Australia’s beef supply chains
Infrastructure issues and implications

Tim Goesch, Kenton Lawson, Richard Green and Kristopher Morey

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Summary

The real value of world agrifood demand is projected to increase by 77 per cent between 2007 and 2050, with most of this increase occurring in Asia (Linehan et al. 2012). Beef is one commodity where there could be a significant increase, with rising incomes in Asia leading to an increase in demand for higher protein foods, including meat and dairy products.

This study describes Australia’s beef supply chains, the industry’s reliance on economic infrastructure, and how this infrastructure influences the competitiveness of the Australian beef industry. It follows on from research into Australia’s wheat and airfreight supply chains.

The state of the road network is a major impediment to improved efficiency in Australia’s beef supply chains. Other potential constraints include restricted access to telecommunications in some rural areas and limited competition in the supply of stevedoring services at container ports.

Transport

Beef production is Australia’s most extensive and geographically dispersed agricultural activity. National Livestock Identification System (NLIS) data on the source and destination of cattle movements show that many cattle are transported long distances from remote areas towards the coast (Map S1). Most beef processing facilities are located near the east coast.

Map S1 Intra-region and inter-region cattle movements, 2008 to 2012, annual average number of cattle

k hd thousand head. AAGIS Australian Agricultural and Grazing Industries Survey subregions.
Source: National Livestock Identification System data
Note: Cattle movements in the Northern Territory and Western Australia are underestimated since they exclude movements from property of birth to abattoirs or live export
Transport costs represent a significant proportion of the farmgate value of beef cattle for some producers. For example, Goucher (2011) estimated that the cost of transporting cattle 320 kilometres by road to an abattoir in south-east Queensland accounted for 5 per cent of the Jap Ox price of cattle exported from Brisbane to Yokohama. NLIS data indicate that many cattle are transported longer distances. For example, 10 million cattle identified as having moved from northern Australia in 2012 were transported 480 kilometres on average, and 14 per cent were transported more than 1000 kilometres.

Poor quality roads, restricted road access and congestion can inflate transport costs, reducing returns to cattle production. Poor quality roads can increase travel times and cause delays because of road closures. They can also cause damage to trucks and increase the number of accidents. Much of Australia’s local road network is in poor condition, particularly in rural areas (Engineers Australia 2010a).

Restricting access by higher mass vehicles on some roads can also increase the costs of transporting cattle because transport operators may have to break loads into smaller units, often more than once (for example, from a road train to B-double), or use smaller trucks for the entire journey. Map S2 shows how access to the road network by higher mass vehicles generally becomes more restricted when cattle are transported to abattoirs in south-east Queensland. For example, moving cattle from Longreach to an abattoir in western Brisbane may mean having to downsize the vehicle twice—first near Roma and again at Toowoomba.

Map S2 Simulated network usage for Queensland in 2012 (consignments with at least 20 animals)

Source: ABARES modelling
Road pricing and funding arrangements

The major causes of inefficiency in the provision of road infrastructure are inappropriate institutional arrangements. According to the Productivity Commission (2006), the problem with current road pricing and funding allocation arrangements is that the averaging of costs and charges and the allocation of funding are not directly related to road use. Under current arrangements, road user charges are collected through vehicle and driver registration fees and Commonwealth-levied fuel taxes, while road funding is independent of the revenue generated by fuel taxes and registration fees for the use of specific roads (GIAC 2004). There are also budget constraints at local, state and federal levels that are likely to limit the extent of public investment in road infrastructure in the future.

One option for increasing efficiency and stimulating private investment in the road network would be to charge users for actual use and return funds to where use and damage occur. The Productivity Commission, the National Transport Commission and, more recently, the National Commission of Audit have recommended user-pays pricing/funding allocation models that take into account vehicle mass, distance travelled and location of use (PC 2014; NTC 2009; NCA 2014).

While the user-pays model is theoretically appealing, there needs to be more research into its practical implications. For example, there could be significant distributional effects (winners and losers) in moving from current institutional arrangements. Further research is also needed to demonstrate how a user-pays model can increase productivity by directing investment to where damage occurs and improving access for high-productivity vehicles.

Better data are required

An important step in improving efficiency in the road transport sector is to collect spatial data on road use, condition and maintenance costs. Even in the absence of road pricing reform, these data can help guide funding to better reflect where use and damage occur. These data are also a prerequisite for introducing a more efficient user-pays road pricing model.

The way this type of spatial data could be used to improve decision-making has been demonstrated using a subset of roads in the Gwydir Shire in northern New South Wales (Juturna Consulting 2011). For example, by combining data on road maintenance costs with estimates of revenue earned from road use through the fuel excise, it is possible to determine whether the revenue raised from use of specific roads covers maintenance costs. Revenue exceeded road maintenance costs for two of the four roads examined, with the other two roads requiring a subsidy (Juturna Consulting 2011).

