final report

FEEDLOTS

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Impact of proposed ethanol mandate on Queensland sorghum prices

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Abstract

Models of the impacts of the proposed *Fuel (Ethanol Content) Bill 2010* in Queensland on grain sorghum prices; farm-gate prices of livestock and livestock products; and retail prices for beef, pork, chicken, milk and eggs were developed. The proposal to introduce a 5 per cent and subsequent 10 per cent ethanol mandate would potentially increase costs of production for livestock, reduce international competitiveness of the livestock industries and increase costs to consumers. The study showed differences in impacts between normal and drought years. In normal years, prices of sorghum were estimated to rise by no more than 1.5 per cent at a 10 per cent mandate level. In drought years grain prices could increase by 20 per cent or higher. The impacts on retail prices were modest, with less than a 1 per cent increase in normal years and up to 7 per cent for chicken in a drought year. Because the mandate acts as a tax, it will have distortionary effects on marketing behaviour and will diminish Queensland's international competitiveness in livestock production.

Executive summary

GHD, in association with JCS Solutions, was contracted by Meat & Livestock Australia (MLA) to investigate the potential impact of both the currently proposed (5 per cent) and possible future (10 per cent) levels of ethanol inclusion in regular unleaded petrol on Queensland sorghum prices, and the flow-on impact on food prices, under a range of scenarios.

The purpose of the project was to quantitatively determine:

- The impact of the proposed Queensland 5 per cent ethanol mandate legislation on regional sorghum prices in the state.
- The impact of the proposed Queensland ethanol mandate legislation on regional sorghum prices in the state, if the 5 per cent mandate is increased to 10 per cent as intended.
- The impact on regional sorghum prices of a 5 per cent and 10 per cent ethanol mandate in Queensland if a drought of the severity of 2002/03 is repeated in future.
- The food price impacts (grain fed beef, pork, poultry meat, poultry egg and dairy) under the above scenarios.

It is estimated that a 5 per cent mandate will lead to a 2 per cent increase in demand for sorghum for ethanol production. A 10 per cent mandate will lead to a 50 per cent increase in demand for sorghum for ethanol production.

Average annual production of sorghum in Australia is 1,881,000 tonnes. The livestock industries in southeast Queensland utilise about 849,000 tonnes of sorghum per year with shortfalls in production met by transfers from central Queensland and northern NSW. In a normal year Queensland exports 353,000 tonnes.

An ‘equilibrium displacement model’ was used to estimate the impact of the increased demand for sorghum for ethanol on regional sorghum prices. This approach required specification of elasticities of demand and supply for 31 variables used in the model with industry input used to determine ‘best-bet’ values as well as alternative sets of values to generate a sensitivity analysis. Key assumptions were made about substitutability of sorghum with other cereal grains for livestock feeding and differences in sorghum supply between normal and drought years.

In a drought year it was assumed that there would be no exports. The calculations for a drought year provide estimated price increases arising directly from the mandate and are *in addition* to the price increases that would be caused by a drought[1]. The model calculated modest increases in sorghum prices at the 5 per cent mandate level for both normal and drought years using ‘best-bet’ values for variables. At the 10 per cent mandate level the price increase in a drought year was more than 20 per cent (see Exhibit 1). The sensitivity analysis indicated a doubling in sorghum price in a drought year using ‘high-end’ but still feasible values for variables.[2]

[1] Drought-induced price increases were beyond the scope of the present study.

[2] Price impacts in a drought year are substantially higher than those in a normal year for two key reasons: in a drought year, sorghum cannot be diverted from the export market in order to satisfy domestic demand. In addition, in a drought year, demand for sorghum to produce ethanol is much greater (in percentage terms) because exports are assumed to be zero.

Exhibit 1 Impact of the ethanol mandate on Queensland sorghum prices

	Northern/central Queensland		Southeast Queensland	
Mandate level	Sorghum price increase % Normal year	Sorghum price increase % Drought year	Sorghum price increase % Normal year	Sorghum price increase % Drought year
5%	0.06	0.93	0.05	0.88
10%	1.40	23.22	1.29	22.06

The increase in sorghum prices was modelled for its impact on both ‘farm-gate’ prices of livestock and livestock products and subsequent increase in the retail price of beef, pork, chicken, milk and eggs.

In view of the uncertainty surrounding the actual behaviour of marketing margins in the processing, wholesaling and retailing sectors, the study assumed alternative simple models of margin behaviour and applied them to the percentage changes in commodity prices (farm-gate prices) to obtain estimates of percentage changes in retail prices.

For the model where the marketing margin is a linear function of retail price, the increase in retail prices from the ethanol mandate is shown in Exhibit 2:

Exhibit 2 Impact of the ethanol mandate on retail food prices

Retail product and mandate	Best-bet retail price increases (%) Normal year	Best-bet retail price increases (%) Drought
Beef:		
5%	0.001	0.026
10%	0.036	0.655
Pork:		
5%	0.004	0.060
10%	0.094	1.492
Chicken:		
5%	0.010	0.154
10%	0.236	3.842
Milk:		
5%	0.004	0.054
10%	0.082	1.356
Eggs:		
5%	0.008	0.134
10%	0.190	3.333

The modest increases in retail prices (estimated by all of the marketing margin models) are to be expected because of the modest increases in the ‘farm-gate’ prices. In addition, for the livestock products of interest (except eggs) there is considerable processing involved in converting the ‘farm-gate’ product into the retail product. The cost of the ‘farm-gate’ product is but one component of the total cost of producing the product delivered to retailers and it might not necessarily be the largest cost component.

The impacts of the proposed 5 per cent ethanol mandate seem modest in a normal year and are more severe in a drought year. A 10 per cent mandate would result in more severe sorghum price increases and increases that are substantial in a drought year. These translate into relatively modest increases in retail prices.

However, these are only the immediate impacts. Impacts five years from the time of introduction depend on several factors, including possible growth in the use of non-sorghum feedstocks for ethanol production, whether new technologies for producing ethanol come on line and changes in trade policies.

Because the mandate will be a tax on an input used by the livestock industries, it will diminish Queensland’s international competitiveness in livestock production. In the course of five years one could expect the Queensland livestock industries to have contracted although perhaps by not very much. There is certainly evidence of this in the US where the expansion in corn use for ethanol has been pronounced, and it is forecast to continue to be the case.

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1 Background

1.1 The Fuel (Ethanol Content) Bill 2010

1.1.1 Background and objectives of the Bill

The *Fuel (Ethanol Content) Bill 2010* (the Bill) was drafted in February 2010. This followed the Queensland government's announcement in August 2006 that it intended to introduce a 5 per cent ethanol mandate for unleaded petrol sold in Queensland by the end of 2010, and that this would subsequently increase to 10 per cent.

Ethanol-blended petrol is already mandated in New South Wales (NSW). In October 2007 the NSW government introduced an ethanol mandate which required 2 per cent of all petrol sold at the wholesale level to be ethanol. The mandate was increased in January 2010 to 4 per cent of petrol sold by wholesalers and major retailers, with a further increase (to 6 per cent) by January 2011. The amended legislation also includes a provision that all regular grade (i.e. non-premium) unleaded petrol become 10 per cent ethanol blended fuel by July 2011.

The Queensland Bill has four stated objectives:

- To support the development of an ethanol industry in Queensland that offers value-adding opportunities and economic benefits for regional areas
- To increase the market share of fuel grade ethanol in Queensland as a way of diversifying the State's transport fuel mix to include a greater share of renewable fuels
- To establish the market conditions for fuel grade ethanol to underpin the development of a second generation ethanol industry based on emerging production technologies
- To contribute to a reduction in greenhouse gas emissions relating to motor vehicles

1.1.2 Application of the Bill

If passed by Parliament the Bill would apply to:

- Petrol sales by wholesalers to retailers
- Sales from retailers to consumers

Retailers that own or operate less than ten retail sites in Queensland are exempt from the Bill.

1.1.3 Suspension or modification of the Bill

The Bill includes a provision for the Minister to suspend or modify the ethanol mandate if one or more of the following applies:

- A significant number of petrol sellers are unable to obtain enough ethanol or petrol-ethanol blend to comply with the 5 per cent mandate
- The mandate threatens the viability of a substantial proportion of petrol sellers' businesses
- The mandate may result in negative economic outcomes for Queensland
- Other extraordinary circumstances exist that justify the Minister suspending or modifying the mandate

1.2 Ethanol production in Queensland

There are currently two main sources of ethanol in Queensland: CSR Sarina and Dalby Bio Refinery. Whilst the Dalby Bio-refinery went into voluntary administration in June 2010, the administrators 'Ernst & Young' are continuing to operate the plant with a view to sell in future. Accordingly, this report has felt it reasonable to assume that the plant will remain an ongoing entity (under current or new owners) in the production of ethanol. The Sarina plant uses molasses from sugar cane and the Dalby refinery uses sorghum as its feedstock. To meet the proposed 5 percent mandate, 183ML of ethanol is required. There are several possibilities regarding future production, as shown in Table 1 below.

Table 1 Potential sources of future ethanol production

Owner and location	Feedstock	Capacity	Status
CSR Sarina	C-Molasses Sugar juice	90ML 100ML	Potential by 2010 Potential by 2011
Heck Group, Rocky Point	C-Molasses Sorghum	10ML	Potential by 2011
David Cox, Burdekin	Cane juice	60ML	Investigating
Mackay Sugar	C-Molasses	60ML	Feasibility Phase
Dalby Bio Refinery	Sorghum and feed wheat	90ML	As at 2010
AgriFuels	Sweet sorghum	146ML	Potential by 2012
Total		556ML	2011+

Source: Queensland Government (2009, p19).

Given the above stated capacities and timeframes, it is expected that 50 per cent of the proposed 5 per cent ethanol mandate requirements will be sourced from the Dalby bio-refinery when the mandate is introduced in December 2010. Accordingly 50 per cent of the mandate will, at least initially, be sourced from sorghum. Therefore the introduction of the ethanol mandate is likely to have an impact on the dynamics of sorghum production and marketing.

1.3 The sorghum industry

1.3.1 Background to the industry

Sorghum is grown as a feed grain crop, with its use historically targeted to both the domestic and overseas animal feed markets. Sorghum is primarily used as an energy source, with the grain providing high levels of available energy for pigs, poultry and cattle feeding. The use of sorghum in animal rations is based upon grain cost relative to other grains including wheat, barley, triticale, oats and maize. Sorghum use is not directly substitutable with other cereal grains as it may require some form of processing (heating or rolling) to improve the availability of nutrients to animals, especially ruminants.

Sorghum as a summer growing crop is ideally suited to the Queensland and northern NSW cropping regions. The area planted annually is subject to the projected price outlook and rainfall leading into the normal planting period. Planting sorghum in less than ideal soil moisture conditions significantly reduces yields, increases the risk of crop failure and places a greater reliance upon in-crop rainfall to produce an economic yield. Sorghum crops grown with adequate soil moisture will typically produce 2.5 – 5.0 tonnes/ha.

While sorghum can be planted over a wide sowing window for most areas, there is a need to avoid sowing too early (cold) or too late (ergot and frosts). The crop should not be flowering during extreme heat, thus there is normally an early and late crop production opportunity. Suitable hybrid varieties are available for early and late crop sowing.

1.3.2 Production and use

Production data identifies the variable production of sorghum in both Queensland and NSW (see Table 2). The cropping area is the most variable, with dry years such as 2002/03 and 2006/07 resulting in reduced area as well as below average yield.

