Available online at www.centmapress.org

INTERNATIONAL JOURNAL ON FOOD SYSTEM DYNAMICS

Proceedings in
System Dynamics and Innovation in Food Networks 2024

DOI: http://dx.doi.org/10.18461/pfsd.2024.2401

Twenty-Five Years and Counting: Preliminary Estimates of the Aggregate Economic Benefits of Meat Standards Australia

Garry Griffith, Maxwell Laurie, Stuart Mounter and John Thompson

Respectively, Adjunct Professor (profgarrygriffith@gmail.com), former Honours student (maxwell.a.laurie@gmail.com), Associate Professor (smounte2@une.edu.au) and Emeritus Professor (jmthommo@gmail.com), Faculty of Science, Agriculture, Business and Law, University of New England, Armidale, NSW Australia

Abstract

Australia is recognised globally as a leader in the beef cattle industry, developing innovations in production systems and in both the domestic and export markets which have benefitted all beef value chain participants. One of the key reasons for its global recognition has been the design, implementation and ongoing improvement of the Meat Standards Australia (MSA) quality assurance scheme which was first trialled in 1998 and celebrated 25 years since commencement in 2023. In this paper the history of the development and implementation of MSA is reviewed, including its alignment with the theoretical principles of the economics of grading and the way in which the initial model has been modified over time. Then, publicly available data is used to estimate the aggregate economic benefits to the industry from its implementation, and these benefits are compared with estimates of the costs incurred in researching, developing and operating the MSA model. The analysis shows that cattle producers, beef processors and beef consumers have all been beneficiaries of the program through the price premiums available for MSA graded beef and cattle. Based on the data available at the time of writing, at the retail level, annual gross benefits have risen substantially to over $400 million in the three years to 2022/23. The cumulative value to 2022/23 is estimated to be $3,125 million. These annual gross benefits are eventually distributed to producers, processors, retailers and consumers in relation to the relative slopes of the demand and supply curves at all the various market levels, as the market adjusts over time to the new level of domestic consumer willingness-to-pay for guaranteed tenderness. At the farm level in the last four years aggregate 'over-the-hook' returns have averaged around $200 million per year. The cumulative value to 2022/23 is estimated to be just under $2,200 million. Over the whole period 2004/05 to 2022/23, producers have received about 70 per cent of the total available willingness to pay. Impact assessment studies have shown that all past R&D expenditure in MSA has been covered, all industry adoption costs have been covered, all annual operating expenses have been covered, and on top of that, a substantial additional benefit has been generated.

Key words: grading scheme; MSA; beef; Australia; consumer preferences

Introduction

Australia is recognised globally as a leader in the beef cattle industry, with effective and well-regarded R&D, marketing and industry policy institutions developing innovations across the range of cattle production systems and in both the domestic and export markets. These innovations have benefitted cattle producers, beef consumers and beef value chain participants. One of the greatest achievements of this industry and a key reason for its global recognition has been the design, implementation and ongoing improvement of the Meat Standards Australia (MSA) voluntary quality assurance scheme. MSA was first trialled in 1998, commercially released in

1999 and celebrated 25 years since commencement in 2023. With MSA celebrating this milestone, it is timely to ask the question: are the cattle producers and value chain participants registered with this program seeing their quality assured products returning sufficient revenue to cover the costs incurred in producing, processing and retailing MSA quality beef in Australia?

To answer this question the history of the development and implementation of MSA is reviewed, including its alignment with the theoretical principles of the economics of grading and the way in which the initial model has been modified over time. Then, publicly available data is used to estimate the aggregate economic benefits to the industry from its implementation, and these benefits are compared with estimates of the costs incurred in researching, developing and operating the MSA model. These results provide an update on an earlier evaluation reported in Griffith and Thompson (2012) which covered the first decade of MSA operations.

The Economics of Grading

Almost 60 years ago, Freebairn (1967) provided a formal treatment of the economic principles underpinning a successful grading scheme for agricultural commodities. He defined a grade as "…a class of a commodity classified on the basis of one or more of the characteristics, properties, or attributes (which we shall call quality characteristics) of that commodity" (Freebairn, 1967, p. 147), with the implicit assumptions, so that it is a grading scheme and not just a classification scheme, that such characteristics, properties, or attributes must be of value to the users of that commodity and that variations in these factors must be able to be ranked in value.

The four main incentives to grade agricultural commodities are to increase buyers' satisfaction; to increase producers' returns; to increase marketing efficiency; and to improve market conduct (Freebairn, 1967). If a grading system is to be regarded as being successful, it must provide the mechanisms to generate these outcomes.

There are also some negativities in implementing and using a grading system. Firstly, a grading scheme that is beneficial and meaningful to consumers might not be meaningful to traders or producers and may also incur different costs at different stages of the value chain that are not where the benefits accrue. Secondly, sorting a commodity into different grades and keeping the different grades separate is costly, so there will be a trade-off between the number of grades that might correspond to maximum consumer satisfaction and the number that minimises transactions costs. Thirdly, a grading scheme may result in less work for some people; retailers may prefer to operate with their own in-house grading schemes; and producers of lower quality might lose if poorer quality is defined in a grading scheme, therefore resulting in the price being discounted for them.

Consumer satisfaction

Different buyers have different tastes and preferences, as well as different levels of purchasing power and they will use a commodity for different purposes. With a grading model in place, an increased level of consumer satisfaction will result, with the consumer able to purchase different levels of quality based on willingness to pay. This can be shown through indifference curve analysis (Freebairn, 1967, his Figure 1).

It can also be shown that the marginal increase in buyer satisfaction will decline as the number of grades increases. If a commodity with only one variable quality characteristic is considered, as the number of grades is increased the substitutes will be closer than if there were fewer grading options. This would be seen in the flattening of the respective indifference curves. And the flatter the indifference curves, the smaller the increase in buyer satisfaction for a given movement towards the optimum allocation, ceteris paribus.

Producer returns

Freebairn explored the effects of grading on producer returns as producers adjust to the market innovation across three time periods, the short run, the intermediate run, and the long run. Using standard microeconomics theory (his Figure 5), whether high quality producers, low quality producers and producers in aggregate will benefit from the grading scheme depends on where the true demand curves (for the graded products) lies in relation to the apparent demand curves (for the ungraded product), as well as the "elasticity of long run supply, … and the opportunities for adjustment in resource use" (Freebairn, 1967, p. 157).

Marketing efficiency

Grading has the potential to lower the costs of providing a range of marketing services including market reporting, storage, transport, and financing. This is made feasible by making possible buying and selling by description, by the provision of a common language for all members of the supply chain, by eliminating the time and expense of arguments over quality and lastly by allowing the pooling and intertwining of products for transport and storage (allowing batches of a commodity produced in different geographical areas to be combined and sold at a standard price based on how that commodity grades which enables trade in large quantities). A further possible efficiency is the reduced need for competitive brand advertising expenditure.

However, some marketing costs will be increased due to the introduction of grading. Examples of this include the actual costs of grading in processing plants and the need for any new technologies, and additional handling, transport and storage costs of the graded product. With the introduction of grading, market knowledge is increased, and the impact of uncertainties associated with the exchange can be limited. Freebairn (1967) uses the concept of net social cost to illustrate these efficiencies, with social cost being the net value of goods and services foregone by producing either too much or too little of a particular commodity.

Market conduct

Lastly, Freebairn's discussion of market conduct focuses on how firms will behave in "adapting or adjusting to the relative markets in which they sell or buy" (Freebairn, 1967, p. 159). This includes many marketing methods and criteria to analyse the output of the firm, "pricing policies, product policies, promotion policies" (Freebairn, 1967, p. 159) and also how they interact with each other. For example, often firms will use the presence of grading as a precondition for subsequent product differentiation. Studies of non-competitive behaviour before and after the introduction of a grading scheme could shed some light on this potential benefit.