Understanding how the revenue collected from the use of specific roads relates to maintenance costs is important because it highlights the level of cross-subsidisation implicit in current arrangements and allows governments to make more informed decisions on the extent to which they are prepared to subsidise particular roads. In assessing the potential impacts of moving to a user-pays system, it identifies which roads are likely to benefit from increased investment and which will require additional funding if their condition is to be maintained.

Unfortunately, spatial data on road use, condition and maintenance costs are generally not available. In the absence of this data, ABARES has combined NLIS data with relative cost data for cattle transport to construct a cattle freight movement model that quantifies road use by the cattle industry (Map S2). This modelling approach can be used to estimate how different regulations affect road use and the relative costs of transport.
CSIRO recently demonstrated the potential to increase the utility of this modelling approach by incorporating quantitative road transport cost data to estimate the actual benefits (in terms of reduced transport costs) of removing specific constraints in the road network (Higgins 2013). The Commonwealth Government announced in May 2015 that CSIRO’s TRANSIT model will be used to test different scenarios, such as how sealing a road will influence transport time and costs, to target upgrades to the road network under the $100 million Northern Australia Beef Roads Fund (Commonwealth of Australia 2015).

If road cost data were also available, it should be possible to estimate the net benefits of removing constraints in the road network, and to rank investment options based on their net benefits; this would be a substantial advance on comparing the relative benefits of projects.

There is a strong case for governments to coordinate and contribute to the collection of a range of transport related data—including data on road use and maintenance and transport costs—given that governments own most of the road network and that there is little opportunity for individuals or private entities to negotiate specific upgrades to the network. As investments in road infrastructure are expensive, some investment in improved data to assist decision making is likely to be beneficial. Such data could also be used to investigate the sectoral impacts of road pricing reforms.
1 Introduction

The real value of world agrifood demand is projected to increase by 77 per cent between 2007 and 2050, with most of this increase occurring in Asia (Linehan et al. 2012). In 2013, ABARES released a scoping study examining the potential for Australia to increase production and exports of a range of agricultural commodities in response to this increase in demand (Nguyen et al. 2013). It also identified a number of infrastructure-related impediments in agricultural supply chains that have the potential to increase costs and reduce the competitiveness of Australian exports. This study adds to that research by examining some of the bottlenecks in Australia’s beef supply chains in more detail.

Beef production is a major agricultural activity in Australia. In 2013–14 the industry produced $7.5 billion of beef and veal and $780 million of live export cattle (for feeder or slaughter purposes), representing 16 per cent of the value of all agricultural commodities produced. Australia is also a major beef exporter. It is currently the world’s third largest exporter of beef and typically exports around two-thirds of its production. Despite Australia’s success in international markets, it faces strong competition for access to markets from other countries. Competition is likely to increase as restrictions are removed on beef imports from countries that were affected by bovine spongiform encephalopathy (BSE) in the past and production from low-cost countries expands.

The analysis in this report uses a case study approach to examine beef supply chains in northern and southern Australia. More specifically, it:

- describes the main characteristics of the Queensland and New South Wales beef supply chains
- identifies the main infrastructure issues that affect the movement of cattle and beef from farms to abattoirs and ports
- illustrates how data on the spatial pattern of live cattle movements in Australia and the use of a freight movement model based on those data can help support effective road infrastructure decisions.

Chapter 2 contains a description of the main characteristics of the Australian beef industry, including the financial performance of the farm sector, and a brief examination of the potential to increase beef production in response to an increase in international demand. This is followed by a description of the main on-farm and off-farm activities in beef supply chains and the main factors that have influenced the industry’s development, including markets and environmental factors (Chapter 3). The use of economic infrastructure (transport, energy, water and telecommunications) and how the reliance of a particular activity on a particular type of infrastructure varies across the supply chain are described in Chapter 4. Chapters 5 and 6 contain detailed descriptions of the Queensland and New South Wales supply chains. Chapter 7 provides an explanation of how a user-pays road pricing/funding allocation model can increase efficiency, and how spatial data on the movement of live cattle can be used to assist decision-making on investments in road infrastructure. It also contains recommendations for future research. The final chapter contains some concluding comments.
2 Background

The beef industry is one of Australia’s most significant agricultural industries. In 2013–14 it produced $7.5 billion of beef and veal and $780 million of live export cattle (for feeder or slaughter purposes) (Table 1). This represents 16 per cent of the value of all agricultural commodities. The industry is also highly export-oriented, with exports usually accounting for around two-thirds of the volume of production. Beef production and exports have been relatively stable over the past decade, with production averaging just under 2.2 million tonnes a year (Figure 1).