Table 2 Sorghum production in NSW and Queensland, 1997/98 – 2009/10

	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	12 year average
Tonnes - '000														
NSW	382	822	804	770	767	531	709	847	747	385	1050	817	655	710
QLD	691	1059	1308	1156	1247	930	1296	1164	1144	896	1635	1500	1195	1171
TOTAL	1073	1881	2112	1926	2014	1461	2005	2011	1891	1281	2685	2317	1850	1881
Hectares - '000														
NSW	123	216	200	258	258	255	212	211	252	162	250	215	200	216
QLD	379	367	419	494	562	405	519	544	495	449	545	817	655	512
TOTAL	502	583	619	752	820	660	731	755	747	611	795	1032	855	685
Yield - t/ha														
NSW	3.1	3.8	4.0	3.0	3.0	2.1	3.3	4.0	3.0	2.4	4.2	3.8	3.3	3.3
QLD	1.8	2.9	3.1	2.3	2.2	2.3	2.5	2.1	2.3	2.0	3.0	1.8	1.8	2.4
TOTAL	2.1	3.2	3.4	2.6	2.5	2.2	2.7	2.7	2.5	2.1	3.4	2.2	2.2	2.7

Source: ABS 97/98 – 08/09, ABARE 09/10

Sorghum production in Queensland occurs mainly in two geographic areas, namely southeast Queensland and northern/central Queensland. The focus of this study is southeast Queensland because this region yields the majority of demand and supply for sorghum in the state.

Within the southeast Queensland region, average normal year production is 747,000 tonnes. The livestock industries in southeast Queensland utilise about 849,000 tonnes of sorghum per year with shortfalls in production provided by transfers from central Queensland and northern NSW. In addition, in a normal year Queensland has been an exporter of sorghum with average export volumes (2001/02 – 2007/08) being 255,000 tonnes and 98,000 tonnes from central and southeast Queensland respectively.

Sorghum demand altered in 2009 with the commissioning of the Dalby ethanol plant that provides additional demand for over 200,000 tonnes of sorghum per year. To meet the changed demand for sorghum, there will need to be either less sorghum exported or a shift in feed grain use from sorghum to wheat and barley.

During drought years with reduced crop availability, additional feed grains will either need to be sourced from other growing regions or demand will decline in line with grain supply. Access to imported grain is restricted due to Australian quarantine laws which make it difficult to secure import permits and which require grain to be processed within metropolitan port zones before it can be transported up country. As a result, the utilisation of imported grain outside port zones is extremely rare.

2 Project objectives

2.1 Purpose and scope

GHD, in association with JCS Solutions, was contracted by Meat & Livestock Australia (MLA) to investigate the potential impact of both the currently proposed (5 per cent) and possible future (10 per cent) mandate levels of ethanol inclusion in regular unleaded petrol on Queensland sorghum prices, and the flow-on impact on food prices, under a range of scenarios. Under all scenarios, the analysis assumes a 10% ethanol blend with regular unleaded petrol.

The purpose of the project is to quantitatively determine:

- The impact of the proposed Queensland 5 per cent ethanol mandate legislation on regional sorghum prices in the state.
- The impact of the proposed Queensland ethanol mandate legislation on regional sorghum prices in the state, if the 5 per cent mandate is increased to 10 per cent as intended.
- The impact on regional sorghum prices of a 5 per cent and 10 per cent ethanol mandate in Queensland if a drought of the severity of 2002/03 is repeated in future.
- The food price impacts (grain fed beef, pork, poultry meat, poultry egg and dairy) under the above scenarios.

The project has been undertaken via targeted consultation with key informants and the development of spreadsheet-based models to calculate potential price impacts of the proposed ethanol mandate in Queensland. This will assist MLA to provide an informed response to any future Queensland Government policy announcements regarding ethanol.

2.2 Structure of this report

The methodology used to undertake the project is described in Section 3, including a detailed description of the models and the assumptions upon which they are based. The results of the modelling are presented in Section 4, including the outcomes of sensitivity analysis. Section 5 provides the conclusions of the analysis.

3 Methodology

3.1 Approach

GHD adopted a five-step methodology to complete the project:

- Step 1: Inception meeting
- Step 2: Desktop analysis and targeted consultation with industry stakeholders
- Step 3: Development of economic models
- Step 4: Validation with MLA / Australian Lot Feeders Association (ALFA)
- Step 5: Reporting

The purpose of the consultation was to:

- Test the robustness of the models' assumptions
- Address any data gaps arising from the desktop analysis

Targeted consultation (in person or via phone) was undertaken with representatives from a variety of stakeholders including: intensive livestock industries; the ethanol industry; and the grains industry.

3.2 Economic model

3.2.1 Model approach

The modelling approach adopted is a two-stage process with the first stage analysing the impacts of the ethanol mandate on sorghum prices and the second stage analysing the impact of increased sorghum prices on final livestock prices and food prices (meat, milk and eggs). The sequential approach is considered to be most suitable within the project scope and timeframes.

3.2.2 Estimating the impact of the mandate on regional sorghum prices

An 'equilibrium displacement model', which is being increasingly used in assessing impacts of government policy, has been adopted to estimate the impact on regional sorghum prices. This approach requires specification of the various market interrelationships in 'displacement' form where the variables of interest (e.g. sorghum prices) are expressed as proportionate changes and are functions of elasticities of demand and supply (percentage change in a dependent variable divided by the percentage change in a causal variable)[3]. The chosen values of the elasticities are 'best-bet' values based on a mixture of judgement, theory regarding elasticity size and sign (i.e. positive or negative) and empirical estimates where available. Alternative sets of elasticity values are used to generate alternative outcomes to produce a sensitivity analysis.

Choosing elasticities to implement an equilibrium displacement model and undertaking sensitivity analysis are not straightforward tasks and care needs to be taken. Moreover, such models present more accurate results when only small changes in variables around their mean values are involved[4]. However, there are problems to be avoided in any sort of modelling and, in the

[3] For example, the percentage change in sorghum demand caused by a percentage change in sorghum price is the elasticity of sorghum demand with respect to the sorghum price.

[4] Tomek and Robinson (2003, pp418-419) outline some of the problems.

present study, the equilibrium displacement approach is a practical way forward given the time, resource and data constraints involved.

The displacement modelling approach makes use of Excel spreadsheets and many studies in the professional agricultural economics literature use this approach[5].

An alternative, and much simpler, approach would have been to utilise a single equation to estimate the impact of a demand change on price in a competitive market. However, this approach does not have a spatial dimension which is required in the terms of reference for this study (i.e. regional sorghum price impacts) and it does not allow for cross-market relationships that exist in the context of the present study (e.g. substitution relationships among various grains, both in demand and in supply). The single equation approach has been used as a check on the results of the displacement model.

The model used in this study
The model used to estimate the impacts of the mandate on annual sorghum prices is presented in equation form in Appendix 8.1. Key assumptions underlying the model are presented in section 3.2.4 below and Appendix 8.1 should be read in conjunction with this.

The model contains 31 endogenous variables (variables whose values are determined in the solution to the model) and 31 equations and 'adding-up' conditions. The model operates by specifying base values for all endogenous variables (the initial equilibrium) and then specifying a value for the extra sorghum demand generated by the ethanol mandate and solving the model for the new equilibrium. The mandate acts as a 'shock' to the system of equations which generates new equilibrium values for all endogenous variables.[6]

Two sets of base values are chosen: one set for a normal year and one set for a drought year. For both normal and drought years, three sets of results are generated:
- one for a set of elasticities that, while being feasible values, yield an upper limit result for the sorghum price change;
- one for a set of elasticities that, while being feasible values, yield a lower limit result for the sorghum price change; and
- one for a set of elasticity values that yield a 'best-bet' or most likely result for the sorghum price change[7].

3.2.3 Estimating the impacts of the mandate on food prices

Model approach
Introducing a mandate on ethanol use in petrol has effects on industries using feedgrains that are equivalent to the effects from the imposition of a tax on an input. The additional demand for sorghum causes an increase in the price of sorghum and users of feedgrains will pay a higher price for any quantity of sorghum that they use. In essence, the mandate acts like a tax on sorghum, just like taxes on fuel[8]. The taxing effect of the mandate is demonstrated diagrammatically in Appendix 8.2.

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[5] The method is outlined in more detail by Piggott (1992) and an example of the application of the method in estimating payoffs from meat advertising in Australia is given in Piggott, Piggott and Wright (1995).

[6] The new equilibrium total quantity of sorghum demanded and the new sorghum prices are adjusted for the extra availability of distiller's grain generated by the mandate. The assumptions underpinning the adjustment are shown in Table 3.

[7] This final set of results uses a set of 'best-bet' elasticities; that is, elasticities that are set at their most likely values.

[8] In economic terms, the supply function of sorghum confronting users of feedgrains moves vertically upward, meaning that a higher price needs to be paid by feedlotters for any quantity of sorghum used. Indeed, the rate of the equivalent tax, expressed as a

With this in mind and wanting to model the impacts of the mandate on food prices, as a first step the increases in the 'farm-gate' prices of commodities (e.g., finished cattle and pigs ready for transport to abattoirs) need to be investigated. These price increases can then be used to estimate the increases in retail prices (e.g., supermarket prices for beef and pork).

Impact on 'farm-gate' prices

The method used to estimate the impact of the mandate on 'farm-gate' prices considers the production processes involved: for example, in the case of beef feedlotting, using live cattle entering the feedlot, sorghum and other grains in the diet, and various other inputs such as labour and energy, to produce an animal ready for slaughter. Inputs have been classified into three types: (a) sorghum; (b) livestock (e.g., cattle entering the feedlot, grower pigs); and (c) all other inputs measured in terms of a quantity index. The output is a 'farm-gate' commodity ready for transporting, processing, wholesaling and retailing to final consumers.

When the price of an input changes (in the present case, sorghum) cost minimising behaviour means that there may be some substitution among inputs (e.g. less sorghum might be used and perhaps more barley). The extent to which inputs can be substituted for each other in response to changes in relative input prices depends on underlying technical conditions of production and seasonal conditions. For example, it may be possible to substitute wheat or barley for sorghum when sorghum crop yields are lower than normal. Eventually, however, price differentials between grains find a level based on nutritional value for feeding, either locally or overseas.

The equilibrium displacement model used for estimating impacts of the increased sorghum prices on 'farm-gate' prices is outlined in Appendix 8.3. It consists of eight equations: two equations representing the demand and supply of the output (e.g., finished cattle) and six equations representing the demand and supply of three inputs (sorghum, livestock and 'other inputs'). The impact of the ethanol mandate on the sorghum market is represented by a vertical upward shift in the supply of sorghum to each livestock industry (i.e. a higher price for any quantity of sorghum used – just like a tax would be modelled)[9].

The model is solved for the percentage increase in the 'farm-gate' commodity price using various assumed parameter values. Values were assumed for input cost shares (choices were informed by information supplied by industry sources), the degree of substitution among inputs used in producing finished cattle (choices were informed by information supplied by industry sources) and some demand and supply elasticities (choices based on empirical evidence and the GHD project team's judgement). Alternative estimates are made with alternative assumed values for parameters (sensitivity analysis).

percentage of the original sorghum price, can be shown to exceed the percentage increase in the price of sorghum. For example, if the price of sorghum increases by one percent because of the mandate, this is equivalent to having a tax imposed on sorghum of something greater than one per cent, the extent of the difference depending on the underlying sorghum demand and supply responsiveness to sorghum price, or price elasticities of sorghum demand and supply. The relevant supply elasticity here is the supply elasticity to a particular industry which is greater than the supply elasticity for sorghum in total. It can be shown that the lower the supply elasticity to a particular industry, the greater the difference between the percentage sorghum price increase and the equivalent percentage per unit tax. Examples are provided when the results for a drought year are discussed.