In summary, it is well known what characteristics of a grading scheme need to be in place for the scheme to provide benefits to consumers, producers and other value chain participants and to generate market efficiencies. If the grading scheme has an objective of increasing consumer satisfaction (such as 'guaranteed eating quality'), then consumer preferences must play a major role in the design of the scheme. Consumers will pay more for a product that increases their overall utility. Once this willingness to pay is evident, pricing mechanisms must be put in place for the additional value to be captured and transmitted to the rest of the value chain, in particular so that producers will be rewarded with premium prices to produce this more desired, higher quality grade of product.

The History of MSA

Introduction

Consumer surveys conducted on behalf of the Australian beef industry in the early 1990s identified variability in eating quality as a major contributing factor to the then downward trend in beef consumption in Australia (Thompson, 2003). A major research and development project was designed and funded over the period 1993-1999 through the Cooperative Research Centre for the Cattle and Beef Industry (Meat Quality) (the Beef CRC). The producer funding agency, now known as Meat and Livestock Australia (MLA), was a key partner, along with a number of universities, government agencies, other industry bodies and leading beef value chain participants. The MSA quality assurance scheme was developed with the vision that beef for the domestic market in Australia could be graded in order to guarantee eating quality to consumers (MLA, 2018). The rationale for the design of the scheme was given by Thompson (2003, p.75): "meat tenderness is a function of production, processing, value adding and cooking method used to prepare the meat for consumption by the consumer. Failure of one or more links in the beef supply chain increases the risk of a poor eating experience for the consumer. A guarantee for eating quality can only be given if the links that most affect tenderness are controlled along the meat production chain". Since a failure in these links could lead to a risk in eating experience, the MSA grading system identified the key characteristics that would impact on eating quality. It was trialled by MLA in 1998 then officially introduced to the market in 1999/00.

Components of the MSA model

MLA's ground-breaking grading scheme is often attributed to the large number of different factors that have been shown to influence palatability quality in beef. As shown in Table 1, the major global beef grading systems are quite different.

The four grading systems shown here are Meat Standards Australia (MSA), United States Department of Agriculture (USDA), European Beef Grading System (EUROP) and Japan Meat Grading Association (JMGA).

In MSA, each carcase that is graded is identified with a carcase ticket with the majority of information that is noted in Table 1 being recorded in a Data Capture Unit. First, the carcase is given a body number and lot number, with cattle from individual vendors being kept in separate lots.

Table 1. Comparison of international beef grading systems

Grading Inputs	MSA	USDA	EUROP	JMGA
Tropical Breed Content	✓			
Hormonal Growth Promotant	✓			
Sex	✓			
Carcase Weight	✓	✓	✓	✓
Carcase Conformation		✓	✓	
Ossification (maturity)	✓	✓		
Meat Texture		✓		✓
Meat Firmness		✓		✓
Milk-fed Veal	✓			
Hanging Method	✓			
Marbling	✓	✓		✓
Meat Colour	✓	✓		✓
pH	✓			
Rib Fat Measurement	✓	✓	✓	✓
Ribeye Area		✓		✓
Fat Colour	✓			✓
Via Saleyard	✓			
Cut Ageing	✓			
Cooking Method	✓			
Individual Cut	✓			

Source: MLA (Meat Standards Australia, 2014, p. 10)

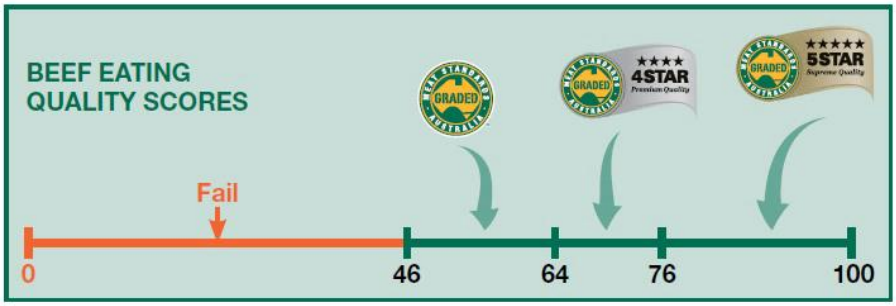
When vendors supply cattle through a MSA compliant processor, it must be stated if the animal has received any hormone growth promotants in its life as this will affect the MSA score obtained for particular muscles. Once the animal is processed, the carcase weight is recorded, which places the carcase into a particular grid depending on what market it is being sold into. Following these market specifications, the sex of the animal is also recorded. Subsequently, tropical breed content is recorded with the measurement of hump height, as tropical breed has been found to have a negative impact on the eating quality of many cuts of beef. From this the carcase hanging method is recorded with either an Achilles hang or tenderstretch, with the latter found to have positive effects on palatability. Once the carcase has been hung for a set time, an animal's ossification (calcification of the bones used to determine carcase maturity), marbling (intramuscular fat), rib fat and pH and temperature are recorded. Whilst ossification determines the maturity of the animal, pH and temperature are often indicators of stress in the animal which can lead to poorer palatability (MLA, 2019). Additional data can be added at the request of the vendor, but many of these optional extras, such as the eye muscle area, fat colour and the meat colour, have been found to have no impact on eating quality (for further reading on the grading process, see *MSA Tips & Tools: Meat Standards Australia* beef information kit (MLA, 2017)).

So, MSA is a "paddock to plate" quality assurance scheme which uses key Critical Control Points (CCPs) to predict the quality of the final product. The majority of research undertaken in the development of MSA was not new.

The major innovations were the integration of the existing strands of research into the CCP framework, and the development of a large-scale consumer testing system that allowed the effects of the CCPs to be linked to cooking method and consumer preferences and quantified using a standard evaluation procedure. "This allowed the CCPs to be ranked on their potential impact on palatability and incorporated into a predictive model" (Thompson, 2003, p. 75). MSA was the first grading system to integrate results into a general model capable of being used on a commercial level in developing a score system on the level of quality of the beef being sold. Prior to this, other prediction models had generally focused on a specific sector of the beef supply chain (Thompson, 2003). Originally a whole carcase grading scheme was proposed, but through MSA experience a cuts'-based grading system was implemented to improve the accuracy of predicting palatability in beef and the need to grade all muscles in the carcase as opposed to just the carcase. As explained by (Thompson, 2003), "analysis of MSA's database indicated that the variation in palatability explained by muscles was approximately 60 times greater than that explained by the variation between animals for the same muscle". Therefore, MSA identified that a major component of understanding differences in the quality of beef is the characteristics of different cuts and how they are cooked.

The original taste scoring trials involved untrained consumers who were used to test and score samples based on four attributes of beef quality: tenderness; juiciness; flavour; and overall acceptability. The "four sensory dimensions were combined into a single palatability or meat quality score by weighting tenderness, juiciness, flavour and overall acceptability" (Thompson, 2003, p. 75) by 30 per cent, 10 per cent, 30 per cent and 30 per cent respectively. From these scores, the optimum boundaries were able to be calculated statistically for the grades assigned by the consumer with "boundaries between the grades of 45.5 for the ungraded and 3 star categories, 63.5 for 3 and 4 star categories, and 76.5 for 4 and 5 star categories" (Thompson, 2003). Then, the beef sample was described as one of the following categories: unsatisfactory; good everyday (3 Star); better than everyday (4 Star); and premium quality (5 Star). This process is shown in Figure 1.

Figure 1. Beef eating quality scores



Source: (MLA, 2017, p. 6)

Accuracy of the MSA model

As can be seen in Table 2 (Thompson, 2003, Table 5a-4) the early ability of the MSA cuts-based model to correctly classify samples into consumer grades was high. "The model correctly classified between 50 to 70 per cent of the samples, with 95 per cent to 97 per cent of the predicted scores being within one grade of their consumer rating. If a muscle was predicted by the cuts-based model to be 'ungraded' then there was ca. a 70 per cent chance that this agreed with the consumer panels… If the model was incorrect it was generally only 1 grade out, i.e. if the model said it was 'ungraded' then there was only ca. a 30 per cent chance it was a '3 star', but essentially little chance it was a '4 star' or '5 star'…. (p. 81).

