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The Accuracy of Market Reporters under Liveweight Selling Conditions ‡

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A series of trials was conducted to test the accuracy of livestock market reporters under liveweight selling conditions in Victoria using a range of cattle types. The performance of the market reporters in carcass weight and fat cover estimation was poorer for cows than for bullocks, while the accuracy of the estimates for bullocks sold under liveweight was similar to that reported earlier for young cattle sold on a per head basis.

Introduction

In an earlier paper, Naughtin (1980) examined the accuracy of market reporters employed by the Livestock Market Reporting Service (L.M.R.S.) in Victoria. The reporters' accuracy was evaluated using a group of young cattle in the per head auction situation where liveweight was not known at (or after) the time of sale. The mean percentage errors for pens of cattle were approximately 3 per cent and 16 per cent for carcass weight and fat cover estimation respectively.

In this paper the accuracy of the market reporters was examined under liveweight selling conditions in Victoria where liveweight is known at the time of sale. The results are reported here of a series of trials conducted during March–June 1981, in which the reporters' estimates of carcass weight and fat cover for pens of bullocks[1] and cows sold by liveweight auction at Newmarket are compared with the actual measurements taken after slaughter. The objective of the analysis was to:

(i) establish the accuracy of market reporters under liveweight selling conditions;

(ii) test the accuracy of market reporters for different sexes of mature cattle under liveweight selling conditions.

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[1] The term bullock is used to cover all castrated male cattle in these trials in the interests of brevity. Cattle within the carcass weight range 250–300 kg would be classified as heavy steers by the L.M.R.S. Carcass weights are shown in Table 1.

Methodology

Liveweight selling at Newmarket is conducted with only a one hour curfew requirement and with the liveweight information displayed on the pen. When cattle are sold on a liveweight basis the market reporters know the liveweight of the pen of cattle and are required to estimate the average dressing percentage and fat cover. They also record the age/sex class and price in cents per kilogram liveweight. A computer programme is used to calculate estimated carcass weight, the equivalent price in dollars per head, and the estimated price in cents per kilogram carcass weight, and to assign the pen of animals to an L.M.R.S. class on the basis of the four criteria age, sex, estimated carcass weight, and estimated fat cover.

Selected pens of cattle purchased by four meat companies were tagged and kept as separate groups until carcass measurements had been taken. The number of animals per pen ranged from 6 to 12 for bullocks and 4 to 18 for cows. Two market reporters were used in these trials, but only one market reporter observed each pen and the estimates for individual pens were not subsequently segregated by reporter. In all 16 pens of bullocks and 35 pens of cows were observed over 12 sale days in the March-June 1981 period, with both reporters observing pens of both sexes. The cattle covered a broad range of L.M.R.S. bullock and cow classes, and were mainly Hereford breed, with a few pens of Angus, Friesian, Shorthorn and British breed crosses. Bullocks were purchased on Thursdays and cows on Fridays, and all cattle were slaughtered the following Tuesday.

The carcasses were dressed on a uniform "fats out" basis (kidney knob and channel fat removed). The weighing procedure differed slightly between works, but the reported carcass weight is a cold dry carcass weight derived from hot wet carcass weight less 2.5 per cent. Fat cover was measured at the 12/13 rib position on the hot unquartered carcass by an experienced operator using the Toland needle probe. Anderson and Truscott (1982) suggest this probe may be more accurate than the cut and measure method if used by an experienced operator.

The pregnancy status of cows was recorded, and the stage of pregnancy in days was estimated by weighting the foetus.

The estimates of carcass weight and fat cover were compared to the actual measurements in a similar fashion to Naughtin (1980). However, in these trials the estimated carcass weight is derived from the product of the estimated dressing percentage and the liveweight. Three measures of the accuracy of the estimates were used—the mean error, the mean absolute error, and the mean percentage error. These measures are defined as:

$$\text{Mean Error} = \sum_{i=1}^{n} (y'_i - y_i)/n$$

$$\text{Mean Absolute Error} = \sum_{i=1}^{n} |y'_i - y_i|/n$$

$$\text{Mean Percentage Error} = \sum_{i=1}^{n} |((y'_i - y_i)/y_i)/_*100|/n$$

where

y'_i = estimated carcass weight or fat cover for the i'th pen of animals,
y_i = actual carcass weight or fat cover for the i'th pen of animals,
n = number of pens of animals.

