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The Cost of Non-Compliance to Beef Market Specifications

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Abstract

Strategic sourcing of cattle that are more likely to meet market specification is a critical challenge for buyers purchasing animals for feedlot finishing. Missing target specifications has the potential to result in a large discount in carcass value. Costs associated with carcass weight and external fat depth that is out of specification impact on both the ability of suppliers to meet customer requirements and levels of productivity or slaughter rates that are nearer to the processor's cost-minimising level of production. This analysis used a subset of Australian beef industry feedlot data from two long-fed feedlots to assess both the costs and causes of carcasses out-of-specification. The economic value associated with products that are out-of-specification can be illustrated by the Taguchi Quadratic Loss Function, carcass specifications, and industry grid prices. At the nominated carcass weight specification (300kg - 400kg) in the short-fed export market, there were 28 per cent outside of specification, while in the long-fed export market (380kg - 450kg), 29 per cent were outside specification. A P8 fat depth specification of 10mm-26mm showed 16 per cent outside of specification in the short-fed market. At the nominated marbling score specification (3+) in the long-fed market, 70 per cent were outside of

specification. These cattle out-of-specification for marbling incurred a loss of $105/head. These results demonstrate that there is a large amount of variation in cattle in Australian beef production systems that has led to a reduction in opportunities for precision management and value-based marketing.

Introduction

For some years now, well-defined carcass specifications have existed for Australian cattle targeted at particular market endpoints. For example, as shown for a very simplified set of specifications in Table 1, cattle targeted at this particular short-fed domestic market should be on feed for around 100 days, should have a hot carcass weight of between 300 and 400 kgs, and should have a P8 fat depth of between 10 and 27 mm. Cattle targeted at this particular long-fed export market have a different range of preferred values for the key quality characteristics. Cattle that have not been fed sufficiently long, or are too light or too heavy, or are too fat or too lean, or are not sufficiently marbled, are “out-of-specification” or “non-compliant”. They will be penalised by the processor through price discounts because they will have to be re-allocated to lower-value markets or it will cost more in processing to fit them into the specified market.

A comprehensive, but dated, summary of various market specifications is available in Allerton (1999), while more recent versions are available from Meat and Livestock Australia (MLA 2004), McKiernan *et al*. (2007) or from individual beef processors. In general, more stringent specifications apply to cattle designed for the higher-valued export markets and for cattle that are targeted at achieving a Meat Standards Australia (MSA) quality grade in the domestic market (MSA 2007).

Table 1: Example feedlot cattle exit specifications (adapted from MLA 2004)

Trait	Short fed specification Specification	Long fed Specification
Days on feed	100	220 +
Hot carcass weight (kg)	300 – 400	380 – 450
Hot P8 fat depth (mm)	10 – 27	10 – 40
Marbling score	NA	3+

Anecdotal evidence suggests that a significant proportion of Australian cattle do not meet the required specifications for their target market. Since approximately the same costs are incurred in managing and feeding animals that do not meet specifications as those that do, a substantial cost is attached to this non-compliance to specification.

Some experimental evidence is available to support this view. For example, Edmondston *et al*. (2006) showed that variation in individual carcass value in northern Australian production systems is significant, with a range of about $210 (as animals from the top and bottom 10 per cent received a $68 profit and a $142 loss, respectively). Similarly, Polkinghorne (2006) estimated the variation present in carcass yield and quality resulted in a difference of $2.50/kg of carcass weight or a net value difference of up to $700 for individual carcasses (when using both yield measurements and the MSA grading model and value differences between grades of $23/kg for ‘‘3 star’’, $39/kg for ‘‘4 star’’ and $50/kg for ‘‘5 star”). McKiernan *et al*. (2007) provided estimates of compliance to a major NSW processor grid for 100-day grain fed steers of different breeds and subjected to different nutritional treatments prior to feedlot entry. Table 4.1.12 from their report is reproduced below as Table 2. Compliance was around 85 per cent for the weight and fat cover criteria, but as low as 20 per cent when the much more stringent fat colour criterion was included. There was a $0.10/kg carcass weight difference in price across these animals which translated into a difference of $146 in carcass value. For the much tighter “preferred” specifications by this processor, compliance rates were much lower.

Using data obtained from the US National Beef Quality Audit, Savell (2001) and Schroeder and Kovanda (2003) estimated that non-compliance resulted in “lost opportunity" per steer and heifer slaughtered of $US279.82 in the year 1991. In Table 3, Savell (2001) partitioned these losses into four causes: waste (excessive fat and incorrect bone to muscle ratio), taste (insufficient marbling, age and gender including castrates and calves), management (pathology such as livers and other infections, bruises as well as dark cutters) and, finally, weight (animals under or over weight specifications).