[9] The extent of the upward shift reflects the equivalent tax rate for the particular industry which, in turn, is computed using the sorghum price increase from the previous step and underlying demand and supply elasticities for the particular industry.

Impact on food prices

The impacts of changes in 'farm-gate' commodity prices on retail food prices have been estimated by using empirical information about marketing margin behaviour. This is detailed in section 4.2.

3.2.4 Key assumptions

Normal year

As with most modelling work, assumptions (or choices) were required to undertake the analysis. The assumptions used to model the impacts of the mandate in a normal (i.e. non-drought) year are presented in Table 3.

Table 3 Model assumptions – Normal year

Model feature	Assumption	Rationale / Source
Increase in demand for sorghum for ethanol production due to ethanol mandate (M)[10]	In the case of a 5 per cent (10 per cent) mandate it is assumed that the demand for sorghum for ethanol production would increase by 2 per cent (50 per cent). (See 4.1.1)	According to Queensland Government (2009, p22), the existing capacity of the Dalby ethanol plant and the planned capacity at the Sarina ethanol plant are almost enough to satisfy the needs of a 5 per cent mandate. However, the foreshadowed 10 per cent mandate would require additional production capacity unless the extra ethanol needs were satisfied by imports of ethanol (which seems unlikely given current duties on the imported product). Additional production capacity might be built at Dalby or Sarina, or it might come about through new plants. Further explanation for the assumed figures is provided on p. 19.
Demand and supply of each type of grain	Are functions of their own price as well as prices of other grains and the prices of final products they are used to produce	This is a standard representation of commodity demand and supply in economics.
Geographic regions	Northern/central Queensland and southeast Queensland	This corresponds to the level of disaggregation of published data for the feed-livestock complex.
Sorghum imports from other states	Northern NSW supplies some sorghum to southeast Queensland	This accords with reality.
Grain transfers between Queensland regions	Northern/central Queensland supplies sorghum and other grains to southeast Queensland	This accords with reality.
Markets for sorghum in northern/central Queensland (in addition to transfers to southeast Queensland)	Sorghum for animal feed and sorghum for the export market	This accords with reality.
Markets for sorghum in southeast Queensland	Sorghum for animal feed, sorghum for ethanol production and sorghum for the export market	This accords with reality.

[10] That is, the value of 'M' in the economic model.

Model feature	Assumption	Rationale / Source
Sorghum supply sources (for southeast Queensland)	Northern/central Queensland, southeast Queensland and northern NSW	This accords with reality.
Cereal grains other than sorghum[11]	Are aggregated together	This was a choice made to minimise model size. Thus, other grain use includes, in addition to grain used for animal feed, grain used for milling and malting. The latter is a fairly constant quantity irrespective of crop size (Personal communication, John Spragg, May 2010).
Supply sources for other grains (in Queensland)	Northern/central Queensland and southeast Queensland	This accords with reality.
Use of other grains for ethanol production in southeast Queensland	Is assumed to be zero	Accords with reality. Only sorghum has been used to date in the Dalby refinery. The model was specified in such a way as to allow for the use of other grains in any future analysis.
Grain price differences between northern/central Queensland and southeast Queensland	$15/tonne	This is the estimated difference in delivered price at northern/central Queensland and delivered price at southeast Queensland (John Spragg, Personal communication, May 2010). Economic theory suggests that this price difference should equal the cost of transporting a tonne of grain between the two locations and, hence, the transport cost per tonne has been set at $15.
Import taxes and quarantine rules	Status quo	Beyond the scope of the present study to consider changes in these rules.
Ethanol mandate in NSW and other states	Status quo	Beyond the scope of the present study to consider changes in other states. Clearly, if the NSW mandate is increased to 10 per cent as is foreshadowed to happen in mid-2011 and/or other states introduce mandates, there could be increases in grain used for ethanol production in those states. This would have an impact on grain availability in Queensland and the Queensland mandate could have greater impacts on sorghum prices than those estimated in the present study.
Ethanol production technology	Status quo	Beyond the scope of the present study to consider changes in technology.
Quantity of sorghum used in the Dalby ethanol plant that can be offset by the refinery co-product, wet distillers grain, in servicing the animal feed market	Given the high water content (65 per cent), variable quality and high sulphur and phosphorous levels in wet distillers grain, it is assumed that distillers grain can only represent one-third of the value of grain on a dry matter tonne for tonne basis.	This assumption was made after considering the evidence on the usefulness of distillers grain in animal rations. While Queensland Government 2009 drew attention to the significant potential for distillers grain to offset the demand for feedgrains, this potential was discounted by ALFA 2009. Consultation with animal nutritionists also discounts this potential because of its variable quality and high moisture content.

[11] Referred to as 'other grains' in this study.

Model feature	Assumption	Rationale / Source
Cereal grains replaced by the extra distillers grain generated by the mandate	One-third of the extra distillers grain replaces sorghum and two-thirds replaces other cereal grains in feed rations.	No hard data available but estimates were in consultation with John Spragg.
Extent that sorghum contributes to total costs of production	The approach adopted in this study is to produce results for differing percentage contributions of sorghum to total costs. The choices were informed by data on cost shares provided by industry sources. The figures used were: cattle lot feeding 12.5 per cent (20 per cent upper limit); pigs 14 per cent (25 per cent upper limit); chickens 28 per cent (50 per cent upper limit); dairy cattle 8 per cent (16 per cent upper limit); and eggs 24 per cent (39 per cent upper limit).	In its response to Queensland Government 2009, ALFA 2009 suggests that sorghum is the principal grain used in feedlots in Queensland but its degree of dominance depends on availability and relative grain prices. Advice received from animal nutritionists shows that sorghum use is dependent on price relative to wheat and barley. Sorghum requires steam flaking which adds to its dietary cost and therefore only becomes the dominant grain when it is at a discount of at least 15-20 per cent to wheat. Another animal nutritionist indicated that sorghum can comprise 100 per cent of the cereal component of a ration if its price is at a 30 per cent discount to other grains. The importance of relative prices in determining the proportion of sorghum in feed rations is confirmed by John Spragg (Personal communication, June 2010). Another influencing factor is the size of the winter crop harvest (wheat and barley). If the winter crop is poor, the importance of sorghum in the ration increases. In relation to other livestock industries, some of the same points apply.
Technological conditions of production underpinning feed grain users	Are characterised by 'constant returns to scale'[12]	This is an often-used and intuitively reasonable assumption in empirical economic analysis. It is also assumed that beef, pork, dairy and poultry producers have an objective of maximising profit through cost minimisation.
Underlying economic parameters (i.e. elasticities of demand, supply and factor substitution)	Results are provided for alternative values including 'best-bet' values	Based on empirical estimates where available, industry sources, economic theory and project team members' judgement.
Extent of competition in the beef, pork, dairy and poultry industry	There is a high degree of competition among the producers and buyers involved in all the processes associated with turning out finished cattle	No known empirical evidence to the contrary. However, there is some empirical evidence to support less competitive behaviour in meat marketing. In particular, there is evidence of what economists refer to as price levelling, price averaging and asymmetric pricing[13].

[12] That is, increasing all input use by x per cent increases output by x per cent.

[13] This is discussed further in the report, when the impacts on retail food prices are examined.

Drought year

The assumptions for a drought year are the same as those for a normal year with some additions and exceptions as shown in Table 4.

Table 4 Model assumptions – Drought year

Model feature	Assumption	Rationale / Source
Grain production	60 per cent of normal year production	John Spragg, Personal communication, May 2010
Grain imports from other Australian states	Other grains are shipped to Queensland from other states such as SA and WA to help cover shortfalls in Queensland supplies	Consultation with grain industry
Sorghum overseas exports	There are no overseas exports of sorghum from northern/central or south-eastern Queensland in drought years.	Probably accords with reality. If there are some exports, then the sorghum price increases for drought years will be slightly overstated.

4 Results and discussion

4.1 Impact on sorghum prices

4.1.1 Impact of mandate on Queensland sorghum prices: Normal year

In the case of a 5 per cent mandate, 183ML of ethanol is required (Queensland Government, 2009, p.18). This is just 3ML more than the combined current capacity of the Dalby (90ML) and Sarina (90ML) plants. Based on the Dalby plant production figures (90ML of ethanol from 207kt of sorghum), it would take about 6.9kt of sorghum to produce the extra ethanol assuming the extra ethanol all came from sorghum. But if only half (an assumption) of the extra ethanol came from sorghum, it would take about an extra 3.5 kt of sorghum to produce it. This would represent an increase in sorghum use for ethanol of 1.7 per cent[14]. Hence, a value of 2 per cent was chosen as the increase in demand for sorghum for ethanol production resulting from a 5 per cent mandate.

For a 10 per cent mandate, 366ML of ethanol would be required. Based on Queensland Government figures (2009, Table 5, p.19), forecast Queensland ethanol production capacity in 2011 is 290ML (Sarina 190ML, Heck Group 10ML, Dalby 90ML), leaving a shortfall of 76 ML[15]. If it is assumed that half of this (38ML) was produced from sorghum, a total of 87.4kt of sorghum grain would be required. This, added to the sorghum used at the Heck Group plant (approximately 10kt – the plant uses both molasses and sorghum), gives a total of about 100kt of extra sorghum to produce (half) of the shortfall in ethanol for a 10 per cent mandate. The total sorghum increase over current levels would be about 50 per cent. Hence, a value of 50 per cent was chosen as the increase in demand for sorghum for ethanol production resulting from a 10 per cent mandate.

[14] That is, 3.5*100/207.

[15] That is, 366-290.

It should be kept in mind that a potentially-significant but uncertain outcome is the foreshadowed additional ethanol production capacity as a result of the AgriFuels project near Childers which would utilise sweet sorghum. According to the Public Benefit Test Report (table 5, p.19), this would have potential production of 146ML by 2012. If this occurs, total Queensland ethanol production capacity could reach 436 ML by 2012 (leaving aside ethanol plants at Mackay and Burdekin that are under consideration). This well exceeds the ethanol required for a 10 per cent mandate (366ML). There would be no additional pressure on sorghum supplies to satisfy the mandates unless new sorghum-based plants were built to supply ethanol to NSW when it moves to a 10 per cent mandate in 2011.

The model was ‘run’ using the range of assumptions outlined above and the model outputs for the estimated impacts of the ethanol mandate on Queensland sorghum prices for a normal production year (i.e. no drought) are shown in Table 5.

Table 5 Percentage increases in price of sorghum due to mandate: Normal year

Mandate level	Northern/central Queensland			Southeast Queensland		
	H	L	BB	H	L	BB
5%	0.17	0.03	0.06	0.16	0.03	0.05
10%	4.31	0.84	1.40	3.96	0.77	1.29

Notes:

1. H = high-end estimate; L = low-end estimate; BB = best-bet estimate.

The estimated price rises for the best-bet parameter values are modest – less than 1 per cent for a 5 per cent mandate and approaching 1.5 per cent for a 10 per cent mandate. However, price increases of the order of 4 per cent are indicated with a 10 per cent mandate using parameter values at more extreme, yet still feasible, levels.

The modest price increases are driven by two key factors:

1. The modest increase in sorghum use for ethanol compared to the overall demand for sorghum in Queensland. In a normal year, current sorghum use for ethanol (207 kt) accounts for about 15 per cent[16] of total sorghum use. A 5 per cent mandate requires only a 2 per cent increase in sorghum use for ethanol amounting to only a 0.3 per cent increase in total sorghum demand. A 10 per cent mandate requires a 50 per cent increase in sorghum use for ethanol which amounts to only a 1.5 per cent increase in total sorghum demand. Moreover, these increases in total sorghum demand have to be adjusted downwards because of the extra production of distillers grain as a result of the mandate which displaces some of the sorghum used for feedgrain.