Table 1 Australian beef cattle industry, 2013–14

<table>
<thead>
<tr>
<th>Category</th>
<th>Unit</th>
<th>NSW</th>
<th>Vic.</th>
<th>Qld</th>
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<th>WA</th>
<th>Tas.</th>
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<td></td>
<td></td>
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<td>236</td>
<td>0</td>
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<sup>cwe</sup> carcass weight equivalent.
<sup>a</sup> Includes ACT.
<sup>b</sup> Does not include dairy cattle.
<sup>c</sup> Includes feedlots. Numbers are for 2011–12.
<sup>d</sup> Excludes live exports. Veal production generally accounts for around 2 per cent of production.
<sup>e</sup> Includes buffalo but excludes dairy cattle and breeders.

Sources: ABS 2015a, b, c, d, e; Commonwealth Government Department of Agriculture 2014

Development of the Australian beef cattle industry

Beef cattle arrived in Australia with the first fleet in 1788. By 1850 the herd had increased to 1.9 million head, and by 1900 it had reached 8.6 million head (ABS 2005). While the herd remained relatively static between 1900 and 1950 (a period that included two world wars and the Great Depression), it increased significantly after World War II, peaking at just under 30 million head in the mid 1970s. This coincided with world oversupply and the imposition of import restrictions in major overseas markets, which led to a collapse in world beef prices (ABS 2005). Even at that time, export income was important to the farm sector, with more than 40 per cent of Australian beef exported. In the 1980s poor prices and seasonal conditions resulted in farmers destocking to the point where the herd fell below 20 million head (ABS 2005). The herd returned to growth in the 1990s, and in June 2014 was 26.3 million head.

A number of factors have contributed to the development of the Australian beef industry, including expansion into new areas, some intensification of activities, improved genetics, increased productivity and expanded access to international markets.
The introduction of new breeds was particularly important, leading to a rapid increase in cattle numbers in the 1960s and 1970s. Up until 1960 the Australian cattle herd was almost exclusively based on British early-maturing breeds. While these breeds were well suited to southern and temperate climates, they were less suited to subtropical and semi-arid regions. Parasites (mainly ticks), droughts and highly seasonal foraging conditions were limiting factors. The introduction of pure-bred Brahman cattle (a *Bos indicus* breed) in the late 1940s and the crossing of the Brahmans with other breeds to develop tropically adapted cattle, such as Droughtmaster, Belmont Red, Braford and Santa Gertrudis, played a major role in the development of the northern cattle herd (Herne 1998). Similarly, large European *Bos taurus* breeds such as Limousin, Charolais and Simmental were introduced in the late 1960s and crossed with British breeding stock to produce larger, later finishing animals (ABS 2005).

The opening up of the US ‘grinder beef’ market in the 1960s was a major development, particularly with the loss of Australia’s preferential treatment by Britain following its alliance with the European Economic Community. Much of the grinder beef goes to the hamburger market. In the mid 1980s, Australia gained access to the Japanese high-quality beef market, which contributed to the development of a lot feeding industry and the export of chilled beef in addition to frozen beef (Herne 1998). And in the early 1990s South-East Asian countries, including the Philippines, Thailand and Malaysia, began importing live cattle from northern Australia. This market has grown substantially since then, with Indonesia now Australia’s major live export market.

**Characteristics of the Australian beef cattle industry**

The beef cattle industry is Australia’s most extensive agricultural industry. Farms running beef cattle account for more than 75 per cent of the total area of agricultural land (Thompson & Martin 2014) and 45 per cent of Australia’s land area (SSCRAT 2014). In 2013–14 more than half of Australia’s 128 454 agricultural businesses ran beef cattle (ABS 2015a), with around half of these businesses specialising in beef cattle production.

The beef cattle herd is highly dispersed, and cattle farming occurs in all states (Map 1). Queensland is the largest beef-producing state, carrying 12.8 million of Australia’s 26.3 million cattle and producing $3.7 billion (slaughter value) of beef in 2013–14. New South Wales is the next largest beef-producing state, carrying 5.3 million head and producing $1.5 billion of beef.
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Tasmania has the smallest herd, carrying around half a million head. Around one-third of the beef cattle herd is located above the Tropic of Capricorn.

Map 1 Beef cattle in Australia, 2010–11

Note: Displayed by Statistical Area Level 2 region. Each region represents a community that interacts socially and economically.
Sources: ABS 2012a; Geoscience Australia 2015

ABARES farm survey data indicate that farms running beef cattle in northern Australia are far more dependent on income from the sale of cattle than farms in southern Australia, which are generally more diversified (Thompson & Martin 2014).