The existing Australian estimates of the cost of compliance are based on relatively small numbers of experimental cattle and mandatory reporting of data as in the US National Beef Quality Audit is not required in Australia. However, the authors have been given access to two large industry data sets composed of more than 40,000 carcasses. We use this industry data to provide new estimates of the cost of non-compliance with typical Australian beef market specifications.

Table 2: Comparison of pre-feedlot growth treatments over all breed types using adjusted mean feedlot entry weights for percentage compliance to standard and preferred grid specifications for weight and P8 separately and combined, for fat colour and for all three traits combined (from McKiernan *et al*. 2007)

	Slow growth	Fast growth
% within grid weight specififcation	87.6	91.3
% within grid P8 specification	96.1	94.6
% within grid weight and P8 specification	84.6	86.6
% within grid fat colour specification	25.5	32.1
% meeting all grid specification	20.5	29.8
% within preferred weight specification	20.8	55.5
% within preferred P8 specification	59.8	60.5
% within preferred weight and P8 specification	26.6	34.4
% within grid fat colour specification	25.5	32.1
% meeting preferred specification	3.4	11.7

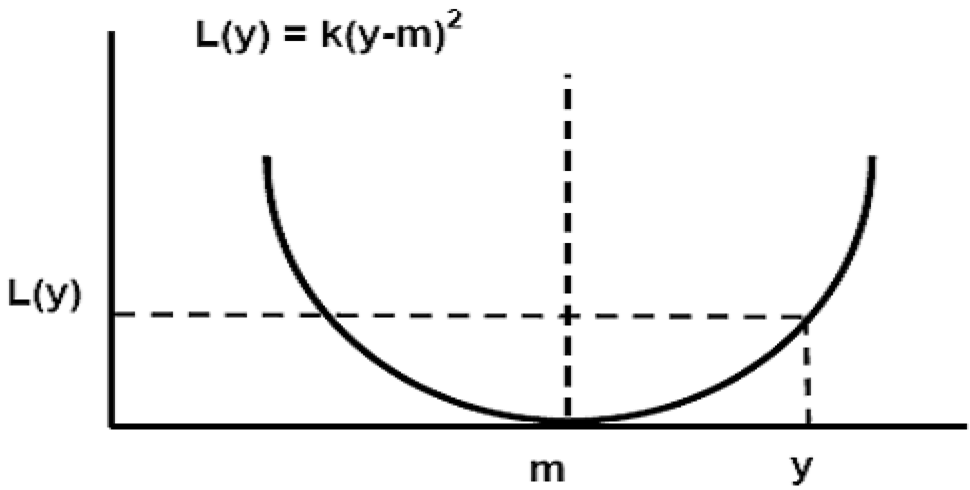
Table 3. The estimated "lost opportunity" per individual steer and heifer slaughtered in the US in the year 1991 (from Savell 2001)

Cause	Estimated loss (US$)	Estimated loss (%)
Waste (fat and muscle to bone ratio)	219	78
Taste (marbling and age)	29	10
Management (bruising and dark cutters)	27	10
Weight (too light or heavy)	5	2
Total loss/animal	280	

Materials and Methods

Risks in meat production are substantial (Hayes *et al*. 1998), the most common risk arising from product diversification. This has resulted in producers becoming non-specialists (Hayes *et al*. 1998). The cost of missing specifications when trading in variable markets causes problems in quality, cost and delivery of products (Patil *et al*. 2002). Economic values associated with products that are out-of-specification can be illustrated by the Taguchi Quadratic Loss Function, which fixes an economic value on quality loss (Patil *et al*. 2002). Figure 1 indicates the quality loss in dollars L(y) due to product variation; m is the target value of the quality characteristic and k is an economic quality loss constant.

Figure 1. Taguchi quadratic quality loss function



The Taguchi loss function was applied to the Australian beef industry using a combination of carcass specifications (MLA 2004), industry grid prices (D. Llewelyn, pers. comm., 12 February 2007; T. Suzuki, pers. comm., 12 February 2007) and two large Australian processor datasets indicated as dataset Group A and dataset Group B. Both of the processor groups operate in the long-fed and short-fed export markets. The target value used for the Taguchi loss function was the first carcass trait value within the specification window defined by MLA (2004). The particular carcass specifications used are shown in Table 4 for short-fed and long-fed cattle and indicate the specifications for hot standard carcass weight (kg) (HSCW), hot P8 fat depth (mm) (HP8), and AUSMEAT marble score. Table 4 also indicates the pricing structure from an industry grid on an "over the hook" basis. The combined Group A and Group B dataset included approximately 20,000 short-fed animals (108±5 days on feed) and 20,000 long-fed animals (220 ± 3 days on feed).

