both at auction and with direct sales (e.g. Parish, 1967). If this

is the case, it is likely to have an adverse effect on the accuracy of prices. The price offered for a mixed lot of cattle is likely to be an average price, relating to the average quality of the lot. Worse still, in some circumstances, the price offered is not an "average" in a statistical sense but relates more to the minimum quality represented within the mixed lot. When price averaging is practised, sellers do not receive precise messages about the value of different qualities of the product sold. With no obvious financial incentive signalled from the consumer to the producer to improve quality, the producer may not allocate resources efficiently from the point of view of society as a whole. This blurring of price signals, resulting in inaccurate prices and inefficient resource misallocation, is most likely to occur when the producer and consumer do not trade directly with each other but via wholesalers and other intermediaries, as happens in many agricultural markets.

Pricing inaccuracies exist primarily because of the existence of incomplete and/or imperfect information available to market participants. As above, the information about quality differences may not be fully perceived by consumers. However, pricing accuracy is also affected by the number of transactions occurring within a trading period at any market. Tomek (1980) examined the effect on pricing accuracy of thin markets for agricultural commodities. He pointed out that an increase in the number of transactions leads to an increase in the amount of information to market participants about the likely level of the unknown equilibrium price. Conversely, a reduction in the number of transactions will lead to a reduction in such information (Tomek, 1980, p.435). Such a reduction in information would be revealed through an increase in the variance on the mean transaction price, or an increased imprecision of these prices. This result, of increased variance in transactions prices, emerges only where market thinness exists in conjunction with imperfect information. As long as they are well informed, a small number of market participants can discover accurate and efficient prices.

This paper examines the extent to which pricing accuracy is affected by price averaging at seven major cattle auctions in Queensland over a six year period. In addition, the impact of market thinness (as indicated by the volume of transactions within a given period) on pricing accuracy is assessed. Finally the information content of market reports produced by the

Queensland Livestock Market Reporting Service (QLMRS) is assessed in terms of the amount of price variation which can be explained by variations in the reported factors.

2 DATA

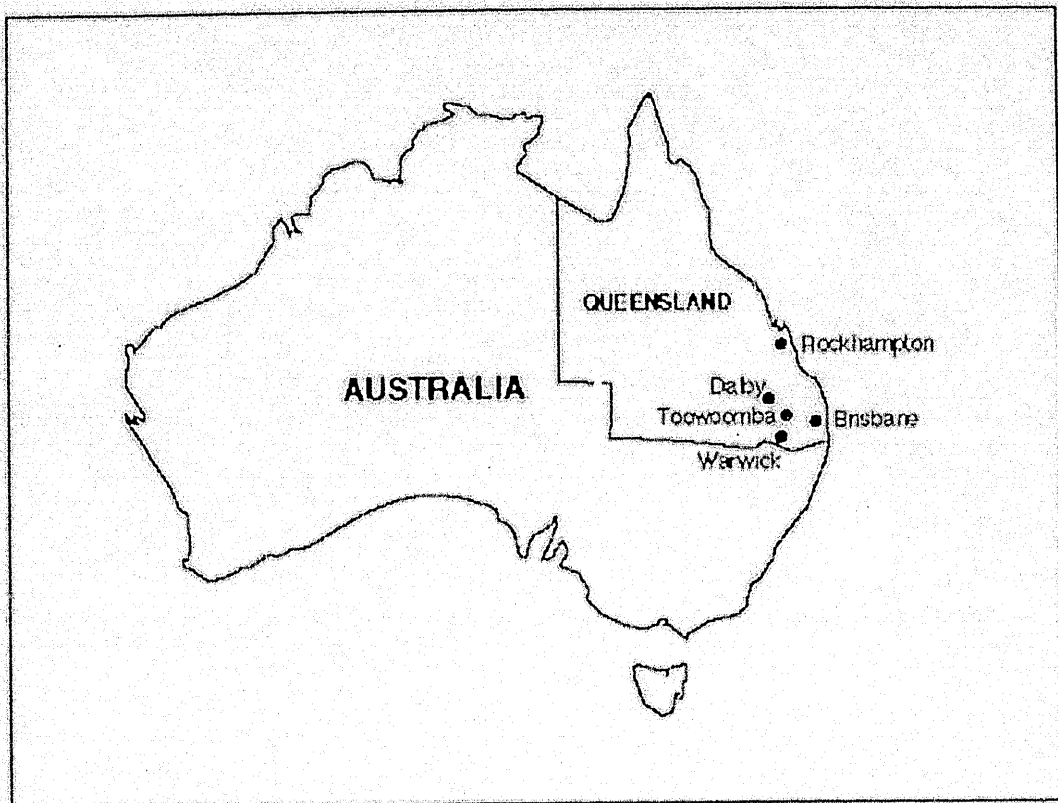
The data used for the analysis were the individual lot data collected by market reporters for use in the production of the QLMRS market reports. These data were provided by the QLMRS in the form of computer data files as they are not available in any published form. Published market reports are compiled using these data but these market reports represent a summary of the individual lot data. The individual lot data contain more specific information than the averaged data recorded in the form of market reports and are thus more suitable for the current analysis.

The data available for individual lots of cattle sold were the price paid for the lot (cents/kg), estimated or actual average weight of each animal in the lot¹ and estimated average fat score of the animals in the lot, the number of animals in the lot and whether the cattle were grain or grassfed. These data were also classified according to sex/age groupings, saleyard and date of sale.

The sex/age groupings analysed were limited to Yearlings, Cows, Heifers and Steers. No analysis was undertaken of Bulls as data were only available on price and weight for this group.

Seven saleyards were selected for analysis: Brisbane, Dalby, Warwick, Rockhampton and three separate yards at Toowoomba, each operated by different agents (see Map). These seven saleyards were chosen primarily on the basis of their ranking by annual throughput among Queensland cattle auction centres. One of these saleyards, Brisbane, was unusual because in 1986, at the beginning of the period covered by this study, this saleyard was one of the more important markets in South East Queensland, particularly for domestic cattle; by 1991, it had ceased to operate. Whether this declining terminal market exhibited different characteristics,

¹ This varied according to whether the reported saleyards were "live" or "remote" (see below).



in terms of price determination and pricing accuracy, from the other continuing centres is of interest. Only one of the saleyards, Warwick, is a "remote" saleyard for the purposes of market reports. The procedure for the collection of data differs between the "live" and "remote" saleyards, in particular, with regard to the collection of average weight data. For Warwick, the average weights are the actual average weights per head in each lot, whereas for the other six centres, the data refer to estimated average per head weights.