Table 2. The ability of the MSA cuts-based model to correctly classify samples into consumer grades

	Grade given by Consumer Panel				
Predicted grade using MSA Model	Ungraded	3 Star	4 Star	5 Star	Total
Ungraded	**68**	29	3	0	100
3 Star	24	**50**	23	4	100

4 Star	3	25	**49**	23	100
5 Star	0	5	32	**63**	100

Source: (Thompson, 2003, p. 82). *Note*: The bolded cells represent the percentage of samples which were graded correctly according to the consumer taste panel results

"Similarly for muscles that graded '3 star' or '4 star', the model was correct about 50 per cent of the time and again, if it was wrong, it was only by one grade" (Thompson, 2003, p. 81). This degree of accuracy was greater than what is feasible from previously used measurements for carcase quality such as fat depth, marbling, dentition and carcase weight. Further, the degree of accuracy has improved over time as the information base has expanded.

Development of the MSA model

The MSA model has been developed using a multiple regression approach. This is where "input variables from the production, processing and value adding sectors were included in a model to predict palatability of individual muscles for a range of cooking techniques" (Thompson, 2003, p. 76). For the very first prediction run there were just 12,700 samples for the development of the palatability scores. This increased to about 55,000 in 2003, to 800,000 in 2018, and at the latest count the model included 1.7 million samples from 250,000 consumers from 13 countries (MLA, 2023).

This grading system is continuously updated with relevant data that continues to create not only a quality eating experience for the consumer, but also aims to increase the understanding of beef producers about how to reach the standards that are required to achieve MSA grading and so receive the price premium that is associated with this quality.

MSA Index

The cuts-by-cooking method grading scheme produces hundreds of different predictions of eating quality for each carcase, especially when possible variations in aging time are taken into account. This is an overwhelming amount of data for producers to make informed judgements about changes in on-farm practices to improve eating quality. The MSA index is a way to simplify this information overload as it predicts the potential eating quality of a carcase. First released in 2013, the MSA index number given for every individual animal falls between 30 and 80 and is expressed to 2 decimal places. Importantly, the MSA Index is "independent of any processing inputs and is calculated using only attributes influenced by pre-slaughter production" (MLA, 2017). Therefore, it is reflective of management practices on farm associated with environmental and genetic differences between cattle. It has been able to be used across all processors, regions and over time. Based on carcase feedback data, producers are now able to see where their cattle rank among other cattle that fall into similar categories, and how their herd has changed over time in terms of eating quality.

The current state of the MSA Quality Assurance Scheme

In the 2022-23 financial year, 3.39 million Australian cattle were presented for MSA grading (MLA, 2023)[1]. That is around 54 per cent of the national adult cattle slaughter. Since the introduction of the MSA Index, compliance rates for cattle have continuously improved, with the national compliance rate now at 95.1 per cent and the MSA average index at 57.52. Grass-fed cattle represented 41 per cent of MSA-graded cattle at a compliance rate of 91.1 per cent whilst grain fed carcases represented 59 per cent of MSA-grade cattle, with a compliance rate at 97.9 per cent. A part of this continual rise can be attributed to almost 1200 new producers receiving MSA education through more than 17 workshops and information sessions across the year.

Across the history of MSA, more than 40,000 registered MSA producers have supplied more than 30 million cattle for grading. With this supply, 172 licensed MSA brands have been developed. With the growth of MSA nationally, over 15,000 different retail, food service providers and wholesalers have been educated and trained in MSA programs.

[1] There is also a MSA scheme for sheep meat, soon to be formally rolled out. In 2022-23, some 2.3 million sheep followed MSA pathways through 14 MSA-licenced processing facilities. More than 70 per cent of all lambs slaughtered were processed through MSA-licenced processing plants.

Although MSA was designed and implemented just for the Australian domestic market, there continues to be significant international interest. Consumer taste tests have been carried out in 13 different countries. For example, in the United States, USDA continues to approve MSA as a Process Verified Program so that brand owners can use the USDA PVP shield alongside the MSA logo on their brands (MLA, 2023). Since 2017 in Europe, the consumer testing protocols used by MSA to support eating quality research have been adopted as the global standard by the United Nations Economic Commission for Europe (MLA, 2017).

MLA (2023, p. 4) estimate the "program delivered a record $259 million in estimated additional farm gate returns to MSA beef producers in 2022-23". That is only part of the value though. In the following sections, the aggregate benefits of the MSA scheme are estimated, and then compared with the costs of achieving these benefits.

Method and Data

Method

Freebairn (1967) outlined the economic concepts on which the benefits of a grading scheme could be established. These were the location and elasticities of the true demand curves (for the various categories of graded products) in relation to the apparent demand curve (for the heterogenous, ungraded product); the elasticity of long run supply and the opportunities for adjustment in resource use; and the provision of pricing mechanisms for the additional value to be captured and transmitted to the rest of the value chain, in particular to producers so that they can be rewarded with premium prices to produce the more desired, higher quality grade of product.

A standard partial equilibrium analysis could then be constructed such that changes in economic surplus could be calculated to provide an estimate of the gross benefit of the implementation of a grading scheme. There are existing such models of the Australian beef industry which could be modified and used in such an analysis (Zhao et al., 1999; Zhang et al., 2016).

For MSA, unfortunately some crucial data inputs required to implement this framework are not available. There is no information on the actual quantities of MSA-graded and non-MSA-graded beef produced and sold, and consequently there is no information on the price elasticity of demand for MSA-graded and non-graded beef. However, there is information available on the number of carcases graded and certified as compliant with the MSA standards, and there is information available on the premiums paid for graded beef at retail and for cattle graded as MSA at the processing plant. An aggregate value differential for MSA-graded beef can be calculated.

In one respect this might over-estimate the benefits of MSA since not all graded carcases or cuts will be labelled as such and no price difference might be apparent in the market. Offsetting this is the fact that the pricing surveys mentioned below only ask for prices of 'graded' vs 'non-graded', that is '3 Star, or 'good every day', vs 'unsatisfactory'. In the price premium data that is available, no account is taken of the potential extra revenue able to be obtained from the higher quality '4 Star' and '5 Star' graded beef.

Retail price differentials for MSA graded cuts

The value of the MSA quality assurance scheme is generated by consumers' willingness to pay higher prices for higher quality beef as predicted by the MSA model. Knowledge of this willingness to pay is therefore a crucial input into estimating the value of the scheme.

Meat Standards Australia began conducting pricing surveys during 2005 (MLA, 2005). Initially, face to face and telephone interviews were conducted each week from January to September, across the wholesale, food service and retail sectors in Brisbane, Sydney, Melbourne, Adelaide and Perth, initially for 13 separate cuts of beef. The focus was on actual transactions – the prices actually paid and received for MSA-graded and non-MSA-graded cuts by independent butchers and food service suppliers. From these prices, the price differentials attributable to the MSA grade could be calculated. Some 25,900 prices in total were collected during the first survey across these three market levels. Another round of price surveys was conducted for the 2006/07 financial year (Millward Brown, 2007b), and the process was repeated during succeeding years. From 2009/10 the price information has been reported in the *MSA Annual Outcomes Reports* (MLA, 2010). Before that, MLA made available the underlying spreadsheet summaries of the pricing surveys.

However, over time there have been major changes in the coverage of the data reported. Some of the less valuable cuts were excluded, and a new cut was included, so in recent *Outcomes Reports* only the differentials for cube roll, tenderloin, striploin, t-bone, rump, knuckle and blade could be calculated. In the most recent 2022-23 *Outcomes Report*, the prices for these individual cuts are not reported, just the simple average differential across those cuts. Further, food service prices are no longer publicly reported. This has limited the type of analysis that could be conducted.