The mean error, mean absolute error and mean percentage error are measures of the bias, consistency, and relative magnitude of the errors respectively.

Carcass Weight Estimation

The estimates and measurements of carcass weight and fat cover for pens of bullocks, together with the range in carcass weight for individual bullocks within a pen, are shown in Table 1. Similarly, the estimates and measurements of carcass weight and fat cover for pens of cows, together with the range in carcass weight for individual cows within a pen, are shown in Table 2.

A striking feature of Tables 1 and 2 is the range of carcass weights for individual animals within a given pen. A range of up to 100 kg in carcass weight between animals within a pen was common, both for bullocks and cows.

The errors in the assessment of average dressing percentage fell within the range of 0–4 percentage points for bullocks and 0–7 percentage points for cows. These errors produced errors in the assessment of carcass weight of up to 20 kg for bullocks and up to 28 kg for cows.

The accuracy of the estimates of carcass weight for bullocks and cows is shown in Table 3. The mean errors of the estimates were -3.9 kg for bullocks and -1.4kg for cows, indicating a small negative bias (underestimation) in the estimates. The mean absolute errors (the average absolute value by which the estimated value differed from the true value) were 8.7 kg for bullocks and 9.2 kg for cows. The consistency of the errors in estimation as measured by the mean absolute error was similar for bullocks and cows, but as the mean carcass weight was lower for cows the relative magnitude of the errors was higher for cows. The mean percentage error for bullocks was 2.8 per cent and for cows was 4.2 per cent.

The information on pregnancy status in Table 2 provides some indication of the nature of the errors in carcass weight estimation for cows. The largest errors in the estimation of dressing percentage and carcass weight appear to have occurred when the reporters incorrectly assessed cows as non-pregnant when they were heavily pregnant, or when the cows were assessed as heavily pregnant when they were non-pregnant. There were also a number of cases where very accurate estimates of carcass weight were made with non-pregnant and heavily pregnant cows. The reporters appear to have had difficulty in assessing the pregnancy status of some pens of cows, and the errors of this type correspond with the larger errors in assessing dressing percentage and carcass weight. It is concluded that errors in the assessment of pregnancy status are an important factor in the lower level of performance in carcass weight estimation for cows than for other classes of stock.

The difficulty of assessing pregnancy status is compounded by the fact that approximately two thirds of the cow pens in these trials contained a mixture of pregnant and non-pregnant cows. There is no obvious reason to expect that the sample of pens chosen for these trials was biased in this respect.

Table 1: *Estimates and Measurements of Carcass Weight and Fat Cover for Bullocks*

Average Liveweight of pen	Estimates				Measurements					
	Dressing Percentage	Carcass Weight	Fat Cover	L.M.R.S. Fat Category	Dressing Percentage	Carcass Weight	Fat Cover	L.M.R.S. Fat Category	Range in Carcass Weight	Range in Fat Cover
(kg)	(%)	(kg)	(mm)		(%)	(kg)	(mm)		(kg)	(mm)
562	54	304	14	4	53.8	302	12	4	267–352	8–18
504	53	267	12	3	56.3	284	10	3	274–302	5–13
525	52	274	12	3	53.7	282	9	3	224–293	5–12
503	53	267	10	3	52.4	264	9	3	244–283	4–11
559	52	291	10	3	55.1	308	11	3	279–358	8–15
549	53	291	14	4	52.3	287	12	3	241–303	7–15
595	54	322	13	4	50.7	302	14	4	252–397	7–32
459	53	243	10	3	54.9	252	8	2	209–293	6–13
594	54	321	16	4	56.4	335	15	4	314–352	12–20
589	52	306	14	4	55.3	326	9	3	293–364	7–13
549	53	291	10	3	54.3	298	13	4	283–302	9–16
533	54	288	10	3	52.2	278	11	3	249–312	9–15
544	53	288	10	3	54.4	296	11	3	260–337	10–14
592	55	326	13	4	55.1	326	15	4	292–348	12–17
587	53	311	14	4	53.2	312	12	3	270–340	10–15
536	54	289	14	4	53.9	289	10	3	226–324	8–13