A four week period in October of each year between 1986 and 1991 (inclusive) was chosen for the analysis. This choice was made on the basis of the relative stability of cattle prices in Queensland over this period of the year. October also represented a period of the year which did not suffer from extreme climatic effects over the years examined. Thus, excessive price volatility and any related adverse impact on the stability of parameters over the four week period was avoided.

An overview of the data set is given by the summary statistics in Appendix Tables 1 to 4. In total, the information for 33,653 lots of cattle was used for this analysis. Some clear patterns emerge from an examination of these tables. In particular, at Warwick, a smaller number of animals are sold in each lot, on average, while at Rockhampton there are, on average, larger lot sizes. This is caused, in part, by the different number of single animal lots at these two saleyards, with up to a third of all animals sold being in single lots in Warwick. The effect of larger lot sizes, if this is also associated with greater lot heterogeneity, may be to reduce pricing accuracy, with greater price averaging over the lot. Specifically, as noted above, the price paid may not relate to the average values and therefore quality of the animals in the lot, but instead to the minimum quality animal in the lot.

3 THE HEDONIC PRICE MODEL

The general form of the estimated hedonic price model for cattle to be used for the analysis is given in equation (1):

$$P_i = P_0 + \sum X_{ij} p_j + \epsilon_i \quad \dots(1)$$

where P_i is the price of the i th lot;

P_0 is the price of the reference lot of cattle²;

X_{ij} is the average quantity of the j th characteristic provided by the i th lot (measured relative to the reference quantity held by the reference lot);

and p_j is the premium/discount associated with a unit change in the amount of characteristic X_{ij} provided by i th lot compared with the reference lot.

The regressors included in this model are weight and fat (as categorical variables), number of animals in the lot (as a linear continuous variable) and feed type (as a dummy variable).

² The reference lot of cattle was taken to belong to the following groups:
 weight range 1, for heifers, yearlings and steers; weight range 2, for cows;
 fat score 3 for all types;
 grass fed;
 and for yearlings the reference sex was taken to be male.

Interaction terms between the weight and fat variables were also included for the analysis.³ Market reports present the price variation by weight range disaggregated by fat score. To exclude the interactions of weight and fat from the analysis would be to bias downwards the estimate of the information contained in market reports as indicated by the explanatory power of the hedonic price model. The data on number of animals in the lot are collected by the QLMRS although the average lot size is not presented in market reports. They were included in the analysis because the number of animals in the lot is a factor which has been found to be significant elsewhere (e.g. Williams *et al.* 1993). However the inclusion of lot size will inflate the estimate of the information content of market reports to the extent that this factor is found to be significant. Also included are three dummy variables to allow for shifts in the base price of the reference lot over the four week period analysed in each year. Again, the significance of these time dummy variables inflates the explanatory power of the market report data. However, it was necessary to use a four week data period to provide an adequate data coverage for the different weight and fat types in each sex/age category.

The analysis is carried out at a disaggregate level, by saleyard, by sex/age grouping and by year.⁴ To allow for the likely presence of heteroscedasticity in the error terms, the estimation procedure used to estimate the hedonic price functions incorporated the use of White's heteroscedasticity-consistent covariance matrix (White, 1980).⁵

³ Detailed analysis of the appropriate form of the hedonic price function, whether linear, quadratic, continuous or categorical, for this data set is reported in Williams (1993).

⁴ Tests for possible aggregation over time and space, reported in Williams (1993), suggested that aggregation would not be valid generally. Aggregation over sex/age type is not possible because of the different weight ranges applicable for each sex type but *a priori* such aggregation is unlikely to be appropriate since the different sex/age categories each represent relatively distinct market segments.

⁵ Some analysis was carried out to try to identify the nature and cause of the heteroscedasticity and thus model the heteroscedasticity directly but this work was inconclusive (Williams, 1993).

4 ANALYSIS

As Stigler (1961) noted, a measure of ignorance in the market is given by the extent of price dispersion. In the case of heterogeneous goods, some variation in prices will be the result of quality variation. The hedonic price technique is directed to explain these variations in quality. The residual variation, that is, the proportion of price variability which is not explained by quality differences, can be taken as some measure of the lack of information and thus of any inaccuracy and inefficiency of prices formed at the seven saleyards investigated. Some variation in prices can be explained by differences in processors' cost structures but, in a highly competitive industry, these differences are not expected to be great over a four week period.

4.1 The Explained Proportion of Price Variation

The results of the estimation of the hedonic price functions for the 164 subsets of data for the seven saleyards, four sex/age groupings and six years are summarised in Tables 1 and 2. Table 1 presents the proportion of variation in price explained by the characteristics collected by the QLMRS for the 164 subsets, while the average, minimum and maximum performance of the hedonic price functions, as measured by the coefficient of determination, is summarised in Table 2.

There is a wide variation in the success of the characteristics included in the hedonic price model to explain price variation, as measured by the coefficient of determination. The minimum proportion of the variation in prices explained was 13.5 per cent for yearlings sold at Dalby in October 1988, while the maximum was 94 per cent for heifers sold at Dalby in October 1991. Over the six year period, the average coefficient of determination, an indicator of the power of the QLMRS characteristics to explain price variation, varied from below a third for yearlings at Warwick and over 80 per cent for Cows at the Monday sale at Toowoomba, Heifers at Brisbane, and Steers at the Wednesday sale at Toowoomba.