Differences in production systems would be expected to be reflected in differences in cost structures. When averaged across all beef-producing farms in Australia between 2010–11 and 2012–13, ABARES farm survey data indicate that the most significant expenses are beef cattle purchases; interest payments; freight, handling and marketing; wages for hired labour; and fodder (Figure 2). However, there are some important regional differences. For example, cattle purchases, interest paid and fodder accounted for a higher percentage of expenses for northern producers. For southern producers, crop and pasture chemicals and fertiliser represented a higher proportion of expenses, reflecting the more diverse range of farming activities undertaken in the southern states, including cropping and the use of improved pastures. Freight, handling and marketing were significant expenses for both northern and southern producers. However, the ABARES estimates of freight costs do not take into account cattle carted by farmers using their own trucks or the costs of transporting cattle off-farm that are paid for by buyers such as feedlots.
Australia's beef supply chains: infrastructure issues and implications

Figure 2 Composition of farm costs, beef cattle–producing farms, 2010–11 to 2012–13, average per farm

Note: Includes farms running more than 100 beef cattle.
Source: Thompson & Martin 2014

As with all agricultural industries, the financial performance of farms producing beef cattle varies over time and between regions depending on a range of factors, including the scale of operations (larger in the north), seasonal conditions, commodity prices, input costs and government policies. In 2013–14, farm cash income of Australian beef farmers averaged $81 000, ranging from $382 100 for farms in the Northern Territory to $41 600 in Victoria (Table 2).

Table 2 Receipts, costs and farm cash income of all beef-producing farms, 2013–14

<table>
<thead>
<tr>
<th></th>
<th>Average total cash receipts ($)</th>
<th>Total cash costs ($)</th>
<th>Farm cash income ($)</th>
<th>Rate of return (%)a</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSW</td>
<td>346 859</td>
<td>257 843</td>
<td>89 016</td>
<td>0.4</td>
</tr>
<tr>
<td>Vic.</td>
<td>168 589</td>
<td>126 959</td>
<td>41 630</td>
<td>–0.8</td>
</tr>
<tr>
<td>Qld</td>
<td>355 359</td>
<td>289 627</td>
<td>65 733</td>
<td>–0.7</td>
</tr>
<tr>
<td>SA</td>
<td>587 727</td>
<td>420 506</td>
<td>167 221</td>
<td>0.9</td>
</tr>
<tr>
<td>WA</td>
<td>507 086</td>
<td>382 739</td>
<td>124 347</td>
<td>1.2</td>
</tr>
<tr>
<td>Tas.</td>
<td>378 531</td>
<td>295 342</td>
<td>83 190</td>
<td>1.2</td>
</tr>
<tr>
<td>NT</td>
<td>1 580 928</td>
<td>1 198 804</td>
<td>382 124</td>
<td>2.9</td>
</tr>
<tr>
<td>Australia</td>
<td>346 670</td>
<td>265 674</td>
<td>80 996</td>
<td>0.0</td>
</tr>
</tbody>
</table>

a The rate of return excludes capital appreciation. It represents the ability of businesses to generate a return on all capital used by the business, including that which is borrowed or leased.
Source: ABARES 2015b

A more complete measure of farm performance is the rate of return on capital invested (excluding capital appreciation) (Figure 3), which measures the ability of a business to generate a return on all capital used, including on borrowed funds and leased items. Between 2007–08 and 2013–14, the average rate of return of Australian beef farms was 0.9 per cent, and ranged between 2.2 per cent for farms in the Northern Territory to 0.2 per cent for farms in Victoria. Rates of return have been volatile—for example, the rate of return for farms in the Northern Territory varied from 3 per cent in 2007–08 to 0.2 per cent in 2008–09.
Average rates of return also vary significantly across farms. The best performing beef farms earned on average 3.9 per cent between 2007–08 and 2013–14, while the bottom performers earned −4.5 per cent (ABARES 2015b). This suggests that there may be some opportunity to increase production in the beef industry if the lower performing farmers adopted the technologies and management practices used by the industry’s top performers, or potentially through farm consolidation. Other potential sources of growth in production include the development and adoption of new technologies, the intensification of activities and expansion into new areas.

Recent research by ABARES shows that many small operators earn significant off-farm income, which means there may be little pressure for some beef farmers operating small unprofitable farms to adjust (Jackson & Valle 2015). Land values have also increased substantially over the past 30 years for many small farms, and when capital gains are included beef farms performed similar to those in the cropping industry (Jackson & Valle 2015).

The Australian beef industry also involves off-farm activities, including processing, retailing and exporting.