Table 2: Estimates and Measurements of Carcass Weight and Fat Cover for Cows

Average Liveweight of pen	Estimates				Measurements							
	Dressing Percentage	Carcass Weight	Fat Cover	L.M.R.S. Fat Category	Dressing Percentage	Carcass Weight	Fat Cover	L.M.R.S. Fat Category	Range in Carcass Weight	Range in Fat Cover	Proportion of Cows Pregnant	Stage of Pregnancy
(kg)	(%)	(kg)	(mm)		(%)	(kg)	(mm)		(kg)	(mm)	(%)	(days)
459	51	234	13	5	48.1	221	15	5	201–252	8–31	55	241
387	44	169	6	3	41.3	160	6	3	134–184	4–9	50	179
568	51	290	13	4	46.1	262	22	5	242–277	12–20	50	25
473	50	237	13	5	51.2	242	19	5	222–268	15–21	16	267
502	48	241	10	4	43.6	219	11	4	196–291	7–15	70	247
394	44	173	5	3	37.6	148	5	3	137–156	1–7	100	260
396	44	174	5	3	44.4	176	4	2	152–196	1–8	0	0
460	47	216	12	5	46.7	215	11	4	198–245	11–12	50	221
453	49	222	14	5	51.0	231	12	5	203–245	7–16	40	143
500	50	250	13	5	53.2	266	15	4	243–287	10–20	0	0
440	44	194	5	3	48.9	215	4	2	197–236	2–7	0	0
443	47	208	10	4	45.6	202	7	3	186–244	4–12	100	195
538	50	269	13	4	48.0	258	14	4	232–299	12–17	100	186
430	40	172	3	2	39.5	170	4	2	130–224	0–10	50	170
492	52	256	13	4	52.6	259	13	4	211–300	7–18	0	0
543	49	266	13	4	50.8	276	16	4	231–306	12–23	16	19
434	46	200	10	4	45.1	196	5	3	158–216	1–11	60	79

Table 2: Estimates and Measurements of Carcass Weight and Fat Cover for Cows—continued

Average Liveweight of pen	Estimates				Measurements							
	Dressing Percentage	Carcass Weight	Fat Cover	L.M.R.S. Fat Category	Dressing Percentage	Carcass Weight	Fat Cover	L.M.R.S. Fat Category	Range in Carcass Weight	Range in Fat Cover	Proportion of Cows Pregnant	Stage of Pregnancy
(kg)	(%)	(kg)	(mm)		(%)	(kg)	(mm)		(kg)	(mm)	(%)	(days)
557	42	234	6	3	44.5	248	4	2	215–277	1–8	80	169
366	40	146	5	3	40.7	149	2	2	114–176	0–4	58	146
507	47	238	10	4	49.7	252	10	4	205–280	6–15	18	215
447	43	192	6	3	43.6	195	6	3	160–251	3–10	70	179
589	52	306	16	4	50.8	299	15	4	251–358	11–20	18	185
443	43	190	6	3	41.3	183	3	2	165–215	2–5	100	20
392	43	169	4	2	43.1	169	2	2	155–183	1–4	0	0
393	43	169	5	3	43.3	170	2	2	152–188	1–4	40	182
347	41	142	2	2	41.2	143	1	2	134–162	1–2	100	232
463	45	208	7	3	44.7	207	6	3	188–227	2–10	83	232
480	45	216	7	3	47.3	227	11	4	207–251	7–15	40	257
534	49	262	16	4	49.8	266	12	4	220–325	4–12	70	196
422	41	173	3	2	43.6	184	2	2	158–205	1–5	55	149
397	44	175	6	3	52.1	207	7	3	169–240	4–12	0	0
343	44	151	7	4	48.7	167	3	2	163–168	1–5	0	0
491	43	211	5	3	43.8	215	3	2	186–227	2–5	100	229
371	41	152	2	2	40.7	151	2	2	131–180	0–5	75	184
569	46	262	10	4	46.7	266	10	4	215–313	5–15	100	149