There appears to be only a slight pattern across saleyard and by type of cattle with regard to the ability of the model to explain price variation. The model was generally poorest for Yearlings and for all sex/age groupings at Warwick. There is no clear pattern in the

Table 1 Proportion of price variation explained by variations in the characteristics collected by the QLMRS

	Brisbane	Toowoomba Monday	Toowoomba Tuesday	Toowoomba Wednesday	Dalby	Rockhampton	Warwick
Yearlings							
1986	0.787 (162)	0.559 (159)	0.669 (206)	0.609 (145)	0.401 (224)	0.352 (54)	0.473 (348)
1987	0.424 (46)	0.474 (158)	0.525 (121)	0.357 (56)	0.431 (169)	0.354 (17)	0.247 (270)
1988	0.651 (36)	0.605 (73)	0.645 (102)	0.710 (36)	0.135 (172)	0.519 (27)	0.207 (335)
1989	0.815 (69)	0.658 (255)	0.591 (219)	0.614 (182)	0.348 (286)	0.637 (74)	0.262 (549)
1990	0.862 (51)	0.717 (248)	0.732 (207)	0.705 (153)	0.727 (255)	0.379 (30)	0.309 (387)
1991	Saleyard closed	0.798 (281)	0.824 (257)	0.838 (103)	0.852 (295)	0.639 (28)	0.427 (823)
Cows							
1986	0.763 (185)	0.806 (458)	0.836 (261)	0.834 (184)	0.779 (207)	0.746 (230)	0.469 (491)
1987	0.708 (79)	0.864 (267)	0.804 (133)	0.730 (168)	0.808 (207)	0.728 (69)	0.619 (231)
1988	0.637 (84)	0.784 (240)	0.679 (141)	0.820 (126)	0.713 (137)	0.629 (88)	0.451 (251)
1989	0.831 (103)	0.781 (323)	0.745 (216)	0.707 (155)	0.645 (175)	0.823 (96)	0.588 (408)
1990	0.845 (68)	0.770 (272)	0.757 (180)	0.748 (191)	0.766 (195)	0.899 (120)	0.458 (198)
1991	Saleyard closed	0.881 (345)	0.855 (386)	0.889 (181)	0.821 (241)	0.856 (130)	0.617 (423)
Heifers							
1986	0.830 (114)	0.742 (254)	0.806 (148)	0.747 (117)	0.706 (154)	0.410 (106)	0.605 (185)
1987	0.789 (147)	0.694 (186)	0.770 (133)	0.788 (131)	0.720 (186)	0.863 (62)	0.527 (123)
1988	0.827 (56)	0.687 (160)	0.773 (91)	0.642 (109)	0.478 (173)	0.682 (76)	0.303 (111)
1989	0.832 (58)	0.695 (93)	0.806 (33)	0.387 (77)	0.700 (73)	0.786 (43)	0.495 (25)
1990	0.911 (20)	0.725 (71)	0.730 (60)	0.739 (31)	0.793 (40)	0.693 (97)	0.414 (20)
1991	Saleyard closed	0.821 (48)	0.788 (46)	0.793 (36)	0.940 (33)	0.808 (86)	0.554 (50)
Steers							
1986	0.758 (593)	0.844 (948)	0.868 (604)	0.875 (464)	0.834 (738)	0.350 (316)	0.759 (653)
1987	0.757 (148)	0.809 (515)	0.870 (373)	0.848 (391)	0.806 (474)	0.567 (134)	0.657 (424)
1988	0.685 (108)	0.683 (508)	0.715 (435)	0.804 (391)	0.596 (527)	0.240 (106)	0.343 (320)
1989	0.769 (98)	0.756 (291)	0.708 (255)	0.680 (237)	0.212 (311)	0.774 (114)	0.352 (112)
1990	0.856 (77)	0.747 (335)	0.770 (188)	0.834 (229)	0.675 (343)	0.754 (151)	0.313 (159)
1991	Saleyard closed	0.905 (341)	0.833 (259)	0.861 (147)	0.882 (353)	0.830 (42)	0.583 (152)

Numbers in brackets are the total number of lots of that type traded at that centre in the 4 week period under analysis.

Table 2 Summary of explanatory power of hedonic price functions including QLMRS characteristics

	Brisbane	Toowoomba Monday	Toowoomba Tuesday	Toowoomba Wednesday	Dalby	Rockhampton	Warwick
Yearlings							
Average R ²	0.708	0.635	0.664	0.639	0.482	0.480	0.321
Minimum R ²	0.424	0.474	0.525	0.357	0.135	0.352	0.207
Maximum R ²	0.862	0.798	0.824	0.838	0.852	0.639	0.473
Cows							
Average R ²	0.757	0.814	0.779	0.788	0.755	0.780	0.534
Minimum R ²	0.637	0.770	0.679	0.707	0.645	0.629	0.451
Maximum R ²	0.845	0.881	0.855	0.889	0.821	0.899	0.619
Heifers							
Average R ²	0.838	0.727	0.779	0.683	0.723	0.707	0.483
Minimum R ²	0.789	0.694	0.730	0.387	0.478	0.410	0.303
Maximum R ²	0.911	0.821	0.806	0.793	0.940	0.863	0.605
Steers							
Average R ²	0.765	0.791	0.794	0.817	0.668	0.586	0.501
Minimum R ²	0.685	0.683	0.708	0.680	0.212	0.240	0.313
Maximum R ²	0.856	0.905	0.870	0.875	0.882	0.830	0.759

explanatory power of the model over time, except that, for all saleyards other than Warwick, the best performance tended to be in either 1990 or 1991. The opposite is true for Warwick with the highest R^2 being observed for the model in either 1986 or 1987. The better performance of the model at all but one saleyard in the later years (1990-91) of the period studied, and the associated reduction in the proportion of variation in prices which is left unexplained by quality variations, occurred despite a tendency for the number of lots traded in October to decline over the six year period.⁶ This result is in conflict with the hypothesis that increased price dispersion is more likely in thinly traded markets. In particular, Brisbane, which ceased to operate in 1991, has the characteristics of a declining terminal market (Tomek, 1980). Yet, there is no tendency for unexplained price variation to increase at Brisbane, as predicted by theory. The declining number of sales experienced over the five year period analysed for Brisbane sales is accompanied instead by an increased proportion of explained price variation, as shown in Table 1. This suggests that either the result refutes the hypothesis that thin markets are less accurate or that there were other factors at work in the Brisbane market which offset the rise in unexplained variation predicted with a decline in the volume of sales associated with a declining terminal market.