It is difficult to accurately identify the number of people employed in the Australian beef industry. Census data for 2011 (ABS 2012b) indicate that around 83 000 people worked in industries related to raising cattle, including feedlots (Figure 4). A further 31 000 were employed in meat processing. More than a third of total employees were located in Queensland and a quarter in New South Wales. Map 2 shows that many of these people were employed in south-eastern Queensland and northern and southern New South Wales. While these figures exclude those involved in the wholesaling, retailing and exporting of beef and overestimate the number of people employed in beef processing (they include those employed in non-beef meat processing), they suggest that the beef industry is an important source of economic activity and employment, especially in regional Australia.
Australia’s beef supply chains: infrastructure issues and implications

Figure 4 Employment in beef-related industries, 2011

![Figure 4 Employment in beef-related industries, 2011](image)

Note: Farming and feedlotting includes sheep, beef and grain farming not further defined, beef cattle farming specialised, sheep-beef cattle farming and grain-sheep or grain-beef cattle farming. Meat processing includes meat and meat product manufacturing not further defined, meat processing, and cured meat and smallgoods manufacturing.

Source: ABS 2012b

Map 2 Share of beef cattle production and meat processing employment in Australia, 2011

![Map 2 Share of beef cattle production and meat processing employment in Australia, 2011](image)

Note: Beef cattle production and meat processing include the following industry classifications: sheep, beef and grain farming not further defined, beef cattle farming (specialised), sheep-beef cattle farming, grain-sheep or grain-beef cattle farming and meat processing. Displayed by Statistical Area Level 2 region. Regions with fewer than 20 people employed in meat processing excluded.

Sources: ABS 2012b; Geoscience Australia 2015

Projections of beef production and exports to 2050

Research by ABARES suggests that the real value of Australia’s beef production could increase by 83 per cent between 2007 and 2050, and the value of exports could increase by 131 per cent (Linehan et al. 2012). These projections reflect, to a large extent, expected increases in global demand for red meat, particularly demand from Asia. While ABARES has released research analysing factors influencing the potential to increase beef production in northern Australia (Gleeson, Martin & Mifsud 2012), it has not analysed the potential for the Australian beef industry to increase production and exports to 2050. Some research is available for Queensland, however, with the Queensland Department of Agriculture, Fisheries and Forestry releasing a
draft action plan for the beef industry that examines the potential to double beef production in Queensland by 2040 (QDAFF 2014). The study contains a trend analysis that indicates that, if the growth trends of the past 20 years continue, beef production in Queensland could increase by nearly two-thirds between 2012–13 and 2040. However, the report states that the growth trend has slowed in recent years, and that a significant increase in productivity would be required to meet the production target.
3  Beef supply chains in Australia

Beef supply chains have several stages. The production stage involves converting grass into beef by grazing cattle on native or improved pastures. The process begins on-farm with the production of calves (Figure 5). If they are not turned off as vealers, the calves are weaned and, if not kept for breeding, finished on grass and sold to processors (either directly or through saleyards) or grown and conditioned to enter a feedlot for grain finishing. This conditioning, or backgrounding, involves grouping and acclimatising animals to prepare them for the intensive environment of a feedlot. It improves their socialisation and feed intake, and allows vaccination to minimise health issues in the feedlot. Cattle are then transferred to abattoirs for slaughter and, after processing, to domestic markets or to container terminals for export. Not all cattle are finished or slaughtered in Australia, with some animals being transported to terminals for live export.

Figure 5 Beef supply chains

On-farm beef cattle production

Beef cattle production in Australia is typically divided into northern and southern systems. The northern cattle-producing region is usually defined as northern Western Australia, the Northern Territory and Queensland, with New South Wales, Victoria, Tasmania, South Australia and southern Western Australia constituting the southern region (Map 3).
There are significant differences between the northern and southern beef cattle industries. Some of these differences are the result of differences in climate, pastures, industry infrastructure and proximity to markets. These differences have resulted in different production systems and market focus.

Temperatures are generally much higher in northern Australia. Large areas have a pronounced wet season in summer (Map 4) that severely restricts the movement of cattle on properties and the road network, crucial parts of which are unsealed. Many producers in the north are remotely located, operate large properties at relatively low stocking rates, and graze cattle on native pastures. *Bos indicus* breeds play a major role in the north because of their ability to adapt to harsh climatic conditions and their resistance to cattle ticks. The trade-off for being able to produce cattle under these conditions is that the beef is generally of lower quality than the beef produced by the British and European breeds (*Bos taurus*) that dominate in the more temperate south (Gaden 2008). This in turn limits the suitability of northern cattle for particular markets. Many of the cattle produced in far northern Australia are targeted at the live export market in South-East Asia, with many of the remaining cattle targeted at the manufacturing beef export market.