Table 3: The Accuracy of Estimates of Carcass Weight and Fat Cover

Cattle Type	Carcass Weight				Fat Cover			
	Mean Carcass Weight	Mean error of estimate	Mean absolute error	Mean percentage error	Mean fat cover	Mean error of estimate	Mean absolute error	Mean percentage error
	(kg)	(kg)	(kg)	(%)	(mm)	(mm)	(mm)	(%)
Bullocks	296	−3.9	8.7	2.8	11.3	0.9	2.1	16.8
Cows	214	−1.4	9.2	4.2	8.1	0.3	2.0	39.6

Fat Cover Estimation

The estimates and measurements of millimetres of fat cover and L.M.R.S. fat class for bullocks and cows are shown in Tables 1 and 2 respectively. The errors in assessment of fat cover were within the range of 0–5 mm for bullocks and 0–8 mm for cows, with errors of around 2 mm being common. Approximately 60 per cent of pens of both bullocks and cows were correctly assessed for L.M.R.S. fat class, and the remainder placed in an adjacent class, with the single exception of one pen of cows placed two fat classes higher than its true class.

The accuracy of the estimates of fat cover estimation for bullocks and cows is shown in Table 3. The mean errors of the estimates were 0.9 mm for bullocks and 0.3 mm for cows, indicating a small positive bias. The mean absolute errors were 2.1 mm for bullocks and 2.0 mm for cows. The consistency of the errors in estimation as measured by the mean absolute error was similar for bullocks and cows, but as the mean fat cover was lower for cows, the relative magnitude of the errors was higher for cows. The mean percentage error for bullocks was 16.8 per cent and for cows was 39.6 per cent.

There does not appear to be any relationship between pregnancy status and errors in the estimation of fat cover.

Discussion

The accuracy of the estimates of carcass weight and fat cover for bullocks sold under liveweight selling was very similar to that reported earlier for young cattle under per head auction selling. The two trials were conducted under broadly similar conditions, but the results are not directly comparable since the trials occurred at different periods of time, using different animal types, and only two reporters were used in the second trial as against four in the first trial. The mean absolute error for weight estimation for bullocks of 8.7 kg is small in both absolute and percentage terms, and small in relation to the L.M.R.S. weight class intervals. The mean absolute error for fat cover estimation of 2.1 mm for bullocks was not insignificant in relation to fat class intervals of 3-9 mm for bullocks, and about 40 per cent of the estimates of fat class placed the pen concerned in an adjacent fat class rather than the correct fat class.

The performance of the market reporters in carcass weight and fat cover estimation for cows was inferior to that for bullocks. The mean absolute errors were of a similar magnitude, but in relative terms the errors were higher for cows than for bullocks. The results support the widely held view in the meat trade that the estimation of carcass weight for cows is more difficult than that for other classes of cattle. It is clear from the dressing percentage figures in Tables 1 and 2 that the dressing percentages for cows in these trials is much more variable than for bullocks. It is also probable that as a general phenomenon the dressing percentages of cows presented at livestock auctions will be more variable than for other classes of cattle. Pregnancy is an important factor in the greater variability of dressing percentage for cows, but the greater variability of fat cover arising from management factors is also important.

The results shed some light on the reasons for the resistance of livestock buyers to liveweight selling for cows. There is a greater probability of significant errors in weight estimation for cows when standard or routine dressing percentage estimates are used than for other classes of cattle. This would be

particularly so if as suggested earlier the errors arose from an incorrect assessment of pregnancy status as well as stage of pregnancy. Livestock buyers may not be indifferent to the method of auction even if their skills in the estimation of carcass weight are similar with both liveweight and per head auctions. Liveweight selling provides a greater degree of public information about the nature of the cattle offered for sale, so that the management of meat works may be able to attribute more precisely failures to meet buying limits or quality constraints to estimation errors.

Speculation on Further Research on Liveweight Selling

The similarity of the results on the accuracy of market reporters reported here for bullocks sold under liveweight selling and in Naughtin (1980) for young cattle sold per head suggests an interesting hypothesis for further research—are market reporters and livestock buyers any more accurate in carcass weight estimation under liveweight selling conditions than under per head selling conditions?; or to put it another way, has there been any improvement in pricing efficiency at livestock auctions as a result of the introduction of liveweight selling facilities?