4.2 Factors Affecting the Explanatory Power of the Model

A simple model was developed not only to test the hypothesis that pricing accuracy (and, thus, pricing efficiency) will decline at a declining terminal market but also to reveal which other factors might affect the ability of the characteristics model above in equation (1) to explain price variation. Following Tomek, it was hypothesised that the volume of transactions affects the variability of prices discovered at a saleyard. Two separate measures of the volume of transactions were considered: the total number of lots sold over the 4 week period at the particular saleyard; and the number of lots of that particular type of cattle sold over the 4 week period at that saleyard. Other factors considered to be potentially important were the sex/age grouping of cattle, the particular saleyard and the year. The saleyard, sex/age grouping of cattle and year were entered into the model as a series of dummy variables, with

⁶ This decline in numbers of cattle sold reflects the increasing proportion of cattle sold directly to the meatworks. The decline is most marked for Heifers where the export market has increased greatly in importance over the period. Many producers, particularly feedlots, now sell directly to the meatworks with a firmer market for this product.

the base for each being, respectively, Toowoomba Monday, Steers and 1986. The results of the analysis are summarised in Table 3.

The appropriate measure of transactions volume is clearly the volume of sales of the particular type of cattle, since the coefficient on the total number of lots sold of all types was not significantly different from zero. The number of lots of a particular type of cattle sold had a significant effect on the amount of explained variation in prices with a sign consistent with the hypothesis that pricing accuracy declines as the volume of trade decreases. The proportion of price variation left unexplained decreased by 2 percentage points for an increase in volume of sales by one hundred lots. However, although the largest number of lots sold for any particular type of cattle was 968, the average number of lots sold in any particular category was just over two hundred. The effect on price variation, although significantly different from zero, is likely to be small in magnitude, on average, four percentage points.

The conclusion above, made on the basis of the data in Table 1, that Warwick appears to have the most unexplained variation in the prices paid for all types of cattle, is confirmed by this analysis: the coefficient of determination is, on average, 28.4 percentage points lower at Warwick than for the Monday sale at Toowoomba (the benchmark or base sale). It was suggested above that greater price averaging associated with larger lot sizes might reduce pricing accuracy. However, Warwick has the highest proportion of single animal lots sold among the seven saleyards examined (Appendix Tables 1 to 4) and, from the results of this section, the lowest pricing accuracy as far as the characteristics reported in the QLMRS market reports are concerned. This suggests that selling animals in single lots does not improve pricing accuracy although it eliminates the possibility of price averaging.

Prices at Dalby and Rockhampton auctions also appear to be less determined by variations in weight and fat than prices at the Toowoomba sales, but to a lesser extent than Warwick. Average lots sizes at these two centres are large, particularly at Rockhampton, so price averaging may be contributing to the reduction in pricing accuracy. The potential importance of price averaging in reducing the explanatory power of the hedonic price model again is

Table 3 Contributing factors to the amount of variation explained by the hedonic price model

Variable	Estimated coefficient (t statistic in brackets)
Total number of lots sold at that saleyard over 4 week period	-0.000 (-0.02)
Number of lots of particular type sold at that saleyard over 4 week period	0.0002 (2.39)**
Brisbane ¹	0.0840 (2.21)**
Toowoomba Tuesday ¹	0.027 (0.81)
Toowoomba Wednesday ¹	0.013 (0.38)
Dalby ¹	-0.078 (-2.32)**
Rockhampton ¹	-0.066 (-1.78)*
Warwick ¹	-0.284 (-8.53)***
Yearlings ²	-0.116 (-4.15)***
Cows ²	0.065 (2.47)**
Heifers ²	0.048 (1.52)
1987 ³	-0.001 (-0.02)
1988 ³	-0.065 (-2.00)**
1989 ³	-0.016 (-0.50)
1990 ³	0.046 (1.37)
1991 ³	0.142 (4.22)***
Constant	0.668 (12.08)***
<p>R² = 0.618 n = 164</p> <p>¹ measured relative to base saleyard, Toowoomba Monday ² measured relative to base cattle type, Steers ³ measured relative to base year, 1986</p> <p>*** indicates significantly different from zero at 1% level ** indicates significantly different from zero at 5% level * indicates significantly different from zero at 10% level</p>	

indicated by the superior performance of the model for cattle sold at Brisbane market: average lot sizes at Brisbane are generally smaller than at the other centres.

The effect of average lot size on the ability of the model to explain price variability was tested directly by incorporating an additional variable, average lot size, in the simple model discussed above. The data used for average lot size are those reported in the sixth column of Appendix Tables 1 to 4. However, although the sign of the coefficient was negative, the coefficient was insignificantly different from zero. Collinearities between average lot size and saleyard were identified and the model was respecified, omitting a group of saleyard dummy variables. The new specification, replacing a group of dummy variables with a variable, average lot size, which has a stronger rationale (as a proxy for price averaging) for its inclusion, was preferred despite its equivalent explanatory power. The results are presented in Table 4.

Increasing the average lot size does appear to lead to a loss in pricing accuracy. The ability of the hedonic price model to explain prices reduces by 1.8 percentage points for every extra animal in the lot, on average. Even after allowing for its lower average lot size, Brisbane still appears to have had greater accuracy in its prices with respect to weight and fat factors. The poorer performance of the model for Rockhampton indicated in the previous specification (Table 3) appears to be largely explained by the larger lot sizes sold at this centre⁷.

Warwick stands out as an exception, having the lowest average lot size of all seven saleyards studied yet the poorest performance in terms of pricing accuracy. The weakness of the model performance at Warwick is highlighted by allowing for the effect of smaller average lots and thus a reduced opportunity for price averaging: the ability of the hedonic price model to explain price variation is 35 percentage points below that of the model using the Toowoomba sales data.

⁷ The collinearity between the dummy variable for Rockhampton and the average lot size variable makes a conclusive statement impossible. However, the coefficient on the Rockhampton dummy became insignificant with the inclusion of average lot size.