Table 4. Over the hook beef cattle grid prices for the short-fed and long-fed markets

Trait	Trait specification, indicator price and price differential											
Short-fed export market												
Hot carcass weight (kg)A	250	270	290	310	330	350	370	390	450	470	490	510
Indicator price ($)	2.90	3.10	3.20	3.30	3.50	3.50	3.50	3.35	3.10	3.00	2.90	2.80
Hot P8 fat depth (mm)A	0	5	10	15	20	25	30	35	40	45	50	55
Indicator price ($)	3.45	3.45	3.50	3.50	3.50	3.45	3.45	3.40	3.35	3.30	3.25	3.20
Long-fed export market												
Hot carcass weight (kg)A	370	380	390	400	410	420	430	440	450	460	470	480
Indicator price ($)	2.90	3.10	3.20	3.35	3.50	3.50	3.50	3.35	3.10	3.00	2.90	2.80
AUSMEAT marble scoreB	0	1	2	3	4	5	6					
Indicator price ($)	3.50	3.50	3.50	4.00	4.50	4.50	5.50					

Source: D. Llewelyn, pers. comm., 12 February 2007; T. Suzuki, pers. comm., 12 February 2007

The Taguchi loss function was used to calculate the economic cost of animals that were outside of specification when compared to the minimum movement required (for the trait of interest) to the first instance within specification. In addition, the out-of-specification costs for individual animals were analysed using generalised linear models. These models included dependent variables for hot carcass weight and hot P8 fat depth (short-fed export market) and hot carcass weight and marble score (long-fed export market).

Results

The distribution of HSCW for short-fed animals in the two industry datasets (Figure 2) ranges between 260kg - 500kg. At the nominated HSCW specification (300kg - 400kg) there are 72 per cent of the industry animals within specification and 28 per cent outside of specification. Figure 3 shows that, in line with the Taguchi loss function, as carcasses move further out of specification the cost per animal increases. The loss for an out-of-specification carcass was very small ($0.25) at 410kg HSCW; however, when carcass weights increased to 500kg the loss per animal was around $60.

Figure 2. Distribution of hot standard carcass weight (kg) for the short-fed market (market specification is indicated by the horizontal line)