2. The presence of Queensland exports of sorghum. The responsiveness of sorghum export demand to changes in the price of sorghum (i.e. the price elasticity of sorghum export demand) can safely be assumed to be high. In this study a best-bet value of -30 has been used, meaning that a 1 per cent increase in sorghum price causes a 30 per cent decrease in the quantity of sorghum demanded by sorghum importers. The reason for this high degree of responsiveness (much higher compared with domestic demand

[16] 207kt out of a total of 1,370kt.

elasticities) is that, in export markets, Australian sorghum has fairly good substitutes available in the form of sorghum available from other exporting countries[17].

The highly price-responsive demand for exports is influential on the modelled results. When the sorghum price starts to rise as aggregate demand for sorghum increases due to the mandate, the demand source with the highest degree of substitutes (export demand in this case) will be ‘choked-off’ first in reaching a new equilibrium price level. If the initial (i.e. before mandate) export levels are sufficiently high, the increased demand brought about by the mandate will result in only a small price rise before a new equilibrium price is reached. In essence, as pointed out in Queensland Government (2009, p23), the new market equilibrium is reached mainly by diversion of sorghum from the export market. Other adjustments to satisfy the increased needs of sorghum for the ethanol market include, but are not limited to, some diversion of sorghum from the feed market and some expansion in sorghum supply.

Table 5 also suggests that the percentage price increases for northern/central Queensland are slightly higher than those for southeast Queensland. This comes about because the model used has sorghum prices in southeast Queensland tied to sorghum prices in northern/central Queensland through transport costs. That is, the equilibrium price in southeast Queensland should always be about equal to the equilibrium price in northern/central Queensland plus the cost of transporting a tonne of sorghum from northern/central to southeast Queensland[18].

A ‘single equation’ model was used as a check on the above outcomes and some results from this checking process are shown in Appendix 8.4. There is very little difference between the two sets of results which suggests that the displacement model used is valid. The fact that the results are so close suggests that cross-commodity impacts of price changes captured in the model used in this study are working in the direction of ‘cancelling out’. Nevertheless, it is best-practice to include such cross-commodity impacts in modelling work to cater for the possibility that cancelling-out does not occur.

4.1.2 Impact of mandate on Queensland sorghum prices: Drought year

The impact of the ethanol mandate on sorghum prices in a drought year are shown in Table 6. The calculations for a drought year provide estimated price increases arising directly from the mandate and are *in addition* to the price increases that would be caused by a drought[19]. In simulating a drought year, exports were assumed to be zero and the model was modified to allow inflows of other cereal grains from South Australia and Western Australia. Industry sources suggest that there might be a small amount of sorghum exports from northern/central Queensland even in a drought year and, if so, this may mean the estimates of sorghum price changes are somewhat overstated. On the other hand, it can be argued that other parameters –

[17] In empirical work it is often assumed that exports of Australian agricultural commodities have perfect substitutes available in the form of exports from other countries, resulting in the demand for Australian exports being extremely or infinitely ‘elastic’. However, information from industry sources suggests that Australian sorghum is somewhat differentiated from the sorghum exported from other countries. For example, Australian sorghum has, among other things, a lower moisture content and lower tannin levels than Argentine sorghum and so Argentine sorghum is not a perfect substitute for Australian sorghum, although it is still substitutable in the face of a price rise in the Australian product.

[18] When the two prices are related in this way, the percentage change in the Southern Queensland price will be equal to the percentage change in the Northern-central price multiplied by the base ratio of the North-central price to the Southern price, this ratio being less than one and, hence, resulting in a smaller percentage price change for Southern Queensland compared with North-central Queensland. If this wasn’t the case then the markets would not be in equilibrium: if the price in Southern Queensland exceeded the price in Northern-central Queensland by more than the transport cost per tonne, money could be made through buying sorghum in Northern/Central Queensland and transporting it to Southern Queensland for sale. The technical term for this is market arbitrage.

[19] Drought-induced price increases were beyond the scope of the present study.

particularly the responsiveness of sorghum demand and supply to price changes – may be lower in a drought year than in a normal year and, given that these parameters were not changed in simulating drought year impacts, the impacts would be somewhat understated. The upshot of these opposing influences on the results means the estimates reported in Table 6 should not be biased very much one way or the other.

Table 6 Percentage increases in price of sorghum due to mandate: Drought year

Mandate level	Northern/central Queensland			Southeast Queensland		
	H	L	BB	H	L	BB
5%	3.88	0.53	0.93	3.69	0.51	0.88
10%	97.03	13.31	23.22	92.18	12.65	22.06

Notes:

1. H = high-end estimate; L = low-end estimate; BB = best-bet estimate.
2. The percentage price increases are over and above price increases due to drought.

The obvious outcome from modelling impacts in a drought year is that the sorghum price increases for each mandate level are substantially higher than for a normal year. The best-bet estimate is that, for a 5 per cent mandate, sorghum prices rise by about one per cent and for a 10 percent mandate they would rise by nearly 25 percent. Using more extreme but still feasible parameter values, sorghum prices could nearly double (increase of more than 90 per cent) under a 10 percent mandate.

There are two broad reasons for this. First, in a drought year, current use of sorghum for ethanol (about 207kt/year) represents about 25 per cent of total sorghum usage and, hence, any given increase in sorghum usage for ethanol would translate into a bigger percentage increase in total sorghum demand compared with a normal year. Second, there are no exports that can be diverted to domestic markets. Another way of describing the higher price rises is to say that the ethanol mandate translates into an even higher per unit tax rate on feed grain users in a drought year compared to a normal year.

One of the adjustments that takes place in response to the mandate is that inflows of other grains from South Australia and Western Australia increase. The base value of these inflows was set at 330kt for a drought year. With a mandate in place and assuming best-bet parameter values they would increase by about 2 per cent under a 5 per cent mandate and by about 5 per cent under a 10 per cent mandate.

In simulating the impacts shown in Table 6, it should be noted that base prices were set at drought-year levels based on information received from industry sources. For example, sorghum prices in southeast Queensland were set at $300/tonne rather than the normal-year level of $185/tonne. Hence, the percentage price rises reported in Table 6 are solely attributable to the ethanol mandate—they are price rises, brought about by the ethanol mandate, that are on top of normal price rises associated with drought conditions.

Second, as previously noted, the percentage price rises imply even higher per unit tax rates. For example, in the case of the cattle lot feeding industry, given our best-bet choice of underlying economic parameters, a rise in the average sorghum price for Queensland of 22.6 per cent as would occur under a 10 per cent mandate during a drought year implies a per unit tax rate on lot feeders of 29.1 per cent[20]. For a 5 per cent mandate the implied tax rate is 1.2 per cent. These are the per unit tax rates on sorghum used by lot feeders that would give rise to the same sorghum price increases as the ethanol mandate does.

In summary, the estimated sorghum price rises associated with an ethanol mandate may be modest in a normal year but in a drought year they are much more severe. This comes about in large part because the scope for diversion of exports to domestic markets disappears in a drought year as modelled here, or is at least quite minimal. The price rises in a drought year are equivalent to a significant per unit tax on users of feedgrain in the case of a 10 per cent mandate (averaging about 25 per cent across those industries), with all the attendant distortionary impacts. In a normal year the implied tax rates are much smaller averaging about 1.3 per cent for a 10 per cent mandate but they still have distortionary impacts.

4.2 Impact on food prices

To model impacts on food prices it is necessary to model the impacts of the ethanol mandate on 'farm-gate' commodity prices (e.g., finished cattle prices, raw milk prices) and how these translate into an increase in retail prices (e.g., supermarket prices of beef and milk).

4.2.1 Impact on 'farm-gate' prices

The increases in sorghum prices modelled above translate into 'farm-gate' price increases for the commodities of interest as shown in Table 7.

Table 7 Percentage increases in 'farm gate' commodity prices due to mandate

Commodity	Mandate level	Commodity normal year		Commodity drought year	
		Best-bet	High end	Best-bet	High end
Finished cattle	5%	0.003	0.005	0.060	0.092
	10%	0.082	0.122	1.489	2.311
Finished pigs	5%	0.007	0.012	0.119	0.201
	10%	0.187	0.309	2.984	5.015
Finished chickens	5%	0.013	0.021	0.208	0.343
	10%	0.319	0.516	5.192	8.567
Raw milk	5%	0.005	0.008	0.074	0.132
	10%	0.113	0.198	1.857	3.305
Eggs	5%	0.010	0.015	0.178	0.264
	10%	0.253	0.375	4.444	6.591

Notes:

1. The sorghum price increases used in these calculations are the increases in the weighted average price of northern/central Queensland and south-east Queensland when parameters are set to best-bet values for both normal and drought years.

[20] One multiplies the percentage price rise by a factor x where x= (supply elasticity minus demand elasticity)/supply elasticity.

2. Best-bet values for price increases are those obtained when values for input shares in total cost, input substitution coefficients and price elasticities of demand and supply are all set at their best-bet values.

3. High-end values for price increases are generated by assuming the cost share for sorghum is at its highest level and elasticities for input substitution are at their lowest levels, with other parameters at their best-bet values.

The estimated impacts are modest. For a normal year the price increases are well less than one percent. For a drought year, the price increases are generally less than one percent in the case of a 5 per cent mandate even in the case of the high-end estimates. It is only in the case of a 10 per cent mandate that prices rise by more than one per cent. The biggest price increase, 8.6 per cent, occurs in the case of finished chickens under a 10 per cent mandate in a drought year.

The main drivers of the mostly-modest price increases are the shares of sorghum in the cost structure for these livestock products, the substitution of other grains for sorghum in feed rations when sorghum prices increase and the extent of the rises in the weighted average price of sorghum.

The estimated increases in the commodity prices would, of course, be greater if more extreme (yet feasible) values for underlying parameters were used when estimating impacts on sorghum prices. Also, there may be years when the sorghum share of costs go beyond the upper limits assumed in Table 3. This might occur when there are poor winter crops such that sorghum becomes the principal grain used in rations. This being the case, the impacts of the mandate on commodity prices would be greater than those shown in Table 7. It was clear from industry comments about the substitutability between sorghum and other feedgrains in feed rations that there is substantial variability in the percentage contribution of sorghum to costs.

4.2.2 Impact on retail food prices

Background

The models used to estimate the impacts of the mandate on commodity prices assume that there is a high degree of competition in grain production and marketing in the livestock industries of interest. Under these circumstances prices are the outcome of supply and demand forces and single producers and buyers act as 'price takers'. When we consider events beyond the 'farm gate', it is far from clear that this remains the case, particularly in the retailing sector. Activities beyond the 'farm gate' include transport, slaughter, carcass preparation for turnover to retailers or overseas shipment and, finally, retailing. In this study we are considering all these activities as being combined into a single production process that transforms the 'farm-gate' commodity into the product purchased by consumers.

In the case of beef and pork, one thing we know from the literature is that there is evidence of various pricing practices which are inconsistent with the 'price-taker' behaviour that characterises the economist's model of perfect competition. One such practice is referred to as 'price levelling' whereby retailers try to level out spikes in retail prices over time by varying their margins, perhaps as a result of wishing to maintain the customer base. Another is 'price averaging' where retailers average their margins across different cuts of meat to minimise the size of price changes. For example, if cattle prices rise, retailers take a smaller margin on beef and a larger margin on pork. Yet another practice is asymmetric pricing. This can take various forms but it refers to the observation that price changes at one point in the marketing chain may not be fully reflected in price changes at another level and there may be time lags involved in the transmission of price changes. Asymmetric pricing can occur for various reasons including the fact that changing prices, in say a supermarket or butcher shop, is not a costless process[21]. Whilst the effects of these pricing practices are more likely to be present in monthly price data rather than in annual price data, the pricing practices are inconsistent with price-taking behaviour.