In contrast, the southern region has a more moderate climate, with farms tending to be smaller, more intensive, more diversified, more likely to graze cattle on improved pastures and located closer to Australia’s major population centres. Almost all cattle are slaughtered domestically, with around half of this beef consumed domestically. The other half is exported, with some going to premium chilled beef markets such as Japan and Korea. Apart from running predominantly British and European breeds favoured by premium markets, southern producers’ proximity to Australia’s major population centres gives them an advantage in servicing domestic markets.
There is considerable diversity within the northern and southern production systems. In far northern Australia, for example, not all income is derived from direct sales to the live export market. This suggests that some of these farms are involved in other activities and some cattle are sold to other regions or states for finishing, or directly to a southern abattoir for slaughter.

The balance of northern Australia that is located outside the live export region is more focused on beef production for domestic slaughter. There is diversity in this region too. For example, while Queensland exports a substantial volume of manufactured beef, it is also a major exporter of chilled beef. Chilled beef is a premium product that usually requires significant \textit{Bos taurus} content. There is some transition in breeds when moving from northern Australia to southern Australia, with the percentage of British and European content increasing when moving south. The increase in genetic options allows some northern producers located closer to southern Australia to produce cattle that are suitable for premium domestic and export markets (see Box 1).

**Box 1 Herd composition**

It is difficult to find any definitive information on the composition of the Australian beef herd by region and industry sector. However, in 2006 AusVet Animal Health Services prepared a report for the Commonwealth Government Department of Agriculture, Fisheries and Forestry that included expert opinion on the herd’s composition. Although somewhat dated, the study showed that \textit{Bos indicus} and \textit{Bos indicus} cross-breeds dominated in the north, while southern cattle were almost exclusively \textit{Bos taurus}. Cross-bred cattle were also found to be relatively common across Australia.

The study also indicated that there is some transition in breeds when moving from north to south. For example, in the region AusVet defines as Central Queensland and North Western New South Wales (which includes the important grain-growing regions of the Darling Downs and northern New South Wales), the study shows the percentage mix of \textit{Bos indicus} and \textit{Bos taurus} content to be roughly equal.

The study also revealed that \textit{Bos taurus} breeds dominated the feedlot sector, although some of the herd in northern feedlots contained some \textit{Bos indicus} content.
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While it may be possible to increase the mix of *Bos taurus* bloodlines in the northern herd to increase beef quality and the range of accessible markets, the potential to do so is limited by the harsh climatic conditions and the existence of cattle ticks. *Bos indicus* breeds have a proven ability to adapt to hot tropical conditions and are resistant to ticks. The more *Bos indicus* genes in a breed or cross-breed, the more resistant it is to ticks, with cattle that are at least five-eighths *Bos indicus* being largely resistant to ticks (MLA 2005).

Source: AusVet 2006, except where otherwise noted

Feedlots

Strong demand for premium-grade grain-fed beef, both domestically and overseas, has led to a significant expansion of lot feeding in some regions over the past 30 years.

Feedlotting involves fattening cattle in yards for slaughter. It allows operators to control feeding regimes, providing greater control over the quality and timing of supply than is possible with grass finishing, which is more reliant on seasonal conditions. They can also tailor feeding regimes to produce beef targeted at particular markets, such as the highly marbled Japanese long-fed market (usually fed for more than 200 days) or the short-fed domestic market (usually fed for 70 to 150 days) (MLA 2015). At any given time, around 2 per cent of Australia's meat cattle are in feedlots (ALFA 2013a).

Feedlotting is a low-margin activity, with cattle and feed costs accounting for around 68 and 25 per cent of revenue earned (Fitzpatrick 2012). Because cattle and feed are bulky and expensive to transport, feedlots tend to be located close to grain-producing regions with ready access to cattle. There are around 450 accredited beef cattle feedlots across Australia, with most located in south-eastern Queensland, the northern tablelands in northern New South Wales and the Riverina in southern New South Wales (ALFA 2013b) (see Map 5).

Map 5 Feedlots in Australia

While feedlotting can be opportunistic and responsive to changes in seasonal conditions and grain prices, the demand for grain-fed beef has been the main driver of investment in feedlot capacity since the early to mid 1980s (SSCRRA 1992). In particular, the liberalisation of the
Japanese beef market that began in the mid 1980s contributed to a rapid expansion of the sector during the 1990s. The imposition of restrictions on beef imports from the United States into Japan following the discovery of BSE in 2003 aided this expansion. The preference of Japanese consumers for grain-fed beef became clear following liberalisation of the market. Between 1987 and 1995, the proportion of Japanese grain-fed beef imports rose from 5 per cent to more than 65 per cent (Chadee & Mori 1996). The preference for grain-fed beef led to a change in Australian production systems, with 60 per cent of Australia’s chilled beef exports to Japan comprising grain-fed beef in 1995. In the same year, nearly 40 per cent of all Australian beef exported to Japan was grain-fed, compared with only 10 per cent in 1988 (Chadee & Mori 1996).