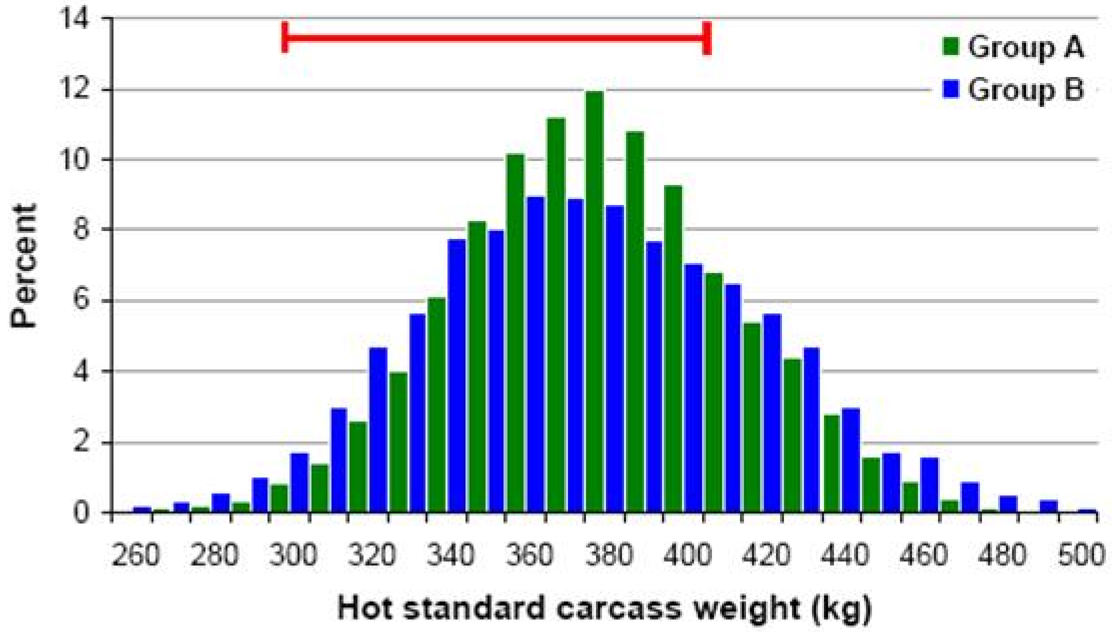
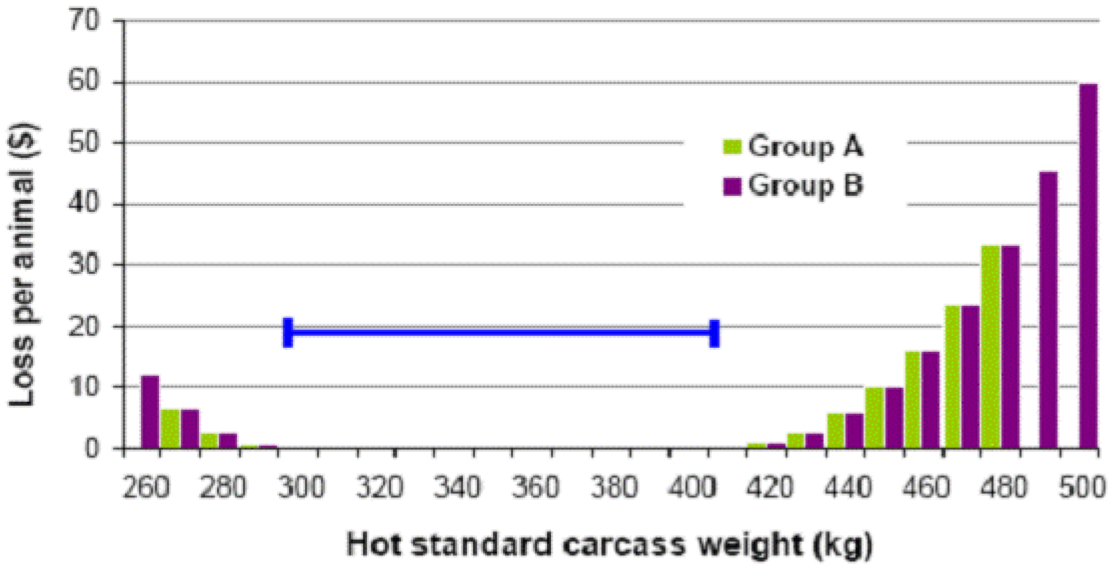


Figure 3. The cost ($/head) for out-of-specification hot standard carcass weight (kg) within a short-fed market (market specification is indicated by the horizontal line)



The distribution of HP8 for short-fed animals in the industry datasets, Figure 4, ranges between 2mm – 46mm. At the nominated HP8 specification (10mm-26mm) there are 84 per cent of the industry animals within specification and 16 per cent outside of specification. Figure 5 shows that the loss for out-of-specification HP8 fat depth (calculated at a carcass weight of 350kg – the centre of the preferred weight range) was much greater in the fatter animals. The loss per animal for 28mm HP8 was only $16.55; however, this loss increased to around $80.00 at 46mm HP8.

Figure 4. Distribution of Hot P8 fat depth (mm) for the short-fed market (market specification is indicated by the horizontal line)