The superior performance of the hedonic price model for Cows, indicated in Table 3, appears to be explained by the average lot size variable, with the coefficient on the Cows dummy variable insignificantly different from zero in the second specification (Table 4). The results

Table 4 Results of respecified model to examine the contributing factors to the amount of variation explained by the hedonic price model

Variable	Estimated coefficient (t statistic in brackets)
Number of lots of particular type sold at that saleyard over 4 week period	0.0002 (2.39)**
Brisbane ¹	0.0550 (1.72)*
Dalby ¹	-0.066 (-2.47)**
Warwick ¹	-0.348 (-9.83)***
Yearlings ²	-0.142 (-4.73)***
Cows ³	0.036 (1.20)
Heifers ²	0.034 (1.16)
1987 ³	0.032 (0.98)
1988 ³	-0.065 (-1.95)*
1989 ³	-0.011 (-0.43)
1990 ³	0.047 (1.43)
1991 ³	0.141 (4.23)***
Average lot size	-0.0183 (-2.83)***
Constant	0.768 (11.52)***
$R^2 = 0.617$ $n = 164$	
¹ measured relative to base saleyard, Toowoomba Monday ² measured relative to base cattle type, Steers ³ measured relative to base year, 1986 *** indicates significantly different from zero at 1% level ** indicates significantly different from zero at 5% level * indicates significantly different from zero at 10% level	

of the second specification suggest that model performance for Cows, Steers and Heifers are equivalent. The ability of the hedonic price model to explain price behaviour for Yearlings, on the other hand, worsens when account is taken of the effect of average lot size.

5 CONCLUSIONS

The data collected by the QLMRS are unable to explain a consistently high proportion of the variation in prices formed at live cattle auctions. To this extent, the market reports produced based on this data may be of limited usefulness, especially for Warwick and for yearlings generally. At best, the characteristics reported in these market reports, weight range and fat score, explain less than half of the price variation in yearlings and less than two thirds of the variation in prices for cows and heifers at Warwick. For the other six saleyards, the information content is generally higher. However, on average over a fifth of price variation is left unexplained.

This lack of explanation of price variation cannot be taken as conclusive evidence of pricing inaccuracies in live cattle market. The existence of other characteristics which appear to be important in determining the price paid for cattle at auction in Queensland may explain the, at times, limited information content of the market reports produced by the QLMRS⁸. However, there is evidence that in the Queensland live cattle auctions studied pricing accuracy declines and unexplained price variation increases as the number of transactions falls, as predicted by Tomek (1980). Although the magnitude of this effect is likely to be small, the negative effect of declining terminal sales on pricing accuracy and thus pricing efficiency may be of concern with the increasing trend away from terminal markets towards sale by direct negotiation between producer and meatworks. In addition, pricing accuracy declines as the number of animals sold in a lot increases, indicating the negative impact of price averaging on the efficiency of price discovery. The data in Appendix Tables 1 to 4 do not indicate any trend towards increased average lot size over the period studied. However, with growing testing requirements for live cattle, usually accruing on a per lot basis, this adverse effect of increasing lot size on pricing accuracy may potentially become more serious.

After allowing for the effects of price averaging and the volume of transactions on pricing accuracy, it is clear that pricing accuracy at Warwick is inferior to that elsewhere and that the ability of the model to explain price behaviour for sales of Yearlings in terms of weight

⁸ For example, see Williams *et al.* 1993

and fat variations is inferior to that for the other age/sex groupings. While the reasons for the apparent pricing inaccuracies at Warwick are obscure, there are potential reasons for the poor performance of the QLMRS characteristics model to explain price behaviour for Yearlings. The domestic market is less concerned with broad end-user specifications and is more driven by quality considerations. While fat is one characteristic which is considered to be important in determining meat quality, there are other characteristics affecting quality which are not among those collected by the QLMRS. There may be some benefit in the form of increased market information to expanding the number of characteristics reported in the QLMRS market reports.

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Appendix Table 1 Individual lot data for lots sold during 4 weeks in October, 1986 to 1991, as reported by the QLMRS: summary statistics for Yearlings

Saleyard	Year	Number of lots	Number of head	Number of single lots	Average lot size	Average weight (kg)	Average fat cover (mm)	Price paid for lot (c/kg)	Proportion Granted
Brisbane	1986	162	718	37	4.43	282.7 (38.0)	7.04 (2.3)	105.5 (6.1)	66.1
	1987	46	185	18	4.02	200 (0)	7.13 (2.2)	100.7 (5.4)	58.7
	1988	36	139	12	3.86	206.9 (29.7)	6.56 (1.9)	115.8 (4.5)	25.0
	1989	69	245	21	3.55	266.5 (45.1)	8.54 (3.6)	112.4 (7.9)	40.6
	1990	51	364	10	7.14	263.5 (41.0)	6.43 (3.6)	106.9 (6.2)	0
	1991	-	-	-	-	-	-	-	-
Toowoomba Monday	1986	159	763	38	4.80	276.6 (26.6)	6.48 (2.2)	102.9 (7.2)	20.7
	1987	158	1296	13	8.20	290.1 (28.2)	8.12 (2.3)	103.9 (5.0)	61.4
	1988	73	395	19	5.41	294.8 (23.9)	7.38 (2.4)	120.3 (8.0)	2.2
	1989	255	1479	51	5.80	348.6 (37.9)	9.98 (3.3)	114.5 (8.4)	35.7
	1990	248	1324	59	5.33	345.1 (35.1)	8.85 (3.3)	113.3 (10.7)	25.8
	1991	281	1500	68	5.41	332.8 (36.6)	7.48 (2.7)	103.2 (10.3)	49.8
Toowoomba Tuesday	1986	206	1092	53	5.30	286.5 (28.7)	7.50 (2.3)	105.2 (7.3)	40.2
	1987	121	749	27	6.19	291.6 (29.6)	7.70 (2.3)	103.8 (6.7)	48.8
	1988	102	432	24	4.24	309.9 (26.3)	8.30 (2.6)	120.9 (7.2)	26.5
	1989	219	1196	47	5.15	335.6 (38.7)	9.29 (3.2)	115.9 (8.2)	31.5
	1990	266	1234	70	4.64	343.5 (37.5)	9.39 (3.0)	115.4 (8.9)	19.9
	1991	257	1100	79	4.28	332.3 (38.3)	7.49 (2.8)	102.5 (11.1)	26.5
Toowoomba Wednesday	1986	145	830	24	5.72	273.5 (27.9)	6.42 (2.2)	103.6 (6.1)	46.2
	1987	56	478	5	8.54	281.7 (31.9)	6.79 (2.1)	101.4 (6.0)	41.1
	1988	36	137	7	3.81	301.3 (17.3)	7.92 (1.7)	120.2 (6.5)	41.7
	1989	182	863	45	4.74	352.6 (39.8)	9.61 (3.3)	113.0 (7.0)	20.9
	1990	153	724	33	4.73	354.1 (39.0)	9.59 (3.4)	113.1 (7.5)	32.0
	1991	103	423	27	4.11	334.7 (36.9)	7.77 (3.1)	102.2 (11.7)	36.9
Dalby	1986	224	1334	31	5.96	287.2 (40.4)	6.84 (3.1)	106.0 (5.8)	39.3
	1987	169	1267	19	7.50	260.2 (34.9)	4.91 (2.3)	97.9 (6.8)	10.7
	1988	172	1325	14	7.70	270.2 (34.7)	5.83 (2.8)	121.3 (7.6)	8.1
	1989	286	1924	42	6.70	330.4 (57.1)	8.57 (3.9)	116.6 (5.6)	16.8
	1990	255	1615	27	6.33	345.6 (52.6)	9.23 (3.9)	113.0 (8.2)	18.4
	1991	295	1827	44	6.19	346.2 (51.1)	8.80 (3.9)	104.3 (11.6)	50.5
Warwick	1986	348	888	177	2.55	266.5 (54.2)	9.49 (3.8)	103.8 (7.3)	NR
	1987	270	768	126	2.84	273.2 (51.2)	7.27 (3.4)	103.5 (6.6)	NR
	1988	335	884	172	2.64	277.5 (47.7)	8.63 (3.5)	120.1 (8.5)	NR
	1989	538	1606	234	2.99	335.3 (88.1)	9.98 (3.6)	113.7 (11.4)	NR
	1990	387	942	204	2.43	308.6 (72.9)	9.86 (3.5)	111.1 (12.5)	NR
	1991	823	2410	349	2.93	290.2 (70.7)	8.03 (3.6)	99.3 (17.1)	NR
Rockhampton	1986	54	288	7	5.33	210 (0)	14.4 (1.6)	91.4 (10.0)	NR
	1987	17	109	4	6.41	210 (0)	4.47 (1.1)	104.6 (21.0)	NR
	1988	27	92	15	3.41	216.3 (32.1)	4.33 (2.4)	118.6 (21.2)	NR
	1989	74	510	11	6.89	369.7 (45.3)	11.9 (2.8)	107.4 (8.2)	NR
	1990	30	239	2	8.63	291.3 (12.6)	8.83 (1.7)	98.2 (7.6)	NR
	1991	28	191	1	6.82	352.1 (32.4)	7.46 (2.3)	87.2 (8.0)	NR