In the case of chicken, there is a high degree of concentration in processing and wholesaling. Milk processing has also become more highly concentrated over time. There is little processing activity in the case of eggs.

In relation to retailing, Australia has a very high level of concentration among the major retailers of food. Although there is no firm evidence of market power being exploited, the degree of concentration is inconsistent with the types of models outlined in Appendix 8.1 and Appendix 8.3 that were used to model grain and farm-gate prices.

We are interested in how changes in the commodity prices of interest translate into changes in retail prices. This requires knowledge of so-called marketing margin behaviour, the marketing margin defined as the difference between prices at two levels in the marketing chain. We know more about marketing margin behaviour when there is a high level of competition (perfect competition in economics jargon) than we do when competition is weak (so-called imperfect competition).[22]

In view of the uncertainty surrounding the actual behaviour of marketing margins in the processing, wholesaling and retailing sectors, we have assumed alternative simple models of margin behaviour and applied them to the percentage changes in commodity prices to obtain estimates of percentage changes in retail prices. Our modelling benefitted from a study on price determination in the Australian food industry (Spencer 2004). The authors of this study indicate quite explicitly that it is not an economic study. It is better described as a qualitative account of price formation processes using contemporary ‘business school’ concepts. Hence there was a limit to the extent that it could be used in the current study where the objective was to produce quantitative estimates of price increases in a short time with a limited budget. However, the GHD team believes that the modelling approaches adopted here are broadly consistent with the table spanning pp. 6-7 of Spencer (2004) which summarises the main drivers of prices. In particular, that table indicates the importance of supply and demand forces in determining farm-gate prices and how these forces ‘blur’ as one moves to retail prices where strategic pricing comes to the fore. This is consistent with our use of traditional supply/demand modelling to estimate impacts of the mandate on sorghum and farm-gate prices, and then alternative models of marketing margin behaviour to estimate impacts on retail prices.

The models are outlined in Appendix 8.5 and detailed results are presented. Selected results for one of these models – marketing margin as a linear function of retail price – are provided below.

Impact on retail food prices – Marketing margin as a linear function of retail price

Table 8 and Table 9 show the commodity price increases arising from the 5 per cent and 10 per cent mandates in a normal year and a drought year, respectively, using the linear function of retail price as the marketing margin. The calculation is based on the ratio of the percentage

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[21] Further information and empirical evidence on these pricing practices can be found in Griffith et al. (1991), Chang and Griffith (1998), Griffith and Piggott (1994), Parish (1966) and Tomek and Robinson (2003, Ch.6).

[22] As pointed out by Tomek and Robinson (2003, p. 139), “Changes in market structure, through mergers and acquisitions, can result in cost savings, especially for the firms involved. These potential savings may be offset wholly or in part by costs associated with nonprice competition such as higher advertising and promotion costs. There is the additional question of whether large firms engage in oligopolistic-oligopsonistic pricing practices...”

change in the retail price to the percentage change in the 'farm-gate' price (parameter *T*). *T* values vary for the different commodities.

For a normal year (Table 8), all of the retail price increases are less than one per cent. The increases are largest in the case of chicken because it has the highest contribution of sorghum to costs and because it has the highest *T* coefficient. However, these price increases are still less than one-half of one percent.

Table 8 Percentage changes in retail prices as a result of the mandate – Normal year (marketing margin a linear function of retail price)

Retail product and mandate	Best-bet percentage price increases		High-end percentage price increases	
	Commodity price	**Retail price**	**Commodity price**	**Retail price**
Beef:		***T=0.44***		***T=0.44***
5%	0.003	0.001	0.005	0.002
10%	0.082	0.036	0.122	0.054
Pork:		***T=0.50***		***T=0.50***
5%	0.007	0.004	0.012	0.006
10%	0.187	0.094	0.309	0.155
Chicken:		***T=0.74***		***T=0.74***
5%	0.013	0.010	0.021	0.016
10%	0.319	0.236	0.516	0.382
Milk:		***T=0.73***		***T=0.73***
5%	0.005	0.004	0.008	0.006
10%	0.113	0.082	0.198	0.145
Eggs:		***T=0.75***		***T=0.75***
5%	0.010	0.008	0.015	0.011
10%	0.253	0.190	0.375	0.281

Notes:

1. *T* is the ratio of the percentage change in retail beef prices (P_r) to the percentage change in finished cattle prices (P_f).
2. The *T* values, except those for eggs, were estimated from Australian data for 1971-1997 by Dr Garry Griffith, Industry and Investment NSW.
3. The value for eggs is based on a modified US value from (George and King 1971, p. 62).

For a drought year (Table 9), the price increases in the retail products are higher than in a normal year but they are mostly in the range of 1.5 to 2 percent. The exception is chicken, with price increases of 7 per cent if the high-end values of ‘farm-gate’ chicken prices apply.

Table 9 Percentage changes in retail prices as a result of the mandate – Drought year (marketing margin a linear function of retail price)

Retail product and mandate	Best-bet percentage price increases		High-end percentage price increases	
	Commodity price	**Retail price**	**Commodity price**	**Retail price**
Beef:		***T=0.44***		***T=0.44***
5%	0.06	0.026	0.092	0.040
10%	1.489	0.655	2.311	1.017
Pork:		***T=0.50***		***T=0.50***
5%	0.119	0.060	0.201	0.101
10%	2.984	1.492	5.015	2.508
Chicken:		***T=0.74***		***T=0.74***
5%	0.208	0.154	0.343	0.254
10%	5.192	3.842	8.567	6.340
Milk:		***T=0.73***		***T=0.73***
5%	0.074	0.054	0.132	0.096
10%	1.857	1.356	3.305	2.413
Eggs:		***T=0.75***		***T=0.75***
5%	0.178	0.134	0.264	0.198
10%	4.444	3.333	6.591	4.943

Notes:

1. T is the ratio of the percentage change in retail beef prices (P_r) to the percentage change in finished cattle prices (P_f).
2. The T values, except those for eggs, were estimated from Australian data for 1971-1997 by Dr Garry Griffith, Industry and Investment NSW.
3. The value for eggs is based on a modified US value from (George and King 1971, p. 62).

The modest increases in retail prices (estimated by all of the marketing margin models) are to be expected given the modest increases in the ‘farm-gate’ prices. In addition, for the livestock products of interest (except eggs) there is considerable processing involved in converting the ‘farm-gate’ product into the retail product. The cost of the ‘farm-gate’ product is but one component of the total cost of producing the product delivered to retailers and it might not necessarily be the largest cost component. Advice received from one source is relevant here. To quote, “For beef, the old rule of thumb from my price spreads work was 40:20:40, ie of the retail price (expressed on a retail carcase equivalent basis), the producer got 40 per cent, the wholesaler/processor got 20 per cent and the retailer got 40 per cent.” (Dr Garry Griffith, personal communication, June 2010). Assuming that shares of the consumer dollar reflect cost shares in producing the retail product, then these figures suggest that about 60 per cent of the costs are incurred beyond the 'farm gate'. Although hard data are not available, retailing costs are no doubt considerable given the quantity of services that time-constrained consumers want embodied in the retail product. Hence, it seems unsurprising that modest changes in 'farm-gate' prices result in even more modest increases in retail prices.

4.3 Discussion

As in any modelling work, several potentially important factors that could influence the impacts of the ethanol mandate on sorghum prices and, hence, on certain food prices had to be set-aside. Our results would need qualification if some of these factors, which are discussed below, changed.

4.3.1 Sources of future ethanol production

One important factor is the source of further ethanol production in Queensland. Given the importance of sugar cane production in Queensland, it was of interest to gain information from an industry source on the likelihood of sugar cane being the source of future production. The industry source was not very optimistic about sugar cane being the future source of ethanol. To quote:

"If the sugar industry was located closer to grain growing areas, and there was land for expansion of cane growing in existing mill areas, we might see an integrated operation set up by which the fermentation plant might operate on a mixture of cane juice during the crushing season, extended at each end of the season by sweet sorghum juice, and then switching to molasses and/or starch (from sorghum or poor quality wheat, which can be transported longer distances because the grain has such a low moisture content) during the off season.…

(But) We just don't have the environmental conditions in Queensland that would enable the situation described above to be set up. The grain growing areas are well inland which would make the grain expensive to use as fermentation feedstock. Land under cane in Queensland is actually declining due to urban encroachment, farmers changing to other crops (macadamias and vegetables in Bundaberg, etc) and there are few other suitable areas to grow cane on the coast unless more water resources are provided. About the only untapped area in Queensland is the Lower Fitzroy river valley and that would require building a major dam on the river - something like the Burdekin Falls dam which I can't see any government doing in the near future. Canegrowing has ceased on the Ord River and the mill taken to Indonesia. I suppose the industry could be re-established there for the production of ethanol but then you have the cost of transport to the east coast to consider."

This is an insightful comment but one that does not give livestock industries much comfort when it comes to future availability of sorghum for feed rations. Clearly, improved technology underpinning second-generation ethanol production would offer some comfort to the cattle lot feeding industry, as would new sources of feedstock for first-generation ethanol production, such as sweet sorghum. Regarding the latter, the development planned by AgriFuels for ethanol production near Childers would add an additional 146ML of capacity and, if it comes to fruition, Queensland would have more than sufficient capacity to meet a 10 per cent mandate, even if plants at Mackay and Burdekin currently under consideration do not eventuate.

4.3.2 Imports of ethanol and grain

Imports of ethanol from overseas (e.g., Brazil) is, in principle, another way of satisfying future ethanol needs resulting from an ethanol mandate. Currently imported ethanol attracts the fuel excise as well as a 5 per cent duty amounting to a significant effective tariff over domestically produced product (see Centre for International Economics 2005, p. 3). The Federal Government recently announced its intention to revise the excise arrangements for imported ethanol such that the fuel excise will gradually reduce from 25c/L to 12.5c/L between July 2012 and 2015. This means that despite the imposition of a 5 per cent tariff on top of this excise, imports of ethanol are more likely to be introduced.

Grain imports to satisfy feedgrain requirements in the face of increased use of sorghum, and potentially other grains, in ethanol production will remain unlikely in the future given existing quarantine rules. Accordingly grain imports are likely to remain a possibility for only the egg and chicken meat industries that are able to process and consume grain close to ports of entry.

4.3.3 Mandates in other States

Another important consideration concerns what happens in other states regarding ethanol mandates. The Commonwealth, Western Australian and Victorian governments have decided against mandates but there is a mandate in NSW that is foreshadowed to increase to 10 per cent in 2011. Existing NSW production of ethanol comes from a plant in Manildra that produces ethanol from wheat starch and grain. The Manildra facility, however, has been unable to meet NSW's mandate requirements and a significant shortfall is expected. This is despite the expansion of Manildra's Nowra facility to produce 300ML of ethanol per year (planned for completion by December 2010). Accordingly, demand for Queensland ethanol to meet the NSW requirements is expected, which would create additional inflationary pressure on grain prices.