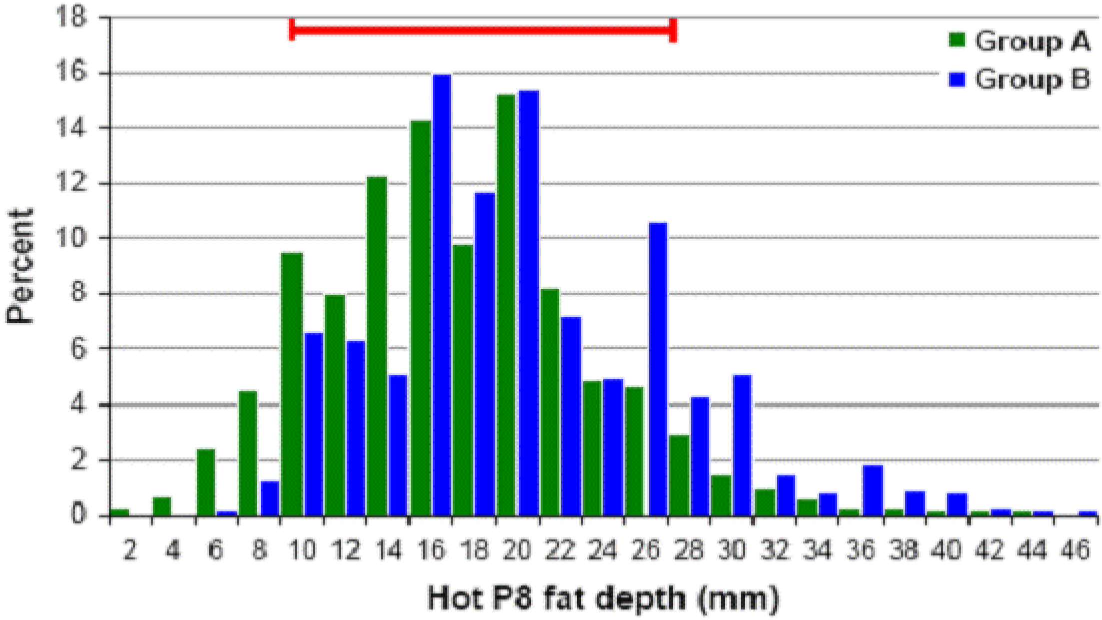
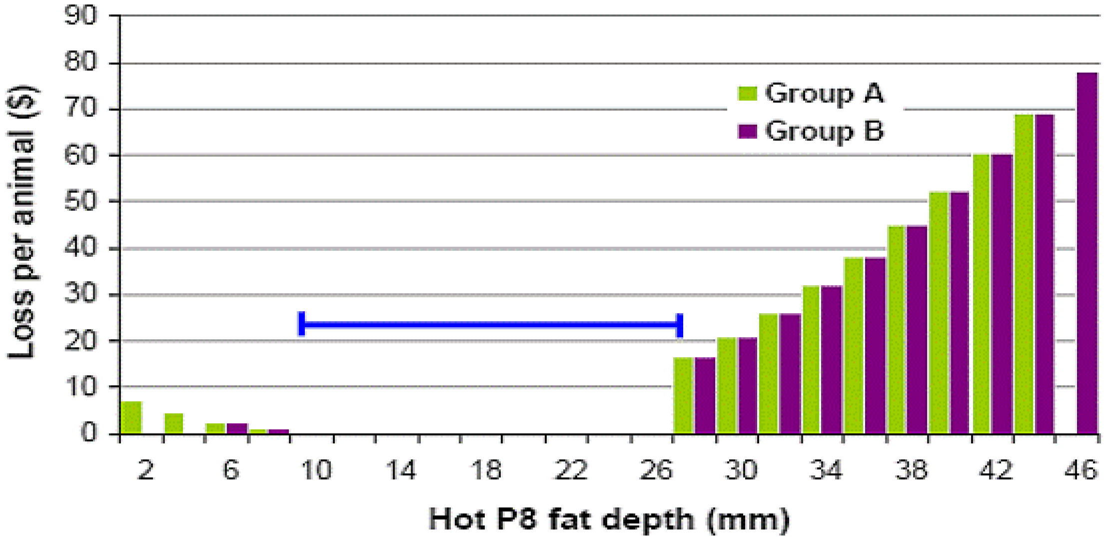


Figure 5. The cost ($/head) for out-of-specification hot P8 fat depth (mm) for the short-fed market (market specification is indicated by the horizontal line)



The distribution of HSCW for long-fed animals in the industry datasets (Figure 6) ranges between 340kg – 540kg. At the nominated HSCW specification (380kg - 450kg) there are 71 per cent of these animals within specification to obtain the maximum price and 29 per cent outside this specification. Figure 7 shows that the loss for out-of-specification HSCW was greater in the heavier animals. The loss per animal with a heavy HSCW (540kg) was $146.00.

Figure 6. Distribution of hot standard carcass weight (kg) for the long-fed market (market specification is indicated by the horizontal line)