NR indicates that none were recorded.
 Figures in brackets are standard deviations.

Appendix Table 2

Individual lot data for lots sold during 4 weeks in October, 1986 to 1991, as reported by the QLMRS: summary statistics for Cows

Saleyard	Year	Number of lots	Number of head	Number of single lots	Average lot size	Average Weight (kg)	Average fat cover (mm)	Price paid for lot (¢/kg)	Proportion Grained
Brisbane	1986	185	521	94	2.82	398.2 (57.4)	4.92 (4.0)	83.1 (9.4)	0
	1987	79	373	21	4.72	398.9 (64.8)	5.13 (6.3)	76.6 (9.3)	0
	1988	84	246	34	2.93	433.3 (69.9)	6.99 (6.9)	86.2 (9.9)	0
	1989	103	285	50	2.77	464.7 (72.6)	7.06 (5.9)	88.2 (7.7)	0
	1990	68	110	47	1.62	451.5 (75.1)	5.38 (6.9)	80.0 (9.7)	0
	1991	-	-	-	-	-	-	-	-
Toowoomba Monday	1986	458	1475	167	3.22	463.4 (57.2)	9.22 (5.0)	89.6 (8.0)	0
	1987	267	1316	57	3.75	439.6 (45.6)	8.57 (4.6)	84.0 (8.4)	0
	1988	240	1375	48	5.73	436.5 (52.3)	9.57 (7.0)	89.0 (7.7)	0
	1989	323	1406	104	4.35	468.1 (60.4)	11.6 (7.5)	93.5 (7.1)	0
	1990	272	1398	67	5.14	469.4 (69.9)	12.7 (9.3)	86.0 (9.0)	0
	1991	345	1296	123	3.76	427.0 (60.8)	8.01 (6.0)	82.1 (14.7)	0
Toowoomba Tuesday	1986	261	933	104	3.57	451.8 (53.3)	9.31 (5.1)	89.1 (8.5)	0
	1987	133	788	28	5.92	424.2 (44.8)	8.21 (5.4)	83.1 (7.4)	0
	1988	141	691	37	4.90	434.5 (42.8)	10.7 (5.9)	90.5 (7.1)	0
	1989	216	1010	84	4.68	448.7 (52.0)	11.2 (7.3)	93.3 (8.3)	0
	1990	180	599	71	3.33	460.4 (62.0)	12.8 (8.9)	85.6 (8.5)	0
	1991	319	1499	99	4.70	414.5 (65.8)	8.68 (7.8)	82.3 (13.5)	0
Toowoomba Wednesday	1986	184	1087	33	5.91	443.0 (56.6)	8.49 (5.1)	87.9 (9.1)	0
	1987	168	1389	16	8.56	431.3 (53.5)	10.5 (6.3)	87.4 (8.4)	0
	1988	126	535	36	4.25	442.8 (53.5)	11.5 (6.3)	92.0 (7.9)	0
	1989	155	872	25	5.63	450.3 (56.3)	11.5 (7.1)	93.7 (6.8)	0
	1990	191	1058	31	5.54	474.7 (66.0)	15.2 (9.6)	86.4 (8.6)	0
	1991	181	1081	37	5.97	426.2 (65.7)	10.2 (7.3)	86.3 (13.8)	0
Dalby	1986	207	949	42	4.58	436.7 (67.4)	10.8 (8.2)	86.7 (9.3)	0
	1987	207	1543	20	7.45	424.0 (59.4)	8.78 (6.5)	89.0 (9.2)	0
	1988	137	854	19	6.96	453.6 (55.6)	11.4 (7.5)	90.9 (7.2)	0
	1989	175	823	40	4.70	454.1 (70.0)	12.7 (9.5)	92.5 (5.9)	0
	1990	195	1173	37	6.02	479.5 (71.6)	13.9 (11.1)	85.0 (8.8)	0
	1991	241	1270	41	5.27	443.4 (66.9)	9.15 (8.8)	84.3 (12.1)	0
Warwick	1986	491	957	301	1.95	433.9 (84.3)	7.89 (5.5)	85.8 (10.3)	0
	1987	231	576	124	2.49	440.2 (76.3)	7.12 (4.5)	82.1 (8.2)	0
	1988	251	693	131	3.00	429.9 (77.8)	6.36 (5.6)	85.9 (9.2)	0
	1989	408	926	236	2.27	436.7 (90.2)	11.5 (5.9)	89.1 (13.8)	0
	1990	198	327	134	1.65	443.6 (84.0)	12.5 (5.8)	79.6 (13.0)	0
	1991	344	711	194	2.07	430.9 (82.1)	9.50 (5.9)	72.6 (16.4)	0
Rockhampton	1986	230	2213	18	9.62	462.0 (33.4)	15.2 (4.2)	88.1 (8.4)	0
	1987	69	740	0	10.72	456.1 (18.0)	13.2 (4.6)	82.2 (11.2)	0
	1988	103	1014	3	9.84	457.8 (13.0)	12.7 (3.7)	89.3 (6.8)	0
	1989	96	833	5	9.20	462.9 (14.1)	12.5 (3.5)	92.6 (6.5)	0
	1990	120	905	15	7.54	468.4 (16.7)	12.6 (4.0)	85.9 (7.1)	0
	1991	130	1134	10	8.72	461.2 (18.4)	10.4 (4.3)	89.2 (8.6)	0