Whilst GHD Hassall is not aware of any plans for further bio-refinery capacity in NSW, if another grain based plant becomes operable, this may have interstate ramifications on livestock industries using these feedstuffs. This would be particularly the case in poor winter crop years and drought years. Furthermore, because the Commonwealth, Western Australia and Victoria have rejected an ethanol mandate in the past, does not mean that these governments will not introduce a mandate in the future. Other states might do so too. This could be harmful to the lot feeders in Queensland and Northern NSW, especially in drought years when grains are transported from the southern and western states for use in the cattle lot feeding industry.

4.3.4 Caveats regarding the models

All models have their shortcomings. Mention has already been made of the limitations of the equilibrium displacement modelling methodology used here: in particular, the need to choose parameter values and the desirability of limiting simulations to small changes. Moreover, time and resource constraints did not permit the undertaking of 'sophisticated' sensitivity analysis based on probability theory. Rather, a limited amount of sensitivity analysis was undertaken in an attempt to correctly bracket the range of possible outcomes. The type of sensitivity analysis presented in this report is consistent with that done in other studies carried out under similar constraints.

5 Impact on meat and livestock industry – Now and in five years time

Whilst the impacts of the proposed 5 per cent ethanol mandate seem modest in a normal year, they are more severe in a drought year. A 10 per cent mandate would result in more severe sorghum price increases and increases that are substantial in a drought year. These are immediate impacts. Impacts five years from the time of introduction depend on several factors, including possible growth in the use of non-sorghum feedstocks for ethanol production, whether new technologies for producing ethanol come on line and changes in trade policies.

Because the mandate will be a tax on an input used by the livestock industries, it will diminish Queensland's international competitiveness in livestock production. In the course of five years one could expect the Queensland livestock industries to have contracted although perhaps by not very much. There is certainly evidence of this, and it is forecast to continue to be the case, in the US where the expansion in corn use for ethanol has been pronounced (see Lawrence et al 2008).

But impacts on livestock industries by a development such as the proposed mandate on ethanol can be more subtle than the impacts on production costs and international competitiveness. Three such impacts are discussed by Lawrence et al. (2008, p.14). Whilst they were writing in the context of expanded US ethanol production, there seems no reason to believe that the Queensland experience would be any different. First, carry-over stocks of feedgrains could become tight and this increases exposure of livestock producers to feed price increases and one would expect that feedgrain prices would become more unstable. Second, the increased availability of wet distillers grain gives those livestock producers located close to ethanol plants a feed transportation cost advantage compared with producers located further away from ethanol plants so there is a shift in comparative advantage among producing areas. Third, as in the US, one might expect that the emergence of an ethanol industry might initially favour beef producers because ruminants can better adapt to using wet distillers grain. As explained by Lawrence et al., once wet-distillers grain is priced more competitively with other feedgrains, the driving influence behind comparative advantage becomes the efficiency of grain conversion into animal products. According to Lawrence et al., this would improve the comparative advantage of the poultry industry because of the industry's greater feed efficiency.

6 Conclusions

6.1 Impact of the mandate on regional sorghum prices – Normal year

It is estimated that, in a normal year, the ethanol mandate will have only modest impacts on sorghum prices – less than one per cent on average in the case of a 5 per cent mandate and about 1.3 per cent on average for a 10 per cent mandate. The price rises are slightly higher in northern/central Queensland compared with south-east Queensland. There are two main reasons for the modest price rises. First, the current usage of sorghum for ethanol amounts to about 15 per cent of total Queensland sorghum use (including exports). Hence, an increase of even 50 per cent in sorghum usage for ethanol which corresponds to a 10 per cent mandate amounts to about a 7.5 per cent increase in overall demand for sorghum. For a 5 per cent mandate the percentage increase in sorghum use for ethanol would be around 2 per cent and this translates into about a 0.3 per cent increase in total demand for sorghum. Second, in a normal year, sorghum can be diverted from export markets to help meet sorghum shortfalls caused by the mandate. Moreover, a high degree of responsiveness of export sales to price changes facilitates the dampening effect on sorghum price increases.

6.2 Impact of the mandate on regional sorghum prices – Drought year

The estimated price changes resulting from the mandate in a drought year are more severe and these are price increases in addition to those attributable to the drought alone. For a 5 per cent mandate sorghum prices would increase on average by nearly one per cent and for a 10 per cent mandate they would increase on average by about 23 per cent. The higher price rises come about because, in a drought year, the level of current use of sorghum for ethanol (about 207kt/year) would represent about 25 per cent of total sorghum usage and, hence, any given increase in sorghum usage for ethanol would translate into a bigger percentage increase in total sorghum demand compared with a normal year. For example, a 50 per cent increase in sorghum use for ethanol would represent a 12.5 per cent increase in total demand. Also, in a drought year, there are no sorghum exports to divert to domestic usage.

6.3 Impact of the mandate on food prices

Regarding impacts on food prices, an important point to note is that, for producers using sorghum as a feedgrain, the mandate has effects identical to those of a new per unit tax on the use of an input – sorghum in this case. Indeed, for a drought year, it would be appropriate to describe the new tax as a ‘big one’. Like any tax, there are resulting distortionary effects (e.g. too much ethanol and too little livestock products being produced). Moreover, Australia’s competitiveness in international beef and other markets is reduced.

However, the impact of the mandate (or tax) on ‘farm-gate’ prices was estimated to be low for a normal year, although larger for a drought year. Finished cattle prices show the lowest percentage increases: best-bet values of 0.003 per cent and 0.082 per cent for a 5 per cent and 10 per cent mandate, respectively, in a normal year. The corresponding percentage increases for a drought year are 0.06 and 1.489. Finished chicken prices show the highest percentage increases: 0.013 and 0.319 for a 5 per cent and 10 per cent mandate, respectively, in a normal year. The corresponding percentage increases for a drought year are 0.208 and 5.192. These low increases come about mainly because of the relatively low share of sorghum in feed rations (based on information from industry sources) and substitution among ingredients in feed rations. One would expect the price rises to be more severe in a poor winter crop year.

The impacts of the mandate on ‘farm-gate’ prices were translated into impacts on retail prices using simple models of marketing margin behaviour. These impacts are hard to measure because of uncertainty about competitive behaviour at the processing, wholesaling and retailing levels. The largest impacts on retail prices occurred when the marketing margin was specified to be a linear function of the retail price. In the case of a normal year and using best-bet values for the farm-gate price increases and the middle value for the T coefficient, the lowest retail percentage price increases were for beef: 0.001 in the case of a 5 per cent mandate and 0.036 in the case of a 10 per cent mandate. Using high-end estimates for the ‘farm gate’ price increases, the corresponding figures are 0.002 and 0.054. The highest retail price increases were for chicken: 0.010 for a 5 per cent mandate and 0.236 for a 10 per cent mandate when best-bet values for the ‘farm-gate’ prices are used, and 0.016 and 0.382 when high-end estimates are used.

The figures for retail price increases are significantly higher for a drought year. Again, the percentage price increases are lowest for beef where they now range from 0.026 to 1.017, and highest for chicken where they range from 0.154 to 6.340.

6.4 Other impacts

The proposed ethanol mandate has impacts beyond increased prices for sorghum, livestock products and Queensland's competitive position as a producer of these products. These effects have been observed, or at least anticipated, in the US where there has been a rapid increase in demand for feedgrains for ethanol production. They include tight carry-over stock positions with subsequent increased exposure to price instability and price risk for livestock producers, changes in the comparative advantage of different livestock producing regions, and changes in the comparative advantage of different livestock industries in producing meat products.

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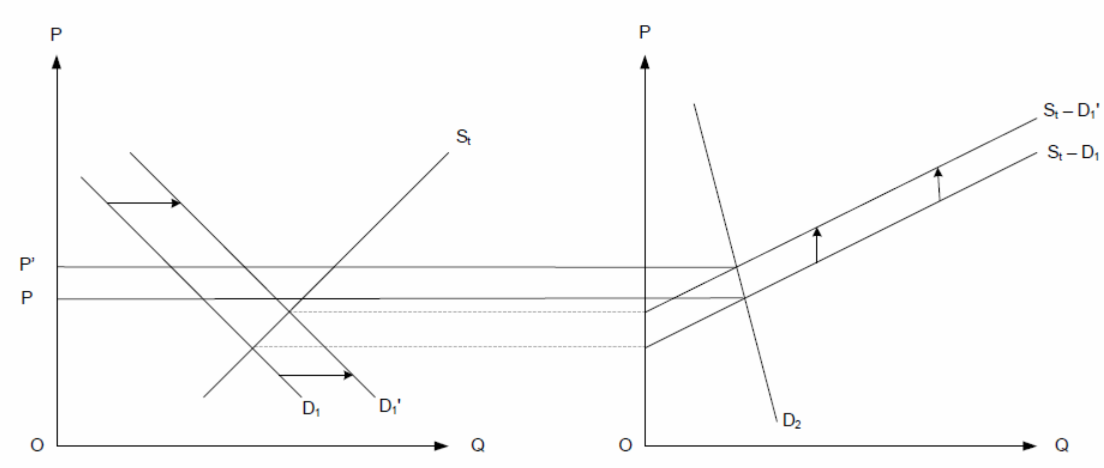
8 Appendices

8.1 Appendix 1: Model for estimating sorghum prices impacts (equation form)

8.2 Appendix 2: Impact of the mandate (diagrammatic form showing taxing effect of mandate)

Figure A1 The impact of the ethanol mandate on sorghum prices[23]

Sorghum for Non-Feed Uses (e.g. ethanol) **Sorghum for Feed**



The function labelled D_1 in the left-hand panel shows the demand for non-feed uses of sorghum before the mandate is introduced. S_t in the left-hand panel represents the total supply of sorghum. At all price levels the total supply of sorghum has to equal the sum of non-feed uses and feed uses. Hence, the supply of sorghum available for feed use in the right-hand panel is equal to the horizontal distance between D_1 and S_t in the left-hand panel. Market equilibrium is established at price P where D_2, the demand for sorghum for feed, intersects the supply function S_t-D_1. When the demand for non-feed uses shifts to the right from D_1 to D_1' in the left-hand panel because of the ethanol mandate, the supply available for feed use at any price is less; that is S_t-D_1 shifts leftward or upward to S_t-D_1'. The equilibrium price rises to P'. The upward shift in the supply function in the right-hand panel is the same effect that would occur from placing a fixed per unit tax on the use of sorghum for feed. The vertical shift in the supply function (or per unit tax equivalent of the mandate) exceeds the increase in the price of sorghum because there is some demand response in the sorghum-for-feed market (i.e. D_2 is not vertical).

The right-hand panel relates to the aggregate feed market (i.e., the sum of the demands by, and supply to, beef feedlots, pig producers, chicken producers, milk producers and egg producers. All of these industries experience a price increase of P'- P. In modelling this price increase as the equivalent of a per unit tax on these producers, the equivalent tax rate needs to be estimated. It can be shown that the equivalent tax rate for any particular industry is given by:

$$\beta = EP(\varepsilon - \eta)/\varepsilon$$

where β is the per unit tax rate, *EP* is the proportionate sorghum price rise, ε is the price elasticity of supply of sorghum to the particular industry and η is the price elasticity of demand for sorghum by the particular industry.

[23] Note that these diagrams are for illustrative purposes only and are not based on the calculations undertaken in this project.

The supply of sorghum to a particular industry is equal to the sum of the supplies from each supply source (in the present case, north/central Queensland, southern Queensland and northern NSW) minus the demands from the various demand sources other than that by the industry for which the supply is being calculated (for example, in the case of beef feedlotting, it would be the demand for exports and the demands by the pig, chicken, dairy, egg and “other” industries using sorghum. The supply elasticity to the particular industry is the weighted sum of supply elasticities for the different sources (the weights being the ratios of the amount of sorghum from the supply source divided by the supply of sorghum to the particular industry) minus the weighted sum of the demand elasticities for the different sources (the weights being the ratios of the amount of sorghum demanded by the demand source divided by the amount of sorghum demanded by the particular industry).