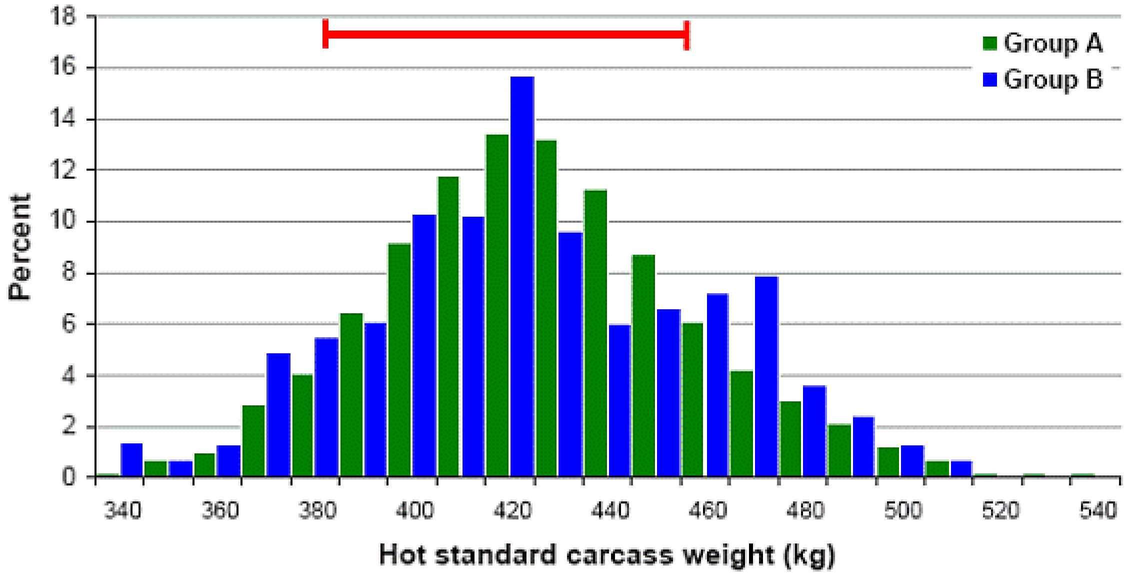
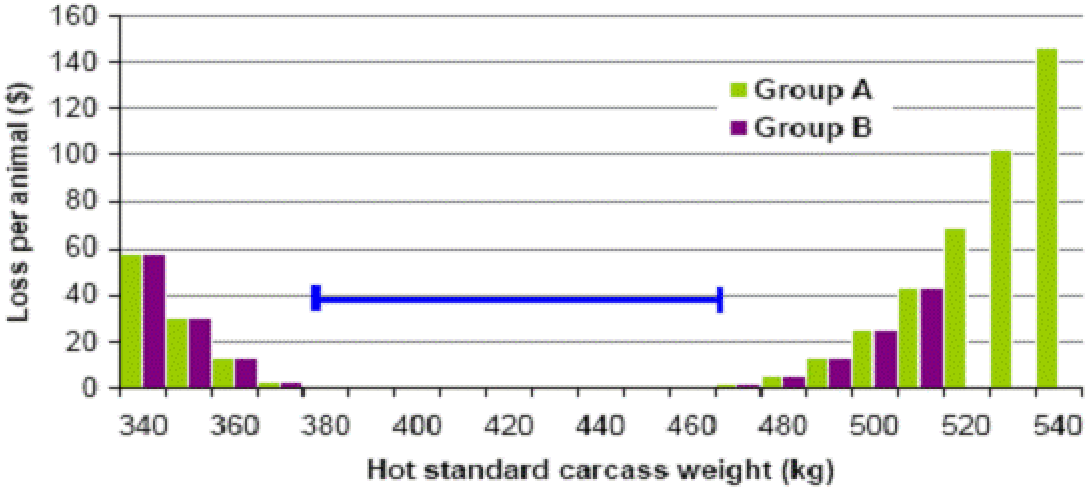
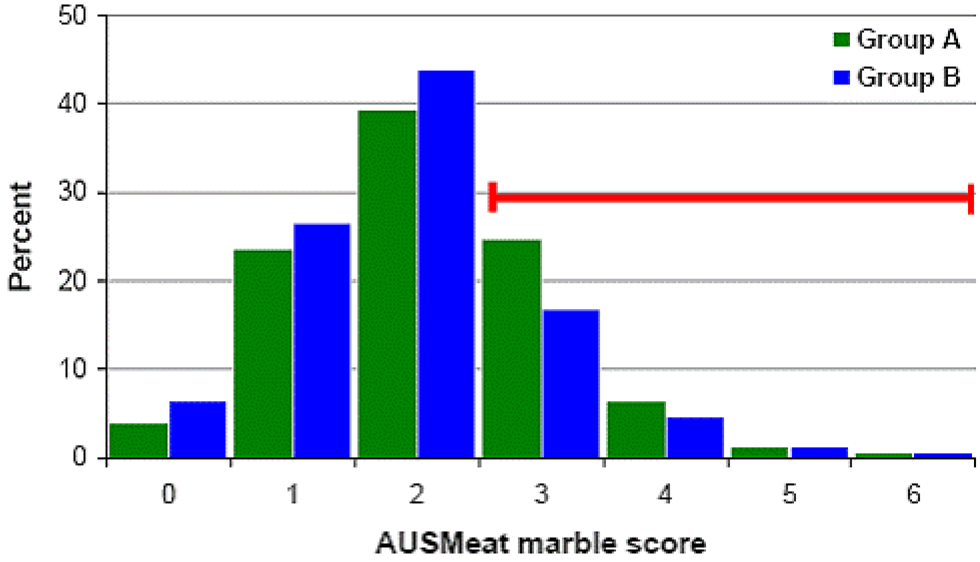