The theoretical argument in favour of liveweight selling is that there is an improvement in pricing efficiency. Thus the P.J.T. (1978, p. 27) claimed that: "Common sense would suggest that animals should be weighed before sale in order that the auction can take place in circumstances where one major unknown, the liveweight of the cattle, is objectively known. (The other major unknown is dressing percentage.) The seller might thereby be expected to obtain a price more accurately reflecting the value of the animals he offers for sale."

A more prosaic expression of a similar notion is that the introduction of liveweight selling was necessary to re-furbish the image of the auction system with the rural community after the beef slump of the mid 1970's. Liveweight selling has continued to expand as saleyards compete for declining cattle supplies, notwithstanding the lack of evidence on the benefits of liveweight selling noted by the B.A.E. (1981).

The postulated improvement in pricing efficiency with liveweight selling depends on an untested hypothesis about the behaviour of cattle buyers—namely that buyers at per head auctions first estimate the liveweight of a pen of animals and then estimate a dressing percentage to calculate an estimated carcass weight. Given this hypothesis the provision of liveweight information will eliminate errors in liveweight estimation, leaving only errors in the estimation of dressing percentage. The hypothesis assumes a high order of skills in mental arithmetic on the part of buyers since, in addition to the above, buying limits in carcass weight prices must be converted back to per head prices, and buyers frequently perform at least one conversion from imperial to metric units. It is little wonder that the arithmetical skills of cattle buyers are legendary.

The realism of this hypothesis is questionable. An alternative hypothesis is that cattle buyers at per head auctions estimate carcass weight directly from an observation of the animals without using formal arithmetical procedures. The mental process may well involve estimates of dressing percentage and even liveweight, and incorporate adjustments for factors such as district of origin, but it would not involve a formal estimation of liveweight and the calculation

of an estimated carcass weight using a dressing percentage. It is our opinion that reporters and buyers use an informal procedure as above to estimate carcass weight in per head sales.

If cattle buyers were to estimate carcass weight directly at per head auctions, then it is not clear that the introduction of liveweight selling will produce an improvement in pricing efficiency. This is because liveweight selling changes the nature of a buyer's task rather than eliminates an intermediate step. With liveweight selling, buyers must bid in liveweight prices and will use dressing percentages to convert liveweight and liveweight price information to carcass weight and carcass price information. However, with per head selling, carcass weight can be estimated directly and buying limits in carcass weight prices can be converted to per head prices, without the need to estimate liveweight. If the estimation of liveweight is not an intermediate step in the determination of values at per head sales, then the introduction of liveweight selling may have had little effect on the accuracy of estimation of carcass weight, and hence on pricing efficiency.

The reasons for the introduction of liveweight selling are complex and have been referred to briefly above. However, insofar as there is an ideological basis for liveweight selling, it is that there is an improvement in pricing efficiency through the more accurate estimation of the yield of saleable meat from a pen of animals and hence value. It remains to be shown that the introduction of liveweight selling has significantly improved the level of pricing efficiency achieved at livestock auctions, whatever other benefits may have been conferred on the various market participants. Indeed, it is likely that the validity of the familiar view, that a significant improvement in the degree of pricing efficiency achieved in the cattle industry will not occur until there is a much more widespread use of carcass pricing methods, remains intact.

References

ANDERSON, S. K. and T. G. TRUSCOTT (1982), "The accuracy of the Toland probe in measuring fat depth," *Proceedings of the Australian Society of Animal Production* 14, 607.

BUREAU OF AGRICULTURAL ECONOMICS (1981), *Livestock and Meat Marketing in Australia—An Economic Evaluation*, Bureau of Agricultural Economics, Industry Monograph No. 1, A.G.P.S., Canberra.

NAUGHTIN, J. C. (1980), "The accuracy of market reporters in the estimation of carcass weight and fat cover for cattle", *Review of Marketing and Agricultural Economics* 48 (3), 169–174.

PRICES JUSTIFICATION TRIBUNAL (1978), *Beef Marketing and Processing*, Report by Prices Justification Tribunal, A.G.P.S., Canberra.