In order to calculate the supply elasticities to the industries of interest it is was necessary to have, in addition to the quantities going to exports, a breakdown of how the total sorghum available for feed use is distributed among the various livestock industries. This distribution was decided in consultation with John Spragg and is as follows: Beef 53 per cent, Pigs 13 per cent, Poultry meat 15 per cent, Dairy 7 per cent, Layers 6 per cent, Other 6 per cent.

The value of η used in the tax rate calculations was set at -0.65 for all the industries.

8.3 Appendix 3: Model for estimating impacts on ‘farm-level’ prices (equation form)

8.4 Appendix 4: Simple model to cross-check results

The simple model aggregates supply and demand upward to the state level and divides total demand into demand for feed, demand for ethanol and export demand. It estimates the impact of an increase in demand for ethanol on sorghum price, the latter being a weighted average price for Queensland. Although the model doesn't directly produce price changes for sorghum in northern/central and southeast Queensland, one can work 'backwards' from the change in the weighted average price for Queensland using the transport cost-related prices to find their percentage changes. What the simple model does not do is take account of substitution relationships in demand and supply and, hence, one would not expect the price changes from the simple model to replicate the price changes in Table 5. The simple model replicates a standard result in economics for the impact on price of a given change in one component of the total demand for a commodity. It is in fact the model underpinning results in a spreadsheet developed to estimate the impact of biofuels on crop and food prices globally (see Baier et.al, 2009).

Some results from this checking process are shown in Table A1.

Table A1 Comparison of some results for sorghum price increases between models

Mandate level	Northern/central Queensland		Southeast Queensland	
	This study	Simple	This study	Simple
5%	0.001	0.001	0.001	0.001
10%	1.605	1.639	1.475	1.506

Note: The simple model results do not take into account the distillers grain co-product. Hence, the comparison is between price increases before adjustment for distillers grain production.

8.5 Appendix 5: Simple models of marketing margins

Introduction

Increases in sorghum prices as a result of the ethanol mandate increase the price of the 'raw material' (e.g., finished cattle) used in making the product that is bought by final consumers (e.g., retail cuts of beef). How these raw material price increases translate into changes in prices of retail products depends on the behaviour of marketing margins, these being the differences in price between two levels in the marketing chain.

Difficulties in the analysis of marketing margins were mentioned in the body of the report. In empirical work, especially when there are time and resource constraints, simple models of the relationship between prices at two levels in the marketing chain are often used. Some of these models lack a strong theoretical underpinning (see, for example, Gardner 1975; Wohlgenant and Haidacher 1989) but they represent a parsimonious approach to obtaining an approximation to actual relationships. An appropriate way to describe these models is that they approximate some of the observed relationships between prices at two levels in a marketing chain without necessarily capturing all the underlying economic forces and behaviour causing those relationships. Some of the models are presented below using finished cattle and retail beef cuts as an example.

The Models

The scenario under examination has the supply function for finished cattle shifting upward or leftward as a result of an increase in the price of one of the inputs used in producing finished cattle, namely, sorghum. With stationary demand functions for finished cattle and retail beef cuts, this results in an increase in the price of finished cattle and, ultimately, an increase in the price of the final product purchased by consumers, namely, cuts of beef in the supermarket. How the increase in the price paid by consumers, or the retail price, changes relative to the price of finished cattle depends on marketing margin behaviour.

To model this, let: P_r=retail price; P_f=finished cattle price; G=marketing margin; and $P_r=P_f+G$. The finished cattle price is the price of the amount of finished cattle liveweight it takes to produce a unit of the retail product. A common conversion factor is 2.4, meaning that it takes 2.4 kg liveweight of finished cattle to produce 1.0 kg of retail product. An underlying assumption is that there is no substitution between finished cattle and other inputs in producing the final product purchased by consumers—finished cattle and other inputs are used in fixed proportions. While there probably is some substitution in practice, the assumption is commonly used in empirical analysis for simplicity reasons.

A factor T is defined as the ratio of the proportionate change in retail price to the proportionate change in finished cattle price. That is:

$T=EP_r/EP_f$

where E represents proportional change. It follows that:

$EP_r=T*EP_f$. Hence, if T and EP_f are known, EP_r can be calculated as their product. The value of EP_f is known from earlier analysis in this study. The value of T will depend on how G, the marketing margin, is defined.

Margin as a Function of Retail Price (Case 1)

This specification has often been used in empirical work, one of the reasons being that it lends itself to easy estimation of the parameter T, which is the ratio of the percentage change in the retail price to the percentage change in the 'farm-gate' price.

In many studies it is assumed that G is a function of the retail price. A conceptual model in price-dependent form that reflects this assumption is as follows:

$P_f^d = P_f^d(Q)$	(demand for finished cattle)
$P_f^s = P_f^s(Q,W)$	(supply of finished cattle)
$G=G(P_r)$	(marketing margin)
$P_r=P_f+G$	(retail price)
$P_f^d=P_f^s=P_f$	(demand=supply)

where Q is the throughput of finished cattle and W is a 'shifter' of the supply function for finished cattle—in the present case, the price of sorghum. The prices P_f^d and P_f^s are interpreted as the price of 2.4 kgs of liveweight finished cattle.

After total differentiation and manipulation of terms, it can be shown that:

$$T=P_f/(P_r-\delta^*G)$$

where $\delta=E(G)/E(P_r)$, or the elasticity of the margin with respect to the retail price.

One could assume values for the determinants of T and then calculate T. Alternatively, the expression for T can be changed to ratio form, namely:

$$T=(P_f/P_r)/(1- \delta^*(G/P_r).$$

Thinking in terms of ratios may be more intuitive than thinking in terms of absolute values for the determinants of T.

A version of this specification that has often been used in empirical work is to assume that $G=a+bP_r$ (i.e., the margin can be approximated as a linear function of the retail price, or linear mark-up marketing margin) where a,b are constants, a is assumed to be greater than or equal to zero and b is assumed to be less than unity and greater than or equal to zero.

After some mathematical manipulation, it follows that:

$P_f= -a+P_r(1-b)$ and

$$T=(1/(1-b))^*(P_f/P_r).$$

The value of b used in calculating T can be obtained by a simple regression of P_f on P_r, and subtracting the slope coefficient from one. Hence, this specification lends itself to empirical investigation. This specification is referred to as Case 1 in this study.

Constant Absolute Margin (Case 2)

There are two special cases of the ‘linear function of retail price’ that have been used in empirical work. The first is where the margin is a constant number of dollars irrespective of P_r (it corresponds to the linear case with b=0). One can see from the expression for T immediately above that, in this case, $T=P_f/P_r$. According to one US source (Goodwin 1993, p. 289), this specification fits marketing activities which have small fixed costs, with most costs varying more-or-less proportionally with throughput. Goodwin suggests fresh fruit and vegetable marketing as an example in the US context, but egg marketing is probably another (there is little processing activity). This is referred to as Case 2 in this study.

Constant Percentage Margin (Case 3)

The second special case is the linear specification with a=0. It implies that $b=G/P_r$ and, bearing in mind that $G=P_r-P_f$, some manipulation of the expression for T immediately above shows that T=1. In this case the percentage change in retail price equals the percentage change in finished cattle price. This is referred to as Case 3 in this study.

According to Goodwin (1993, p.292) and assuming b is positive, the specification suits marketing activities which have “large fixed investments and substantial economies of scale”, such as those for dairy products. It implies that the additional or marginal costs of processing and marketing an increment of throughput decrease with the volume of throughput. It can be argued that this specification suited margin behaviour in Australian food marketing at least until recent times. It was often the case that food processing plants, such as county-council owned abattoirs, often operated irrationally at low throughput levels for which unit costs were diminishing. This was because these plants had social objectives, such as employment creation, as well as economic objectives. In more recent times there has been some rationalisation of food processing with large-scale operations replacing small-scale operations and it is more likely the case that the processing and marketing of beef is characterised by a margin that increases with Q, or decreases with P_r.

Margin as a Function of Throughput (Case 4)

In some studies G is specified as some function of Q where Q is throughput. An example would be where $G=c+dQ$ with c and d being positive constants; that is, the margin is a linear function of throughput. This specification implies a larger absolute margin as throughput increases or, equivalently, a larger (smaller) absolute margin as price decreases (increases). The conceptual model under-pinning this case is the same as for the case where the margin is a function of retail price except that the marketing margin equation becomes $G=G(Q)$.

This case is consistent with the situation where the additional or marginal cost of handling an increment of throughput increases as the volume of throughput increases. According to Goodwin (1993, p.294), the specification suits those marketing activities that have “significant levels of fixed investment costs, but have substantial variable costs as well.” He cites the meat industries as an example in the US context. As he puts it, “While economies of scale may be available, most of these scale economies are realized at relatively low levels of output.”

After mathematical manipulation, it can be shown that:

$$T=\eta\alpha\ (G/P_r)+(1-(G/P_r))$$

where η is the price elasticity of demand for finished cattle, α is the ratio of the percentage increase in the margin to the percentage increase in throughput of finished cattle (a measure of the sensitivity of marginal processing and marketing costs to changes in throughput) and other variables are as previously defined. This is referred to as Case 4 in this study.

Model Results

Margin as a linear function of retail price (Case 1). Table A2 and Table A3 show the results of applying this specification to the commodity price increases resulting from sorghum price increases for a normal year and a drought year, respectively. For a normal year (Table A2), all of the retail price increases are less than one per cent. The increases are biggest in the case of chicken because it has the highest contribution of sorghum to costs and because it has the highest *T* coefficient. However, these price increases are still less than one-half of one percent. For a drought year (Table A3), the price increases in the retail products are much more than in a normal year but they are mostly in the range of 1.5 to 2 percent. The exception is chicken with price increases of 7 per cent if the high-end values of 'farm-gate' chicken prices apply.

Table A2 Percentage changes in retail prices as a result of the mandate – Normal year: Case 1 (marketing margin a linear function of retail price)

Retail product and mandate	Best-bet percentage price increases				High-end percentage price increases			
	Commodity price	Retail price			Commodity price	Retail price		
Beef:		***T=0.34***	***T=0.44***	***T=0.54***		***T=0.34***	***T=0.44***	***T=0.54***
5%	0.003	0.001	0.001	0.002	0.005	0.002	0.002	0.003
10%	0.082	0.028	0.036	0.044	0.122	0.041	0.054	0.066
Pork:		***T=0.4***	***T=0.5***	***T=0.6***		***T=0.4***	***T=0.5***	***T=0.6***
5%	0.007	0.003	0.004	0.004	0.012	0.005	0.006	0.007
10%	0.187	0.075	0.094	0.112	0.309	0.124	0.155	0.185
Chicken:		***T=0.64***	***T=0.74***	***T=0.84***		***T=0.64***	***T=0.74***	***T=0.84***
5%	0.013	0.008	0.010	0.011	0.021	0.013	0.016	0.018
10%	0.319	0.204	0.236	0.268	0.516	0.330	0.382	0.433
Milk:		***T=0.63***	***T=0.73***	***T=0.83***		***T=0.63***	***T=0.73***	***T=0.83***
5%	0.005	0.003	0.004	0.004	0.008	0.005	0.006	0.007
10%	0.113	0.071	0.082	0.094	0.198	0.125	0.145	0.164
Eggs:		***T=0.65***	***T=0.75***	***T=0.85***		***T=0.65***	***T=0.75***	***T=0.85***
5%	0.01	0.007	0.008	0.009	0.015	0.010	0.011	0.013
10%	0.253	0.164	0.190	0.215	0.375	0.244	0.281	0.319

Notes:

1. *T* is the ratio of the percentage change in retail beef prices (P_r) to the percentage change in finished cattle prices (P_f).
2. The central values, except that for eggs, were estimated from Australian data for 1971-1997 by Dr Garry Griffith, Industry and Investment NSW.
3. The value for eggs is based on a modified US value from (George and King 1971, p. 62). The central values are accompanied by two alternative values.