NR indicates that none were recorded.
 Figures in brackets are standard deviations.

Appendix Table 3

Individual lot data for lots sold during 4 weeks in October, 1986 to 1991, as reported by the QLMRS: summary statistics for Heifers

Saleyard	Year	Number of lots	Number of head	Number of single lots	Average lot size	Average weight (kg)	Average fat cover (mm)	Price paid for lot (c/kg)	Proportion Grainfed
Brisbane	1986	144	332	43	2.91	370.4 (34.5)	7.02 (3.2)	101.8 (6.9)	34.2
	1987	147	1216	9	8.27	365.6 (20.0)	7.90 (2.6)	100.2 (5.3)	61.9
	1988	56	207	18	3.70	367.9 (22.3)	6.43 (2.6)	111.0 (8.1)	23.2
	1989	58	253	16	4.36	353.1 (55.2)	8.64 (4.6)	105.6 (9.4)	39.7
	1990	20	76	7	3.80	310.0 (43.6)	7.65 (7.6)	94.8 (6.9)	0
	1991	-	-	-	-	-	-	-	0
Toowoomba Monday	1986	254	1338	64	5.27	344.4 (42.2)	8.89 (3.3)	98.4 (5.9)	11.8
	1987	186	1392	26	7.48	343.5 (36.8)	10.2 (3.4)	97.8 (5.9)	37.6
	1988	160	932	31	5.83	360.8 (40.1)	9.75 (3.9)	110.5 (7.7)	16.9
	1989	93	579	12	6.20	398.5 (31.7)	11.4 (4.4)	104.0 (6.3)	5.4
	1990	71	452	13	6.37	408.3 (38.8)	14.1 (6.5)	99.4 (7.9)	0
	1991	48	245	12	5.10	382.1 (39.3)	9.01 (4.2)	97.6 (10.1)	8.3
Toowoomba Tuesday	1986	148	840	28	5.68	339.6 (52.6)	8.88 (3.6)	98.3 (7.4)	12.8
	1987	133	1199	21	9.02	341.5 (41.7)	9.32 (4.1)	95.2 (7.0)	18.8
	1988	91	479	25	5.26	366.1 (51.4)	10.9 (4.1)	111.8 (5.9)	12.1
	1989	33	166	10	5.03	410.5 (37.8)	13.0 (4.5)	100.5 (6.1)	3.0
	1990	60	288	22	4.80	417.9 (39.6)	13.0 (5.3)	101.9 (8.0)	0
	1991	48	197	14	4.28	409.5 (41.6)	11.3 (4.0)	99.9 (7.9)	2.2
Toowoomba Wednesday	1986	117	880	16	7.52	333.4 (43.0)	7.75 (2.9)	99.2 (5.6)	26.5
	1987	131	1105	7	8.44	342.1 (40.1)	9.76 (4.0)	96.3 (6.7)	40.4
	1988	109	507	24	4.65	360.1 (40.1)	9.66 (3.5)	110.5 (6.0)	27.5
	1989	77	494	7	6.42	382.0 (25.2)	12.1 (3.8)	103.1 (4.0)	44.2
	1990	31	188	4	6.06	417.3 (41.3)	12.6 (4.2)	104.1 (6.3)	3.2
	1991	36	227	15	6.31	386.7 (29.0)	8.81 (3.8)	95.1 (6.1)	0
Dalby	1986	154	1172	13	7.61	334.4 (52.4)	8.21 (4.5)	97.5 (6.9)	20.8
	1987	186	1361	15	7.32	353.9 (39.8)	9.14 (4.2)	94.5 (7.3)	25.3
	1988	173	1165	27	6.73	357.7 (44.5)	9.09 (3.7)	112.1 (7.2)	18.5
	1989	73	464	14	6.36	413.4 (39.3)	13.4 (6.3)	104.9 (7.7)	11.0
	1990	40	266	6	6.65	410.0 (46.5)	10.7 (6.3)	100.1 (10.3)	2.5
	1991	33	248	4	7.52	411.2 (28.9)	11.5 (5.0)	102.3 (10.5)	24.2
Warwick	1986	185	505	92	2.73	311.1 (67.9)	9.37 (4.2)	95.7 (9.3)	NR
	1987	123	481	39	3.91	309.6 (47.0)	8.24 (3.8)	96.3 (8.5)	NR
	1988	111	302	64	2.72	327.1 (65.9)	9.66 (3.6)	107.6 (12.9)	NR
	1989	25	64	12	2.56	368.3 (57.4)	12.0 (3.7)	98.1 (6.8)	NR
	1990	20	46	14	2.30	381.3 (57.4)	11.7 (5.6)	91.3 (12.9)	NR
	1991	40	107	18	2.68	377.5 (58.9)	9.70 (4.1)	89.9 (12.6)	NR
Rockhampton	1986	106	939	10	8.86	397.3 (28.9)	15.8 (1.6)	94.9 (7.5)	NR
	1987	62	571	7	9.21	396.1 (31.2)	13.0 (3.2)	90.9 (9.2)	NR
	1988	97	852	1	8.78	392.2 (40.7)	13.0 (2.4)	102.2 (6.9)	NR
	1989	43	298	4	6.93	411.2 (23.3)	13.4 (2.7)	104.2 (6.8)	NR
	1990	97	495	21	5.10	408.8 (19.2)	13.1 (2.0)	98.0 (7.0)	NR
	1991	86	679	10	7.40	404.7 (44.1)	11.6 (2.8)	97.3 (8.9)	NR

NR indicates that none were recorded.
 Figures in brackets are standard deviations.