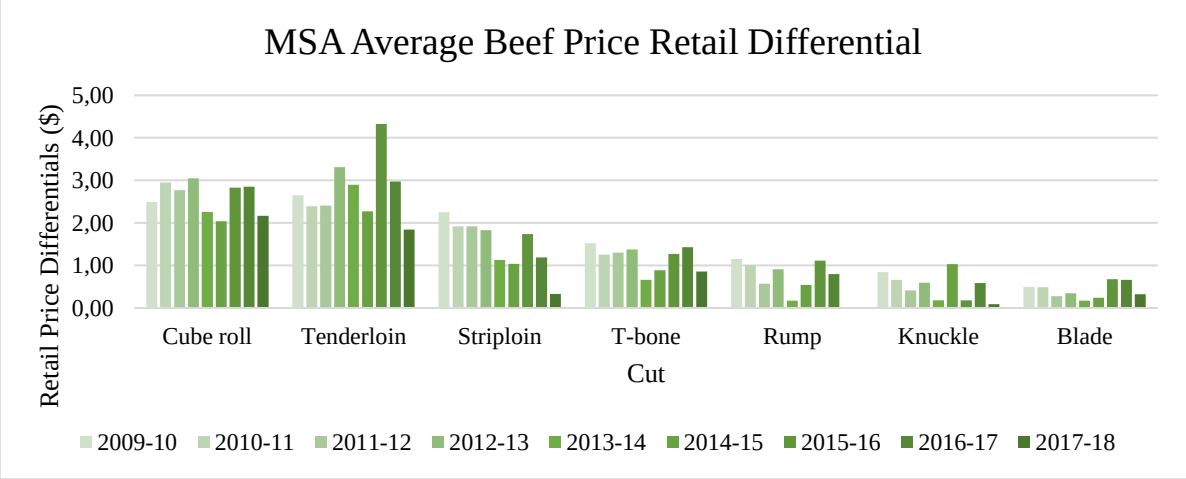
Another longstanding issue is that these retail (and wholesale if that level is being analysed) prices and premiums refer to retail cut weight (a kg of blade steak or a kg of cube roll), whereas the price premium relevant to the producer is price per kg carcase weight. Additionally, the quantity side of the equation of value is measured in number of carcases. Thus, the retail (and wholesale) prices have to be adjusted to 'carcase equivalent', so that like can be compared with like.

In Griffith and Thompson (2012), because prices for MSA-graded and non-MSA-graded beef across 13 separate cuts were available, a full beef carcase cuts component model could be used to calculate an estimated retail carcase equivalent price for a MSA-graded carcase and for a non-MSA-graded carcase, and hence a MSA premium for the whole carcase. An example table is shown in Appendix 1. These retail carcase equivalent (RCE) calculations are shown in the row named *RCE Av.* in Table 3 for the years 2005 to 2010/11.

Once the number of cuts reported was substantially reduced and actual prices were no longer reported from 2020/21, this procedure could not be continued. The relationship between the average premium for the seven currently reported cuts and the calculated RCE average premium over the period 2005 to 2010/2011 was analysed. The simple correlation coefficient was very high at 0.93. A simple regression equation was used to estimate a RCE average premium for the subsequent years. These estimates are shown in bold in Table 3.

Three features of the average annual retail premiums attributable to MSA grading shown in Table 3 are noteworthy. First, as illustrated in Figure 2 for a subset of these premiums for the period 2009/10 to 2017/18, there are substantial differences across the cuts.

Figure 2. MSA average beef price retail differential, 2009/10 – 2017/18, $/kg, retail weight



Source: (MLA)

In this sample of data, the premiums for the two higher quality cuts, cube roll and tenderloin, are around $2.50/kg, while the premiums for the two lower quality cuts, knuckle and blade, are only around $0.50/kg. These differences in premiums of course reflect the differences in base prices of the different cuts (in Appendix 1, in 2005 prices, $23-31/kg for the higher quality cuts vs $12-13/kg for the lower quality cuts).

Second, there are sometimes substantial differences from year to year. For example, in Figure 2, after four years of relatively stable differentials, 2013/14 saw a substantial drop in all cuts, and more so in the lower value cuts. These rises and falls in price differentials may be due to the influence of drought, over supply of beef to the domestic market, fluctuations in quality of beef being processed and the total percentage of cattle being graded under MSA.

Third, until the last three years, the average MSA beef retail differential has reduced over time. Although there have been some exceptions, as indicated above, the majority of cuts have not reached the same price differentials from when they were first recorded. The average price differential across the seven cuts was $2.08 /kg in the first four years, whereas it was $1.12/kg in the four years 2016/17-2019/20. A major factor explaining this steady decline is the substantial expansion in the number of carcases graded as MSA compliant, as mentioned above. The substantial premiums in the last three years can be put down to the COVID pandemic effect on consumer purchasing behaviour, and record prices for cattle in Australia.

Available online at www.centmapress.org

INTERNATIONAL JOURNAL ON FOOD SYSTEM DYNAMICS

Proceedings in
System Dynamics and Innovation in Food Networks 2024

DOI: http://dx.doi.org/10.18461/pfsd.2024.2401

Table 3. MSA average retail price differentials, 2005 – 2022/23, $/kg, retail weight

Cut	2005	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Cube roll	5.35	3.31	3.87	2.81	2.49	2.95	2.77	3.05	2.26	2.04	2.83	2.85	2.17	2.40	2.29	-	-	-
Tenderloin	2.73	3.10	3.69	2.97	2.65	2.39	2.41	3.31	2.90	2.27	4.33	2.97	1.84	2.80	2.11	-	-	-
Striploin	3.85	2.64	2.77	2.03	2.25	1.92	1.92	1.83	1.13	1.04	1.74	1.19	0.33	0.45	0.92	-	-	-
T-bone	-	-	-	-	1.52	1.26	1.30	1.38	0.66	0.89	1.27	1.43	0.86	0.90	1.26	-	-	-
Rump	1.19	0.93	1.32	1.28	1.15	1.01	0.57	0.91	0.18	0.54	1.11	0.80	0.00	0.15	0.62	-	-	-
Knuckle	0.66	0.62	0.73	0.88	0.84	0.66	0.42	0.60	0.18	1.03	0.18	0.59	0.09	-0.10	0.33	-	-	-
Blade	0.68	0.79	0.85	0.78	0.50	0.49	0.28	0.35	0.17	0.24	0.68	0.66	0.32	0.05	1.01	-	-	-
Av. of 7 cuts	2.41	1.90	2.21	1.79	1.63	1.53	1.38	1.63	1.07	1.15	1.73	1.50	0.80	0.95	1.22	2.77	2.77	2.80
RCE Av.	*0.39*	*0.27*	*0.30*	*0.29*	*0.24*	*0.22*	**0.20**	**0.24**	**0.15**	**0.16**	**0.26**	**0.22**	**0.10**	**0.13**	**0.17**	**0.42**	**0.42**	**0.43**

Source: (MLA Annual *Outcomes Reports*)

Table 4. Average annual price differential for selected MSA categories of cattle sold OTHs, 200708 to 2022/23, ¢/kg CWT

Year	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Trade Steer	8.30	6.87	10.48	11.75	8.45	18.83	20.56	21.34	33.06	21.89	25.50	23.71	-	-	-	-	-
Trade Heifer	-	-	-	-	-	-	-	21.61	33.31	23.44	26.50	24.71	-	-	-	-	-

Yearling	36.41	17.19	-9.40	-8.37	28.23	25.77	42.24	41.66	30.70	27.29	19.34	23.86	30.02	22.46	17.60	24.96	44.91
Grain fed 70 days	-	-	-	-	-	-	-	-	13.49	15.70	12.05	13.89	17.16	12.78	10.05	16.87	-
Average	11	17	12	15	10	12	18	19	21	19	19	17	17	22	19	18	23

Source: (MLA Annual *Outcomes Reports*). *Note:* 'Average' refers to the average OTHs price differentials across all weight categories, sex categories and grain fed and non-grain fed. Values from 2006/07 to 2009/10 are taken from Griffith and Thompson (2012)

Available online at www.centmapress.org

INTERNATIONAL JOURNAL ON FOOD SYSTEM DYNAMICS

Proceedings in
System Dynamics and Innovation in Food Networks 2024

DOI: http://dx.doi.org/10.18461/pfsd.2024.2401

Some of the variability in MSA average retail price differentials and the longer-term downward trend may be attributed to the partnership that the supermarket chain Woolworths Australia and MSA had from 2012 until 2018, with Woolworths accounting for approximately 30 per cent of red meat retail sales in Australia. Woolworths departure from the direct branding of MSA was dubbed as "part of a broader beef branding project… backed by consumer research suggesting that many consumers did not understand what the MSA symbols meant" (Condon, 2018).