Table A3 Percentage changes in retail prices as a result of the mandate – Drought year: Case 1 (marketing margin a linear function of retail price)

Retail product and mandate	Best-bet percentage price increases				High-end percentage price increases			
	Commodity price	Retail price			Commodity price	Retail price		
Beef:		***T=0.34***	***T=0.44***	***T=0.54***		***T=0.34***	***T=0.44***	***T=0.54***
5%	0.06	0.020	0.026	0.032	0.092	0.031	0.040	0.050
10%	1.489	0.506	0.655	0.804	2.311	0.786	1.017	1.248
Pork:		***T=0.4***	***T=0.5***	***T=0.6***		***T=0.4***	***T=0.5***	***T=0.6***
5%	0.119	0.048	0.060	0.071	0.201	0.080	0.101	0.121
10%	2.984	1.194	1.492	1.790	5.015	2.006	2.508	3.009
Chicken:		***T=0.64***	***T=0.74***	***T=0.84***		***T=0.64***	***T=0.74***	***T=0.84***
5%	0.208	0.133	0.154	0.175	0.343	0.220	0.254	0.288
10%	5.192	3.323	3.842	4.361	8.567	5.483	6.340	7.196
Milk:		***T=0.63***	***T=0.73***	***T=0.83***		***T=0.63***	***T=0.73***	***T=0.83***
5%	0.074	0.047	0.054	0.061	0.132	0.083	0.096	0.110
10%	1.857	1.170	1.356	1.541	3.305	2.082	2.413	2.743
Eggs:		***T=0.65***	***T=0.75***	***T=0.85***		***T=0.65***	***T=0.75***	***T=0.85***
5%	0.178	0.116	0.134	0.151	0.264	0.172	0.198	0.224
10%	4.444	2.889	3.333	3.777	6.591	4.284	4.943	5.602

Notes:

1. *T* is the ratio of the percentage change in retail beef prices (P_r) to the percentage change in finished cattle prices (P_f).
2. The central values, except that for eggs, were estimated from Australian data for 1971-1997 by Dr Garry Griffith, Industry and Investment NSW.
3. The value for eggs is based on a modified US value from (George and King 1971, p. 62). The central values are accompanied by two alternative values.

Constant absolute margin (Case 2). The results of applying this specification to the increases in the ‘farm-gate’ price increases for eggs are shown in Table A4. The percentage increases in the retail price of eggs range from 0.004 per cent (best-bet parameter values, 5 per cent mandate, normal year with a ‘farm-gate’ to retail price ratio of 0.35 percent) to 3.625 per cent (high-end parameter values, 10 per cent mandate, drought year with a ‘farm-gate’ to retail price ratio of 0.55 percent). The most likely increases range from 0.005 per cent (normal year with a 5 per cent mandate) to 2 per cent (drought year with a 10 per cent mandate).

Table A4 Percentage changes in retail egg prices as a result of the mandate: Case 2 (constant absolute marketing margin)

Year and mandate level	Best-bet price increases				High-end price increases			
	'Farm gate' price increase	'Farm gate'/retail price			'Farm gate' price increase	'Farm gate'/retail price		
		0.35	***0.45***	***0.55***		***0.35***	***0.45***	***0.55***
Normal year:								
5%	0.01	0.004	0.005	0.006	0.015	0.005	0.007	0.008
10%	0.253	0.089	0.114	0.139	0.375	0.131	0.169	0.206
Drought year:								
5%	0.178	0.062	0.080	0.098	0.264	0.092	0.119	0.145
10%	4.444	1.555	2.000	2.444	6.591	2.307	2.966	3.625

Notes:

1. The middle value for the 'farm gate'/retail price (0.45) is based on information from industry sources.

Constant percentage margin (Case 3). As noted above, this specification is thought to suit milk processing. In this case the percentage increases in retail price are equal to the percentage increases in 'farm-gate' prices. Hence, they would range from 0.005 per cent corresponding to a normal year with a 10 per cent mandate using the best-bet estimate of the 'farm-gate' price increase for raw milk, to 3.3 per cent corresponding to a drought year with a 10 per cent mandate using the high-end estimate of the 'farm-gate' price increase for raw milk (these figures are shown in Table 7) and are larger than the retail milk price increases under the Case 1 margin specification.

Margin as a linear function of throughput (Case 4). Table A5 and Table A6 show the results from applying this specification to the 'farm gate' price increases in a normal year, for best-bet and high-end values of the commodity price increases, respectively. Table A7 and Table A8 show these results for a drought year. The general pattern across all four sets of results is for retail price increases less than those for the previous case where the margin was modelled as a linear function of the retail price. The highest retail price increase was a little less than 3 per cent in the case of chicken, corresponding to a drought year with the high-end estimate of the farm-gate price increase and when the ratio of the marketing margin to retail price is set at 0.5.

Table A5 Best-bet percentage changes in retail prices as a result of the mandate – Normal year: Case 4 (marketing margin a linear function of throughput)

Retail product and mandate	Commodity price	Best-bet percentage price increases								
		G/R=0.5			G/R=0.6			G/R=0.7		
		α=0.5	α=1.0	α=1.5	α=0.5	α=0.75	α=1.0	α=0.5	α=0.55	α=0.6
Beef:										
5%	0.003	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000
10%	0.082	0.028	0.014	0.001	0.017	0.009	0.001	0.006	0.004	0.002
Pork:										
5%	0.007	0.002	0.001	0.000	0.001	0.001	0.000	0.001	0.000	0.000
10%	0.187	0.063	0.033	0.002	0.038	0.020	0.002	0.014	0.009	0.005
Chicken:										
5%	0.013	0.004	0.002	0.000	0.003	0.001	0.000	0.001	0.001	0.000
10%	0.319	0.108	0.056	0.004	0.065	0.034	0.003	0.023	0.016	0.009

Notes:

1. G/R is the ratio of the marketing margin to retail price and α is the ratio of the percentage change in the marketing margin to the percentage change in throughput resulting from the price increases. There are no industry standards or empirical estimates for this parameter. However, the reciprocal of this parameter is the price elasticity of supply of processing and marketing services and the chosen values for the parameter are consistent with reasonable values for this elasticity.

2. The figures are calculated using a value for the price elasticity of demand for the commodities (e.g., finished cattle) of $\eta = -0.65$.

3. Values shown as '0.000' are positive price increases but less than 0.001 in value.

Table A6 High-end percentage changes in retail prices as a result of the mandate – Normal year: Case 4 (marketing margin a linear function of throughput)

Retail product and mandate	Commodity price	Best-bet percentage price increases								
		G/R=0.5			G/R=0.6			G/R=0.7		
		α=0.5	α=1.0	α=1.5	α=0.5	α=0.75	α=1.0	α=0.5	α=0.55	α=0.6
Beef:										
5%	0.005	0.002	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000
10%	0.122	0.041	0.021	0.002	0.025	0.013	0.001	0.009	0.006	0.003
Pork:										
5%	0.012	0.004	0.002	0.000	0.002	0.001	0.000	0.001	0.001	0.000
10%	0.309	0.104	0.054	0.004	0.063	0.033	0.003	0.022	0.015	0.008
Chicken:										
5%	0.021	0.007	0.004	0.000	0.004	0.002	0.000	0.002	0.001	0.001
10%	0.516	0.174	0.090	0.006	0.106	0.055	0.005	0.037	0.026	0.014

Notes:

1. G/R is the ratio of the marketing margin to retail price and α is the ratio of the percentage change in the marketing margin to the percentage change in throughput resulting from the price increases. There are no industry standards or empirical estimates for this parameter. However, the reciprocal of this parameter is the price elasticity of supply of processing and marketing services and the chosen values for the parameter are consistent with reasonable values for this elasticity.

2. The figures are calculated using a value for the price elasticity of demand for the commodities (e.g., finished cattle) of $\eta = -0.65$.

3. Values shown as '0.000' are positive price increases but less than 0.001 in value.

Table A7 Best-bet percentage changes in retail prices as a result of the mandate – Drought year: Case 4 (marketing margin a linear function of throughput)

Retail product and mandate	Commodity price	Best-bet percentage price increases								
		G/R=0.5			G/R=0.6			G/R=0.7		
		α=0.5	α=1.0	α=1.5	α=0.5	α=0.75	α=1.0	α=0.5	α=0.55	α=0.6
Beef:										
5%	0.06	0.020	0.011	0.001	0.012	0.006	0.001	0.004	0.003	0.002
10%	1.489	0.503	0.261	0.019	0.305	0.160	0.015	0.108	0.074	0.040
Pork:										
5%	0.119	0.040	0.021	0.001	0.024	0.013	0.001	0.009	0.006	0.003
10%	2.984	1.007	0.522	0.037	0.612	0.321	0.030	0.216	0.148	0.081
Chicken:										
5%	0.208	0.070	0.036	0.003	0.043	0.022	0.002	0.015	0.010	0.006
10%	5.192	1.752	0.909	0.065	1.064	0.558	0.052	0.376	0.258	0.140

Notes:

1. G/R is the ratio of the marketing margin to retail price and α is the ratio of the percentage change in the marketing margin to the percentage change in throughput resulting from the price increases. There are no industry standards or empirical estimates for this parameter. However, the reciprocal of this parameter is the price elasticity of supply of processing and marketing services and the chosen values for the parameter are consistent with reasonable values for this elasticity.

2. The figures are calculated using a value for the price elasticity of demand for the commodities (e.g., finished cattle) of $\eta = -0.65$.

Table A8 High-end percentage changes in retail prices as a result of the mandate – Drought year: Case 4 (marketing margin a linear function of throughput)

Retail product and mandate	Commodity price	Best-bet percentage price increases								
		G/R=0.5			G/R=0.6			G/R=0.7		
		α=0.5	α=1.0	α=1.5	α=0.5	α=0.75	α=1.0	α=0.5	α=0.55	α=0.6
Beef:										
5%	0.092	0.031	0.016	0.001	0.019	0.010	0.001	0.007	0.005	0.001
10%	2.311	0.780	0.404	0.029	0.474	0.248	0.023	0.168	0.115	0.021
Pork:										
5%	0.201	0.068	0.035	0.003	0.041	0.022	0.002	0.015	0.010	0.002
10%	5.015	1.693	0.878	0.063	1.028	0.539	0.050	0.364	0.249	0.046
Chicken:										
5%	0.343	0.116	0.060	0.004	0.070	0.037	0.003	0.025	0.017	0.003
10%	8.567	2.891	1.499	0.107	1.756	0.921	0.086	0.621	0.426	0.078

Notes:

1. G/R is the ratio of the marketing margin to retail price and α is the ratio of the percentage change in the marketing margin to the percentage change in throughput resulting from the price increases. There are no industry standards or empirical estimates for this parameter. However, the reciprocal of this parameter is the price elasticity of supply of processing and marketing services and the chosen values for the parameter are consistent with reasonable values for this elasticity.
2. The figures are calculated using a value for the price elasticity of demand for the commodities (e.g., finished cattle) of η= -0.65.