Appendix Table 4

Individual lot data for lots sold during 4 weeks in October, 1986 to 1991, as reported by the QLMRS: summary statistics for Steers

Saleyard	Year	Number of lots	Number of head	Number of single lots	Average lot size	Average weight (kg)	Average fat cover (mm)	Price paid for lot (¢/kg)	Proportion Grainfed
Brisbane	1986	593	3564	134	6.01	474.3 (75.6)	11.2 (4.1)	115.9 (7.3)	51.1
	1987	148	883	28	5.97	436.1 (71.7)	10.7 (3.9)	107.0 (5.8)	53.4
	1988	108	500	29	4.63	470.2 (75.1)	11.9 (4.7)	118.9 (5.6)	44.4
	1989	98	592	22	6.04	496.3 (55.6)	11.6 (3.9)	114.0 (5.6)	18.4
	1990	77	548	19	7.11	530.9 (48.4)	12.3 (5.0)	113.9 (6.4)	12.3
	1991	-	-	-	-	-	-	-	-
Toowoomba Monday	1986	968	5502	177	5.68	458.3 (87.9)	11.3 (3.8)	114.8 (9.0)	15.8
	1987	515	4299	33	8.35	439.8 (84.2)	11.6 (3.9)	111.3 (6.4)	25.6
	1988	508	3456	72	6.80	443.1 (80.7)	11.3 (4.0)	120.6 (6.3)	20.1
	1989	291	1792	38	6.16	507.9 (71.6)	13.8 (4.5)	116.6 (5.0)	6.9
	1990	335	2156	42	6.44	540.1 (68.8)	15.0 (4.4)	117.8 (5.9)	6.0
	1991	341	2256	61	6.62	495.8 (66.5)	11.2 (5.1)	116.4 (10.9)	11.1
Toowoomba Tuesday	1986	604	3399	143	5.63	449.8 (92.3)	11.3 (4.1)	114.0 (9.4)	17.1
	1987	372	3422	25	9.20	438.7 (84.7)	11.6 (4.1)	109.8 (7.2)	27.7
	1988	435	2816	74	6.47	434.7 (74.1)	11.6 (3.8)	119.9 (5.7)	19.8
	1989	255	1770	39	6.94	511.0 (65.6)	14.7 (4.3)	117.1 (4.9)	2.7
	1990	187	1099	41	5.88	528.2 (81.6)	14.7 (4.9)	118.9 (5.9)	0.5
	1991	239	1448	52	6.06	501.4 (67.5)	12.8 (4.7)	117.1 (9.8)	14.6
Toowoomba Wednesday	1986	464	3150	53	6.79	456.9 (89.3)	11.3 (4.1)	115.7 (9.8)	36.6
	1987	391	3467	20	8.87	440.5 (78.0)	11.8 (4.2)	110.4 (5.8)	33.5
	1988	391	2406	44	6.15	448.6 (76.0)	11.6 (3.9)	118.6 (5.5)	22.8
	1989	237	1517	31	6.40	506.4 (72.0)	15.3 (5.2)	116.4 (4.7)	3.8
	1990	229	1147	28	6.32	530.9 (73.3)	15.3 (6.6)	115.0 (8.2)	1.3
	1991	147	947	16	6.44	501.4 (68.1)	12.4 (4.5)	119.0 (9.8)	15.0
Dalby	1986	738	5439	67	7.37	467.6 (92.0)	12.4 (5.5)	116.2 (9.1)	19.5
	1987	474	3845	19	8.11	443.7 (84.3)	11.4 (5.3)	108.7 (6.6)	24.5
	1988	527	4222	50	8.01	445.6 (81.8)	11.2 (5.0)	119.7 (5.6)	17.8
	1989	311	2481	10	7.98	533.2 (74.5)	15.8 (4.2)	117.5 (7.1)	14.1
	1990	343	2404	26	7.01	542.1 (82.9)	15.5 (5.9)	117.4 (6.3)	6.8
	1991	353	2737	25	7.51	512.8 (67.8)	13.3 (4.0)	120.8 (9.4)	24.1
Warwick	1986	653	1974	273	3.02	404.6 (103.8)	10.9 (4.4)	109.3 (10.3)	NR
	1987	432	1610	158	3.73	421.3 (103.6)	10.1 (3.9)	108.9 (7.5)	NR
	1988	320	987	141	3.08	427.6 (93.9)	11.0 (4.3)	116.9 (8.5)	NR
	1989	112	419	45	3.74	510.2 (91.1)	14.5 (4.5)	104.4 (17.8)	NR
	1990	175	445	88	2.54	492.6 (101.4)	14.3 (4.2)	112.0 (5.0)	NR
	1991	142	351	61	2.47	462.1 (87.6)	10.9 (4.9)	104.4 (17.8)	NR
Rockhampton	1986	316	3631	3	11.49	524.4 (71.8)	17.1 (2.5)	110.5 (14.3)	NR
	1987	134	1817	0	13.56	500.7 (75.5)	14.0 (3.8)	104.4 (12.1)	NR
	1988	147	1514	5	10.30	463.4 (82.4)	13.7 (3.0)	112.8 (16.5)	NR
	1989	114	1335	4	11.71	493.2 (74.8)	13.8 (2.5)	112.8 (3.0)	NR
	1990	151	1292	14	8.56	492.4 (55.7)	12.9 (2.5)	108.8 (5.4)	NR
	1991	142	1141	12	8.04	510.1 (69.7)	13.1 (3.2)	112.9 (8.6)	NR

NR indicates that none were recorded.
 Figures in brackets are standard deviations.