Given these developments, growth in the feedlot sector has outpaced growth in the broader beef cattle industry, with turn-off via feedlots increasing from around 8 per cent in 1992 to 28 per cent in 2013–14 (SSCRRRA 1992; ALFA 2014). There was also significant growth in feedlot capacity over this period. In absolute terms, Queensland and New South Wales contributed most to this growth over the past decade (Figure 6).

Figure 6 Feedlot capacity, 2001–02 to 2013–14

The share of cattle turned off via feedlots varies between states. Queensland and New South Wales have higher shares than other states, and Queensland has a higher share (39 per cent in 2013–14) than New South Wales (33 per cent) (Figure 7). The turn-off rate via feedlotting in Victoria tends to be much lower than in other states, and is typically around 10 per cent.
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Figure 7 Share of Australian cattle slaughter turned off via feedlots, 2001–02 to 2013–14

![Graph showing share of Australian cattle slaughter turned off via feedlots, 2001–02 to 2013–14]

Sources: ABS 2015c; ALFA 2014

There has been some rationalisation in the feedlot sector in recent years, with growth in feedlotting mainly in larger capacity facilities. In 1990 around half of total Australian capacity was in feedlots that could carry more than 5 000 head, and in 2014 around half of total Australian capacity was in feedlots that could carry more than 10 000 head (SCCRRRA 1992; ALFA 2014). There has also been an absolute decrease over the past decade in facilities that can carry less than 1 000 head.

The feedlot sector is closely linked to the Australian grain industry. In 2011–12, around 11.6 million tonnes of stock feed was consumed by domestic livestock, with beef cattle consuming 2.7 million tonnes, dairy cattle 3.0 million tonnes and poultry 3.7 million tonnes (Spragg 2012). This feed included 9.3 million tonnes of grain. To the extent that expansion in beef production relies on feedlotting, it will also depend on the availability and affordability of feed grains and the competing demands of other livestock industries.

**Saleyards**

Saleyards are the first point of aggregation in many beef supply chains, providing a venue for the auction of a range of cattle types. They tend to be strategically located to facilitate the sale and distribution of beef cattle to other cattle farmers for fattening or backgrounding for entry into feedlots, to feedlots for grain finishing or to abattoirs for slaughter (Map 6). According to the Australian Livestock Markets Association, its membership covers 128 saleyard sites across Australia, with 50 per cent located in New South Wales, 22 per cent in Victoria, 17 per cent in Queensland, 4 per cent in Western Australia, 4 per cent in South Australia, two sites in Tasmania and one site in the Northern Territory. Collectively, these sites account for around 70 per cent of Australia’s saleyard throughput (ALMA 2015). Hassall & Associates (2007) estimate that around six million cattle are sold through the national saleyard network in an average year, with most sold through New South Wales and Victorian saleyards.
While around half of all beef cattle in Australia were sold via auctions at saleyards in 2013–14, the reliance on saleyard auctions varies between states. They tend to dominate in the southern system, with saleyard auctions in Victoria and New South Wales accounting for 70 per cent of sales. In contrast, northern producers make greater use of paddock and over the hooks sales, with saleyard auctions accounting for 3 per cent of sales in the Northern Territory and 44 per cent in Queensland (Figure 8).

Saleyards must comply with a variety of regulations, including biosecurity, animal traceability, environmental protection and animal welfare regulations. The cost of compliance can be significant, particularly for some smaller facilities. While local governments have sustained some smaller saleyards, there has been some rationalisation of saleyards, including private investment in larger capacity saleyards. For example, Regional Infrastructure Pty Ltd built the Central Tableland Livestock Exchange near Blayney to replace outdated saleyards at Orange, Blayney and Bathurst (RIPL 2014). The new saleyard opened in 2008 and cost around $18 million. It can house around 4 000 head of cattle under cover, with sales expected to reach 160 000 head a year.
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Figure 8 Methods of sale by state, 2013–14

Note: Figures may not add to 100 per cent because of rounding.
Source: ABARES 2015b

Meat processing

Processing involves transforming live cattle into a range of beef products. It involves stunning, bleeding, removing the hide and internal organs, trimming excess fat, washing the carcass, chilling, boning and freezing or holding in cold storage. Boning involves cutting the carcass into smaller pieces called primals (for example, whole rump). Processing also leads to the production of by-products, such as edible offal, that have a commercial value. Beef is chilled or frozen depending on its final market. It is then transported to domestic outlets in refrigerated trucks or to ports in refrigerated containers. Some high-value beef is also exported via airfreight.