MSA price differentials in over-the-hooks (OTHs) cattle prices

Pricing data on cattle offered for MSA grading direct to processors, or over-the-hooks (OTHs), was first reported in 2007. Initially it was just for trade steers (240-260kg), then expanded in 2013/14 to include trade heifers (240-260kg), and the reports now include heavy yearling steers and heavy yearling heifers (both 300-320kgs) as average carcase weights continue to rise. Premiums for 70-days and 100-days grain fed cattle have also been reported since 2015/15.

The average annual OTHs premiums for a number of different categories of cattle offered for grading and compliant with MSA requirements are shown in Table 4 for all time periods since these prices have been monitored. Three features of these premiums are noteworthy.

First, as with the retail price premiums, there is significant year-to-year variability in the OTHs premiums, especially in the earlier years for trade steers and yearlings. But, even throughout the drier seasons of 2013, 2014 and again in 2017 and 2018, the difference in price has remained above 20 c/kg on an annual basis.

See Appendix 2 for monthly OTH prices for trade steers in NSW since 1999, and as well the addition of prices for MSA trade steers in 2007. From the monthly MSA price differentials shown in Figure 3 for a subset of the data, it is clear that there is also substantial within-year variability in premiums, with some extreme month to month changes in some years.

Second, trade heifer pricing data was not released until mid-2014, but from Table 4 and Figure 3, MSA trade heifer price differentials have moved similarly to that of MSA trade steers, with the average premium for heifers slightly above that for steers.

Third, separate OTHs price reports for grass fed and grain fed cattle were released from 2010/11. As shown in Figure 4, the premium for MSA-graded grass fed cattle has been substantially above that for grain fed cattle, sometimes double.

Finally, as shown in Table 4 and in both Figure 3 and Figure 4, in spite of the variability across years and classes of cattle, there is a clear long-term upward trend in MSA price differentials for producers. This means processors are willing to pay more for preferred cattle that are meeting MSA requirements. However taking all MSA graded cattle into account, the OTHs premium has been quite stable during the last decade.

MSA beef grading numbers and compliance rates

The numbers of cattle offered for MSA grading and as a proportion of national adult cattle slaughter numbers are shown in Figure 5 for the period 2002/03 to 2022/23. Grading numbers increased slowly to begin with then increased sharply to around 3.4 million in 2014/15 and have remained around or just above the 3 million mark since. However, as national slaughter numbers were falling during this period, the share of adult slaughter has been steadily growing. The 3.39 million cattle graded in 2022/23 represents around 54 per cent of total cattle slaughter.

Not all cattle offered for MSA grading actually make the grade. Compliance with the strict MSA requirements is very good but not perfect. In 2022/23, MSA compliance for grain fed cattle was close to 98 per cent, while compliance for non-grain fed cattle was 91.1 per cent. Non-compliance varies through the year with seasonal conditions and feed quality, and is mainly due to carcases not meeting the pH criteria (too acidic or too alkaline – a measure of stress, and a negative effect on meat tenderness). An example is shown in MLA (2023).

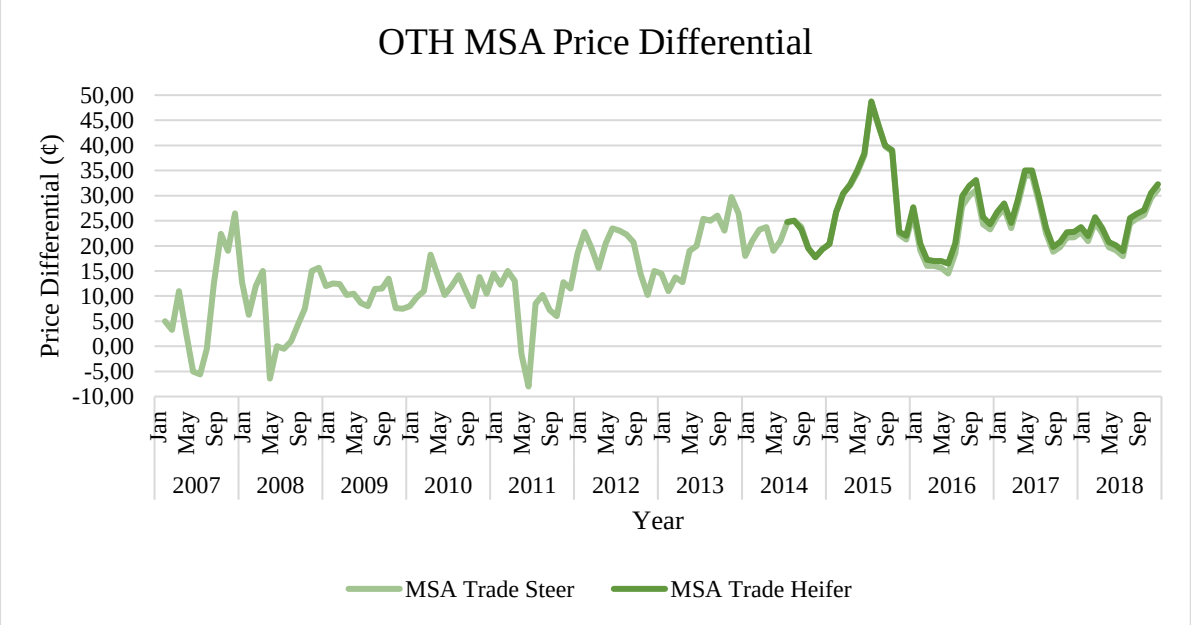
Available online at www.centmapress.org

INTERNATIONAL JOURNAL ON FOOD SYSTEM DYNAMICS

Proceedings in
System Dynamics and Innovation in Food Networks 2024

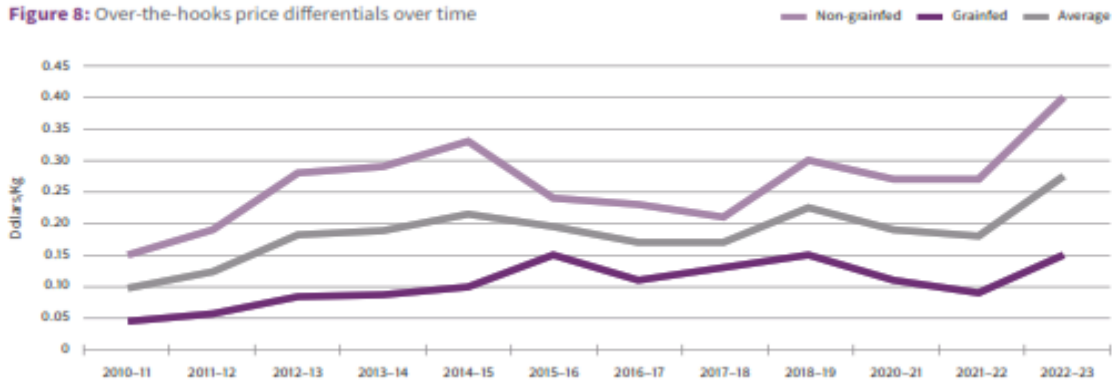
DOI: http://dx.doi.org/10.18461/pfsd.2024.2401

Figure 3. OTH monthly MSA price differential for trade steers and trade heifers, Jan 2007 – Sept 2018, ¢/kg CWT



Source: (MLA)