Figure 7. The cost ($/head) for out-of-specification hot standard carcass weight (kg) for the long-fed market (market specification is indicated by the horizontal line)



The distribution of marbling for long-fed animals in the industry datasets (Figure 8) ranges between 0-6. At the nominated AUSMeat marble score specification (3+) there are only 30 per cent of the animals within specification while 70 per cent are outside of specification. Using the grid pricing structure from Table 4 and a long-fed average carcass weight of 420kg, it can be calculated that 70 per cent of these industry cattle that are destined for the long-fed market incurred a loss of $105/head due to marble scores that are out-of-specification.

Figure 8. Distribution of AUSMeat marble scores for the long-fed market (market specification is indicated by the horizontal line)



Further calculations using the short-fed cattle data (n~20,000) show that the cost incurred for delivery of out-of-specification for HSCW totals more than $31,000 or an average per animal of $5.50 for the 28 per cent that do not comply with the HSCW specification. However, there are also differences across the two data sets. The mean loss for Group A cattle was $4.25/head or $12,300 in total, while the mean loss for Group B cattle was $6.00/head or $18,000 in total. This is shown in Figure 3, where there are heavier cattle in the Group B data. Similarly, total costs for non-compliance to the HP8 specification in the short-fed data were around $64,000 or $17.50 per animal for the 16 per cent out of specification, calculated at an average carcass weight of 350kg. As shown in Figure 5, Group A incurred lower costs for carcasses out of specification than Group B. The mean for Group A was $13.35/head or a total loss of about $20,000, compared to the Group B mean of $25.50/head or a total loss of $44,600.

Long-fed animals in these data (n~20,000) incurred an out-of-specification cost totaling $62,800 or an average of $11.00 per animal for the 29 per cent that did not meet the HSCW specification. In this case there was little difference across the two component data sets in terms of cost per animal (Figure 7). The mean cost for Group A non-compliant animals was $11.50/head for a total cost of $28,000, while the mean cost for Group B non-compliant animals was $9.70/head or $32,000 in total.

The largest cost in the long-fed data set was for the 70 per cent of animals that were out of specification for marble score: the total estimated cost was around $1,470,000 or an average per head cost of $105 calculated at an average carcass weight of 420kg. Again, the losses were very similar by Group: Group A totaled $704,000 and Group B $756,000. It should be noted that these loss estimates are based on an average carcass weight; however, more realistically, the fatter carcasses would also be heavier.

Furthermore, the calculated losses for out-of-specification are additive. For the average short-fed animal out of specification for both weight and fat score, the loss would be $23, while for the average long-fed animal out of specification for both weight and marble score, the loss would be $116. Note also that these calculations do not incorporate any differences in variable costs (i.e. feeding) or fixed costs between compliant and non-compliant animals.

A statistical analysis was undertaken of these data to determine the factors contributing to out-of-specification costs. The analysis showed (Table 5) that out-of-specification costs were primarily due to pre-feedlot factors. Induction weight (kg/live) ($P<0.001$) and producer effects ($P<0.001$) contributed significantly to out-of-specification costs in both the short- and long- fed export markets. Within the short-fed export market there was an additional effect of Hormonal Growth Promotant (HGP) implant ($P<0.01$) on HP8. Out-of-specification cost for HSCW in the long-fed export market was effected by days on feed ($P<0.01$), and marbling compliance cost was significantly effected by both days on feed ($P<0.001$) and implant ($P<0.01$). Variables denoting breed, illness, season and year were not significant. The variable induction allocation (market allocation decision at induction to short-, medium- or long-fed markets by feedlot managers and staff), while not statistically significant in this analysis, did indicate feedlot managers' initial market allocation decisions, when adhered to, decreased out-of-specification costs, but this effect was small.