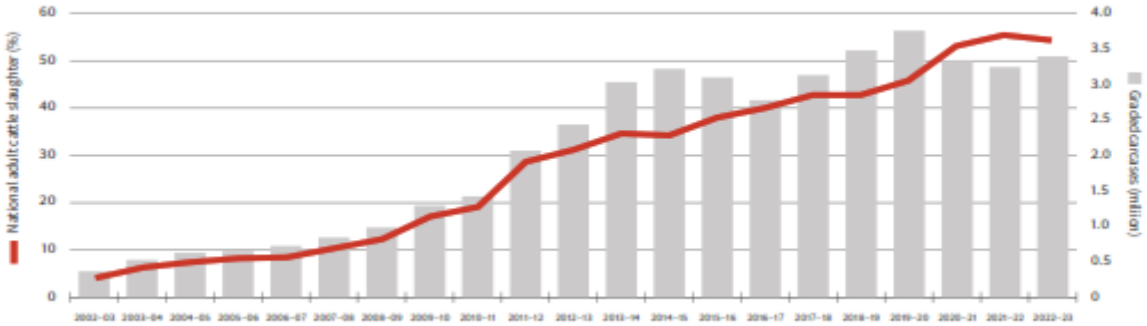
Figure 4. OTHs MSA annual price differentials for grain fed and grass fed cattle, 2010/11 to 2022/23, $/kg CWT



Source: MLA (2023)

Figure 5. National MSA beef grading numbers, 2002/03 to 2022/23

Figure 2: National MSA beef grading numbers (2022–23)



Source: MLA (2023)

Estimated Economic Impact

Aggregate benefits

In relation to the approximate economic analysis framework described above, the two basic sets of data required to implement the calculations have been collected and collated.

Some caveats on these data should be mentioned. Retail price premiums are only available for part of 2005 and for 2006/07 onwards. There were no similar price surveys done in previous years, so there is a need to estimate what the price premiums are likely to have been from 1999/00 until 2004/05. Although there is some anecdotal evidence that large premiums were available for some specialist butcher shops in the early days of MSA **(**Cameron Dart, pers. com., Rod Polkinghorne, pers.com.), the very conservative assumption has been made that there was no premium in the first year, and that premiums increased in a simple linear manner from 2000/01 until 2004/05, then continued at that level for 2005/06. The assumed and estimated retail premiums over time are shown in Table 5.

A similar procedure was applied to the OTH premiums. The preferred 'average' value is only available from 2010/11, while premiums for trade steers and yearlings go back to 2006/07. An average for the trade steer and yearling series was assumed for 2006/07 to 2009/10, a value of 10c/kg was assumed for 2004/05 and 2005/06, and then it was assumed (in line with the retail data) that the premiums decreased in a linear manner back to zero in 1999/00. The assumed and estimated OTH premiums over time are shown in Table 6.

The appropriate weight to use for MSA graded carcasses is also an issue. As noted above, the over-the-hooks' prices reported by the National Livestock Reporting Service to indicate premiums for MSA quality in the live cattle market have varied over time. Initially the weight ranges were 170-230kg, and 230kg+, but as additional classes of cattle have been added, average weights have increased. On the other hand, the proportions of individual cuts used by Meat and Livestock Australia to derive weighted average values, as shown in Table 3, were based on a 260kg carcass. Actual average weights of MSA graded carcases have been made available by MLA and these are reported in Tables 5 and 6. Compliance rates have also been sourced from MLA documentation.

Multiplying the estimated and assumed premiums by the known number of carcasses graded and compliant and the known carcase weights provides an estimate of the gross potential annual economic value at the retail and OTH levels of the improvement in certainty about beef quality brought about by the MSA system, over the years 2000/01 to 2020/23.

At the retail level, annual gross benefits increased from a low base to $83 million in 2010/11, and then ranged between approximately $100 million and $200 million up to 2019/20, before rising substantially to over $400 million in the three years to 2022/23. The cumulative value to 2022/23 is estimated to be $3,125 million.

At the OTH level, average OTH premiums have been relatively stable in the past decade, so aggregate returns have risen in line with the number of carcases graded. In the last four years aggregate OTH returns have been

higher due to both slightly increased premiums and higher grading numbers, averaging around $200 million per year. The cumulative value to 2022/23 is estimated to be just under $2,200 million.

Note that all of these estimates are in current $ values, without applying any discounting or compounding factors.

Distribution of benefits

These annual gross benefits are eventually distributed to producers, wholesalers, retailers and consumers in relation to the relative slopes of the demand and supply curves at all the various market levels, as the market adjusts over time to the new level of domestic consumer willingness-to-pay for guaranteed tenderness. This is the sort of information provided by equilibrium market models such as the one reported in Zhao *et al.* (2001).

Available online at www.centmapress.org

INTERNATIONAL JOURNAL ON FOOD SYSTEM DYNAMICS

Proceedings in
System Dynamics and Innovation in Food Networks 2024

DOI: http://dx.doi.org/10.18461/pfsd.2024.2401

Table 5. Aggregate economic value of MSA at the retail level

	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11
Carcasses Graded (000)	225	291	353	366	523	626	645	716	839	979	1280	1420
Carcasses Compliant (000)	187	253	300	316	476	576	593	649	758	890	1174	1339
Average Carcass Weight (kg)	228	239	257	237	250	253	250	265	264	271	276	281
Estimated Retail Price Premium (c/kg cw)	0 (a)	7.8 (a)	15.6 (a)	23.4 (a)	31.2 (a)	39.0	39.0	27.0	30.0	29.0	24.0	22.0
Additional Value at Retail ($m cw)	0	4.7	12.0	17.5	37.1	56.8	58.3	46.4	60.0	69.9	77.8	82.8

	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23
Carcasses Graded (000)	2050	2400	3000	3250	3100	2750	3150	3500	3800	3250	3200	3390
Carcasses Compliant (000)	1927	2250	2820	3055	2915	2585	2970	3283	3587	3100	3100	3230
Average Carcass Weight (kg)	280	285	290	290	295	300	308	280	279	315	327	334
Estimated Retail Price Premium (c/kg cw)	0.20	0.24	0.15	0.16	0.26	0.22	0.10	0.13	0.17	0.42	0.42	0.43
Additional Value at Retail ($m cw)	107.9	153.9	122.7	141.8	223.6	170.6	91.5	119.5	170.1	410.1	425.8	463.9

(a) No prices recorded, assumed value. Values up to 2010/11 are taken from Griffith and Thompson (2012).

Table 6. Aggregate economic value of MSA at the OTH level

	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11
Carcasses Graded (000)	225	291	353	366	523	626	645	716	839	979	1280	1420
Carcasses Compliant (000)	187	253	300	316	476	576	593	649	758	890	1174	1339
Average Carcass Weight (kg)	228	239	257	237	250	253	250	265	264	271	276	281
Assumed OTH Price Premium (c/kg cw)	0 (a)	2 (a)	4 (a)	6 (a)	8 (a)	10 (a)	10 (a)	11 (b)	17	12	15	10 (c)
Additional Value at OTH ($m cw)	0	1.2	3.1	4.5	9.5	14.5	14.9	18.9	34.1	28.9	48.6	37.6 (c)

	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21	21/22	22/23
Carcasses Graded (000)	2050	2400	3000	3250	3100	2750	3150	3500	3800	3250	3200	3390
Carcasses Compliant (000)	1927	2250	2820	3055	2915	2585	2970	3283	3587	3100	3100	3230
Average Carcass Weight (kg)	280	285	290	290	295	300	308	280	279	315	327	334
Assumed OTH Price Premium (c/kg cw)	12	18	19	21	19	19	17	17	22	19	18	23
Additional Value at OTH ($m cw)	64.7	115.4	144.7	186.0	163.4	147.3	155.5	156.3	220.2	185.5	182.5	248.1

(a) *No prices recorded, assumed value. (b) Restricted data available. (c) Revised. Other values up to 2010/11 are taken from Griffith and Thompson (2012).*

Available online at www.centmapress.org

INTERNATIONAL JOURNAL ON FOOD SYSTEM DYNAMICS

Proceedings in
System Dynamics and Innovation in Food Networks 2024

DOI: http://dx.doi.org/10.18461/pfsd.2024.2401

Griffith and Thompson (2012) found that across Australia over the period 2004/05 to 2010/11, retail beef consumers were prepared to pay on average $0.30/kg extra for MSA branded beef on a carcass weight equivalent basis to guarantee tenderness. This beef was primarily sold through independent butcher shops. These retailers kept about $0.06/kg and paid their wholesale suppliers the remaining $0.24/kg to source MSA compliant cattle and MSA graded carcases (wholesale price differentials by cut were regularly reported then). About $0.13/kg was passed back to cattle producers on average. Thus, based on the average c/kg distribution of consumer willingness to pay over the period 2004/05 to 2010/11, retailers retained about 20 per cent of the value, wholesalers received about 35 per cent of the value and cattle producers received some 45 per cent.