Discussion and Implications

The analysis of industry data in this paper suggests that the costs of non-compliance to Australian beef market specifications were substantial. Out-of-specification costs for hot carcass weight and external fat depth (hot P8) in the short-fed export market averaged $5.50/head and $17.50/head, but may be as high as $60/head and $80/head, respectively. The costs for out-of-specification in the long-fed export market for carcass weight are an average of $11.00/head, but could be up to $145/head, and for marble score are an average loss of $105/head for marble scores below the required AUSMeat marble score 3. Thus, for the 40,000 animals in these two datasets, the minimum total cost of non-compliance was around $1,628,000, or around $40/head across all animals.

Table 5. Factors affecting out-of-specification costs for the short-fed and long-fed export markets (n=20,000 for each subsample)

Market	Short fed	Short fed	Long fed	Long fed
Effect	HSCW	HP8	HSCW	Marble score
Induction weight (kg/live)	***	***	***	***
Days on feed	NS	NS	**	***
Implant	NS	**	NS	**
Producer	***	***	***	***
Breed	NS	NS	NS	NS
Illness	NS	NS	NS	NS
Induction allocation	NS	NS	NS	NS
Year	NS	NS	NS	NS
Season	NS	NS	NS	NS

, *, NS P<0.01, <0.0001, not significant respectively

Extrapolating these estimates across the whole Australian feedlot industry is not easy. Official ALFA/MLA feedlot survey data suggests that around 2.5 million cattle are turned off Australian feedlots each year and, of these, approximately two-thirds are destined for the export market. Thus, if the data sets analysed here are anywhere near representative of the industry, there are potentially very large industry costs from non-compliance.

Out-of-specification costs are due to inefficient sourcing and allocation of animals to their optimal market end points. Strategic sourcing of cattle that meet market specification is a critical challenge for firms (Talluri and Narasimhan 2004). The results from Figure 2 to Figure 8 demonstrate that there is a large amount of variation in cattle across beef production systems and this has led to a reduction in opportunities for precision management and value- based marketing. Sethi *et al*. (2005) argue that products out of specification are a source of customer irritation and are costly to clients and manufacturers. Missing target specifications has the potential to result in a large discount in carcass value. Costs associated with carcass weight and external fat depth that is out of specification impact on both the ability of suppliers to meet customer requirements (Sethi *et al*. 2005) and levels of productivity or slaughter rates (Gum and Logan 1965) that are nearer to the processor's cost-minimising level of production (Anderson and Kimberly 2001, Anderson *et al*. 2003).

There are opportunities for the Australian beef industry to make changes to quality and yield grades of cattle and add value to cattle through the better use of information and technology (Storer 2006). Quality and yield grade explain much of the variation in profits when cattle are priced on a grid system (Greer and Trapp 2000). Opportunities for better management from recording quality and yield data have arisen from the introduction of the National Livestock Identification Scheme; further gains can be made by integrating information through advanced technology in the form of data capture, monitoring and transfer. The availability of growth and composition models and equations allow prediction of carcass endpoints and alignment of these carcasses to optimal markets. These tools allow the beef industry to increase productivity by implementing value-based marketing, or trading based on the merits of an individual carcass. It becomes possible to sort cattle at induction or prior to slaughter to meet the optimal end points, thus ensuring carcass uniformity (Tatum *et al*. 1999).

For example, the analysis of the short-fed data showed that Group B cattle were on average heavier and fatter than Group A cattle and consequently suffered higher average costs for non-compliance. If processor B used the available tools (as shown in Table 5), then many of these cattle would not have been targeted at the short-fed market and the cost of compliance would have been lower.

The emergence of value-based marketing systems: facilitates clear specifications for market targets for cattle (Tzokas and Saren 1999), helps information transfer along the production chain (Edmondston *et al*. 2006; Cross and Savell 1994), increases the accuracy of allocation of cattle with regard to the genetics and management used by the producer, and allows sorting of individual cattle to specific target markets (rather than selling on the average) which results in value creation along the supply chain and increases the profit earned from individual animals. Slaughtering groups of cattle with a common endpoint increases carcass uniformity (Tatum *et al*.

1986; Trenkle 2001) and, if managed correctly, will increase the proportion of carcasses that meet market specifications at slaughter.

Better information sharing and coordination between all parts of the value chain has the potential to achieve optimal slaughter allocation and lower the costs of non-compliance as well as help ensure beef palatability and consistency (Tronstad and Unterschultz 2005).

Conclusion

In conclusion it can be seen that, if cattle were more efficiently allocated to management groups that resulted in more uniform carcass traits, it would increase the ability to manage animals so that they would more often meet market specifications and therefore decrease the cost of non-compliance.

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