Since then, the benefit distribution pattern has changed dramatically. In the last 12 years, the average retail premium was 24.2 c/kg while the average OTH premium was 18.6 c/kg. Some 77 per cent of consumer willingness to pay was transmitted back to cattle producers, while the remaining 23 per cent was shared between processors and retailers.

Over the whole period from 2004/05 to 2022/23, producers received 70 per cent of the estimated available willingness to pay.

However, there is considerable variability underlying these average values. It has been mentioned already that there have been some large differences in price levels and price premiums for the various cuts across the various States and over time at the retail level, and that premiums for live cattle that eventually grade MSA also vary considerably by State and over time. This variability in the underlying raw data may have a large effect on the average distribution estimates. In a competitive market we would expect the retail premium to exceed the wholesale premium which in turn would exceed the producer premium. This was certainly the pattern in the early years. But as shown in Griffith and Thompson (2012), there have been years where the wholesale premium was less than the producer premium, and where the retail premium was less than the wholesale premium. In Tables 5 and 6 above it is evident that the retail premium has even been less than the producer premium in some years. To take 2022/23 as an example, while the retail premium was $2.80/kg (across the seven major graded cuts), or $0.43 c/kg on a carcase equivalent basis (Table 3), the wholesale premium was higher at $3.02/kg (MLA, 2023, their Figure 9), and the producer premium was only just over half of the retail premium.

It appears that MSA-graded beef is often used as a loss-leader in independent butcher shops. This is not necessarily irrational behaviour given the general deflationary price environment in recent years, the fact that supermarkets are paying more attention to beef and that specialists butchers have to respond, and the large structural changes that have been occurring in the processing sector (Umberger and Griffith, 2011).

Benefits in relation to costs

It would be preferable to compare the time paths of the benefit estimates shown in Table 5 and 6 with a similar time path of the costs incurred in researching, implementing and operating the MSA system. However, many of these costs are not now available for public scrutiny. Some evaluations have been completed at different points in time, and these can be assessed for an overall indication of return on investment.

As part of Beef CRC evaluation processes, Griffith *et al*. (2009) compared estimated benefits with the estimated total costs of the R&D and the subsequent development of the MSA system. An *ex post* R&D benefit-cost ratio to 2008/09 was estimated to be 4.7:1 when valued at the retail level – all past R&D expenditure had been covered and on top of that a substantial additional benefit had been generated. The authors estimated that including the broader range of implementation and compliance costs would have brought the industry benefit-cost ratio down to about 2:1 at that point in the implementation of MSA.

An evaluation of the broader Meat and Livestock Australia investment in red meat eating-quality R&D was completed by CIE (2012). This report suggests that total expenditures for beef eating quality in nominal terms were between $255 million and $304 million over the period 1998/99 to 2009/10, depending on assumptions about how Beef CRC costs are included. These costs include direct MLA investments, Beef CRC investments, on-farm compliance costs and costs of adoption by beef processors. These estimates imply a net benefit to the Australian beef industry from the MSA innovation of between $219 million and $268 million, or benefit cost ratios of between 1.72 and 2.39. These values are close to the industry benefit cost ratio of around 2:1 estimated earlier by Griffith et al. (2009). This report reaffirmed that all past R&D expenditure in MSA had been covered, all industry adoption costs had been covered, and on top of that a substantial additional benefit had been generated. Griffith and Thompson (2010) noted that these net industry benefits were expected to continue to grow in future years as throughput increased and ongoing development and operational costs stabilised.

In the Exit Report for the Beef CRC, Griffith and Burrow (2015) reported a benefit cost ratio of 3.74 for the Beef CRC investments in enhancing the scientific basis of MSA and in communicating those enhancements to industry.

Another impact assessment conducted by MLA analysing the period between 2010 – 2015 reported a net benefit of the MSA quality assurance scheme to the industry of $679 million, with a benefit cost ratio of 12.5:1 from an investment over the five-year period of $54 million (just the operating costs, excluding initial R&D and implementation investments). Current benefit cost ratios may be close to double that figure, with the large increase in OTH premiums in recent years.

And of course, some of these industry-funded assessments only focus on the returns to cattle producers – there are substantial additional benefits available to other value chain participants flowing from consumer willingness to pay for MSA graded beef.

Discussion and Conclusion

Australia's MSA beef quality assurance scheme has been designed to comply with what economists would say are the principles required for an effective grading scheme. Incorporating consumer preferences for different qualities of beef, and the way in which these preferences are related to cuts and cooking method and are linked to a whole of chain assessment of the CCPs which define differences in quality across breeds and production and processing environments, are the key differences from other global beef grading schemes. The other major distinguishing factor is that it is not a set and forget scheme – it is being continually upgraded and improved as more data points are added to the underlying prediction model, as new prediction factors are proposed, tested and added, as new scientific evidence is developed, and as information programs develop a better understanding of the different cuts and how quality varies across the carcase.

While the underlying model is very complex, considerable effort has been put into codifying this complexity. At the end user level, there are only four grades to consider - ungraded beef, 3 star, 4 star and 5 star – with well-defined boundaries and expectations about quality. Willingness to pay can be more readily and confidently expressed, and the small number of grades effectively means the grades will not compromise each other as substitutes.

At the producer level, the MSA Index has been developed and implemented. As the Index provides a direct link between quality grades and on-farm influencing factors, and the education and training packages that go with it, producers can now directly see the impact of shifting production management strategies (such as feed requirements and genetic improvement) in order to meet MSA grading requirements.

The analysis reported above shows that cattle producers, beef processors and beef consumers have all been beneficiaries of the program through the price premiums available for MSA graded beef and cattle. At the retail level, annual gross benefits increased from a low base in the early years before rising substantially to over $400 million annually in the three years to 2022/23. The cumulative value to 2022/23 is estimated to be $3,125 million. These annual gross benefits are eventually distributed to producers, wholesalers, retailers and consumers in relation to the relative slopes of the demand and supply curves at all the various market levels, as the market adjusts over time to the new level of domestic consumer willingness-to-pay for guaranteed tenderness. At the OTH level in the last four years aggregate OTH returns have averaged around $200 million

annually. The cumulative value to 2022/23 is estimated to be just under $2,200 million. Over the whole period 2004/05 to 2022/23, producers have received about 70 per cent of the total available willingness to pay.

The MSA grading scheme has been mentioned in the literature as a prime example of the design and implementation of a 'chain good' – an innovation put in place by a value chain to minimise the impact of or to overcome a chain failure (Fleming et al., 2021). The net returns to the Australian beef industry from this investment over 25 years so far have been enormous and have far exceeded the costs incurred in researching, implementing and operating the scheme.

It should be mentioned again that the analysis reported here only differentiates between 'ungraded' and 'graded' product. Graded product could be 3 star, 4 star or 5 star. No account is taken of any additional value that might be achieved from selling the beef at these higher quality levels, even though there are many examples of specialised beef retailers doing exactly that (Polkinghorne et al., 2008; Griffith et al., 2009) and extensive willingness to pay studies (Lyford et al., 2010) which show 50 per cent premiums for 4 star over 3 star and 100 per cent premiums for 5 star over 4 star.

Further, while neither of the two major Australian supermarket chains brand their beef offerings as MSA, it is broadly recognised all their beef products are backed by the MSA grading scheme. Both supermarkets offer home brands that sit beside the equivalent MSA grades. For example, Coles sells grain-fed and grass-fed beef as 'Coles Finest' and 'Graze' respectively (Condon, 2017). The MSA grading scheme has been used to shape the branding of particular products in the beef industry. This is evident across the whole MSA program where in 2022/23, 194 licensed brands run under the guidelines of MSA both on a national and international level.

References

Centre for International Economics (2012), *Red Meat Eating Quality – recent program performance and emerging roles*, Report prepared for Meat and Livestock Australia, CIE, Canberra and Sydney, January (approved for release May 2012).

Condon, J. (2017, October 11), *Coles celebrates differences between grain and grassfed in new beef campaign*. Retrieved from Beef Central: https://www.beefcentral.com/trade/coles-celebrates-differences-between-grain-and-grassfed-in-new-beef-campaign/

Condon, J. (2018, October 29), *Branding changes, consumer research behind Woolies' decision to drop MSA logo*. Retrieved from Beef Central: https://www.beefcentral.com/trade/branding-changes-consumer-research-behind-woolies-decision-to-drop-msa-logo/

Fleming, E., Griffith, G., Mounter, S.M., Hartmann, M. and Simons, J. (2021), "Food value chain coordination in practice: European and Australian case studies of the creation of chain good innovations", *International Journal on Food Systems Dynamics* 12(3), 1-10.

Freebairn, J. (1967), "Grading as a market innovation", *Review of Marketing and Agricultural Economics, 35*(03). Retrieved 11 6, 2018, from https://econpapers.repec.org/repec:ags:remaae:9136

Griffith, G.R., Rodgers, H.J., Thompson, J.M. and Dart, C. (2009), "The aggregate economic benefits from the adoption of Meat Standards Australia", *Australasian Agribusiness Review* Volume 17, Paper 5, pp. 94-114. Available at: http://www.agrifood.info/review/2009/Griffith_Rodgers_Thompson_Dart.pdf

Griffith, G., & Thompson, J. (2012), "The Aggregate Economic Benefits to the Australian Beef Industry from the Adoption of Meat Stanrds Australia: updated to 2010/11", *Australian Agribusiness Review*, 20(2), 11-38.

Griffith, G.R. and Burrow, H.M. (2015), "The Cooperative Research Centre for Beef Genetic Technologies: using the Impact Tool to evaluate realized and anticipated benefits, 2005/06-2020/21", *Animal Production Science* 55, 133-144.

Lyford, C., Thompson, J., Polkinghorne, R., Miller, M., Nishimura, T., Neath, K., Allen, P. and Belasco, E. (2010), "Is willingness to pay (WTP) for beef quality grades affected by consumer demographics and meat consumption

preferences?", *Australasian Agribusiness Review* Volume 18, Paper 1, pp.1-17. Available at: http://www.agrifood.info/review/2010/Lyford_et_al.pdf

Meat Standards Australia (2014), *Meat Standards Australia: Beef.* Sydney: Meat and Livestock Australia Limited.

MLA (2005), *Comparison of MSA vs. Non-MSA Product in the Australian Domestic Market,* Meat and Livestock Australia, Sydney, December.

MLA (2010), *Meat Standards Australia Annual Outcomes Report 2009-10.* Sydney, Australia: Meat and Livestock Australia.

MLA (2011), *Meat Standards Australia Annual Outcomes Report 2010-11.* Sydney, Australia: Meat and Livestock Australia.

MLA (2012), *Meat Standards Australia Annual Outcomes Report 2011-12.* Sydney, Australia: Meat and Livestock Australia.

MLA (2013), *Meat Standards Australia Annual Outcomes Report 2012-13.* Sydney, Armidale: Meat and Livestock Australia.

MLA (2014), *Meat Standards Australia Annual Outcomes Report 2013-14.* Sydney, Australia: Meat and Livestock Australia.

MLA (2015), *Meat Standards Australia Annual Outcomes Report 2014-15.* Sydney, Australia: Meat and Livestock Australia.

MLA (2016), *Meat Standards Australia Annual Outcomes Report 2015-16.* Sydney, Australia: Meat and Livestock Australia.

MLA (2017), *Australian Beef Eating Quality Insights 2017.* Sydney: Meat & Livestock Australia.

MLA (2017), *Meat Standards Australia Annual Outcomes Report 2016-17.* Sydney, Australia: Meat and Livestock Australia.

MLA (2017), *MSA Tips & Tools: Meat Standards Australia beef information kit.* Sydney: Meat & Livestock Australia.

MLA (2018), *Delivering consumer confidence in eating quality for 20 years.* Sydney: Meat & Livestock Australia.

MLA (2018), *Meat Standards Australia Annual Outcomes Report 2017-18.* Sydney, Australia: Meat and Livestock Australia.

MLA (2019), *Grading*. Retrieved from Meat & Livestock Australia: https://www.mla.com.au/marketing-beef-and-lamb/meat-standards-australia/msa-beef/grading/

MLA (2023), *Meat Standards Australia Annual Outcomes Report 2022-23.* Sydney, Australia: Meat and Livestock Australia.

Millward Brown (2007b), *Retail Wholesale Price Report 2006/07,* Meat and Livestock Australia, North Sydney.

Polkinghorne, R., Thompson, J., Watson, R., Gee, A., & Porter, M. (2008), "Evolution of the Meat Standards Australia (MSA) beef grading system", *Australian Journal of Experimental Agriculture*, 48, 1351-1359.

Thompson, J. (2003), An overview of MSA. *2003 Armidale Feeder Steer School*, 75-82.

Umberger, W. and Griffith, G.R. (2011), "Beef cattle producer strategies to accommodate more concentrated and more organised value chains and more discriminating consumers", *Farm Policy Journal* 8 (3), 27-37.

Zhao, Xueyan, Griffith, Garry and Mullen, John (2001), "Farmer returns from new technologies in the Australian beef industry: on-farm research versus off-farm research", Review Paper No. 1, Volume 9 in *Australasian Agribusiness Review,* [Online]. Available: http://www.agribusiness.asn.au/review/2001v9/Griffith_Beef_Research/Zhao_Griffith_Mullen.htm

Zhang, Yue, Mounter, Stuart and Griffith, Garry (2018), "Updating and recalibrating equilibrium displacement models of the Australian livestock industries: beef", *Australasian Agribusiness Review* Volume 26, Paper 4, 48-67.

Appendix 1. National Average Retail MSA Premium on a Carcass Equivalent Basis, January-September 2005 [a] (from Griffith and Thompson, 2012, Table 1a)

Cut	Retail MSA Price ($/kg)	Retail Non-MSA Price ($/kg)	Retail MSA Margin ($/kg)	Retail MSA Margin (%)
HINDQUARTER				
Topside	16.51	14.05	2.46	17.5
Thick Flank (knuckle)	14.03	13.37	0.66	4.9
Outside (silverside)	11.33	12.51	-1.18	-9.4
D-Rump (rump)	19.83	18.64	1.19	6.4
Tenderloin (butt fillet)	34.05	31.32	2.73	8.7
Striploin (sirloin)	27.12	23.27	3.85	16.5
FOREQUARTER				
Navel End Brisket	8.00	8.00	-	-
Point End Brisket	8.00	8.00	-	-
Cube Roll	28.82	23.47	5.35	22.8
Blade	12.85	12.17	0.68	5.6
Chuck Roll	15.13	15.13	-	-
Chuck Tender (stir fry)	19.45	15.13	4.32	28.6
Shin Shank (diced)	13.56	12.96	0.60	4.6
Thin Skirt	8.00	8.00	-	-
Flank Steak	8.00	8.00	-	-
Trimmings (mince)	8.00	8.00	-	-
Meat Yield	9.44	8.88	0.56	6.3
Fat	0.30	0.30	-	-
Bone	0.05	0.05	-	-
HSCW Equivalent	6.53	6.15	0.39	6.3

Source: MLA (2005). [a] Chuck roll not quoted; estimated to be the same base price as chuck tender based on the MLA spreadsheet of the underlying carcass breakdown. Navel end brisket, point end brisket, thin skirt, flank steak and trimmings not quoted; estimated to be the same base price as trimmings based on the MLA spreadsheet of the underlying carcass breakdown.

Appendix 2. Trade Steer vs MSA Trade Steer, 1999-2018