While processing facilities vary in the extent to which they further transform carcasses, most abattoirs have on-site processing facilities where boning, packing, and chilling or freezing are carried out.

Abattoirs source cattle directly from farms, saleyards or feedlots. There is also a trend for businesses operating processing facilities to be increasingly integrated with the upstream stages of the beef supply chain, including farming and feedlotting (Witham 2013). For example, JBS Australia operates five feedlots that support its meat processing plants. Some companies involved in upstream activities are also diversifying into downstream activities. The Australian Agricultural Company, which owns and operates farms and feedlots covering around 7 million hectares in Queensland and the Northern Territory, recently opened an abattoir near Darwin, and the Yeeda Pastoral Company, which controls several pastoral leases in Western Australia covering around 1.6 million hectares, also owns abattoirs and is building a new facility in the Kimberley that is expected to open in the second half of 2015 (Thompson 2015).

While beef cattle are widely dispersed across Australia, processing facilities tend to be concentrated near population centres and export terminals (Map 7). Most are located in Queensland, New South Wales and Victoria, where most beef cattle production occurs. Queensland typically accounts for around 50 per cent of total beef production, while New South Wales and Victoria together account for around 40 per cent (Figure 9).
The major meat processing companies in Australia are JBS Australia, Teys Australia and NH Foods Australia. According to Lin (2015), these three companies are likely to account for 16.5 per cent, 12.1 per cent and 4.0 per cent, respectively, of the processing industry’s revenue in 2014–15. JBS Australia is a division of the Brazilian company JBS, which is the world’s largest meat processing company (Witham 2013). Until recently JBS Australia operated 10 processing plants and five feedlots across Queensland, New South Wales, Victoria and Tasmania. These facilities had a daily slaughter capacity of more than 8 000 head of cattle and 21 000 head of small stock, including sheep, pigs and calves. The company’s facility at Dinmore in Ipswich is Australia’s largest, with a daily processing capacity of 3 350 cattle (JBS Australia 2014). Cattle processed by JBS Australia are predominantly sourced from farms in northern Australia. Around 85 per cent of JBS Australia’s output is exported (Lin 2015). In early 2015 JBS concluded its acquisition of the Primo Group. The Primo Group is Australia’s largest producer of ham, bacon, pork and continental small goods. The acquisition will also provide JBS with additional beef processing capacity in southern New South Wales (Beef Central 2015).
Teys Australia—A Cargill Joint Venture is the second largest meat processor in Australia. The business was formed in 2011 as a 50:50 joint venture between Teys Bros Australia and Cargill (Lin 2015). The company operates six processing facilities and two feedlots, as well as a hide processing facility. These are located in Queensland, New South Wales and South Australia. Total annual capacity is around 1.5 million head of cattle.

Similar to the feedlot sector, the meat processing industry tends to operate on high volumes and low profit margins (Lin 2015). According to research by Witham (2013), Australia suffers a cost disadvantage, with the local industry not taking full advantage of economies of scale. Many local abattoirs still operate single shifts, and ongoing industrial disputes inflate costs compared to overseas processors. The study also identifies utility costs for energy and water as being significant, since high levels of energy and water use in abattoirs are necessary to meet strict food safety requirements. Water is used to water and wash incoming stock and to clean livestock carcasses, processing equipment and work areas. There is also the issue of safe effluent discharge, with processors facing heavy fines for any non-compliance with environmental laws.

Overall, processors suggest that beef processing costs in Australia have been and continue to be high by world standards. JBS Australia indicates that the cost of processing cattle in Australia is twice that in Brazil and the United States (Witham 2013).

Competitive pressures at the processing stage have resulted in a contraction in the number and geographic distribution of facilities over a long period of time. Between 1980 and 2002 the number of red meat processing plants roughly halved, from 475 to around 236 (MLA 2002a; Bindon & Jones 2001). There has been further rationalisation in recent years, with the Australian Meat Processor Corporation reporting that it currently has 124 members operating 150 meat processing facilities across Australia. These facilities account for more than 97 per cent of Australia’s red meat processing capacity (AMPC 2015).

At the same time, some of the biggest companies in the sector have expanded their operations (Bindon & Jones 2001; QDEEDI 2010). Expansion and investment in new technology, coupled with more secure access to cattle through backwards integration into feedlotting, address some of the factors that have been regarded as disadvantaging beef processing in Australia in the past.
Domestic market

Following processing, beef is distributed to domestic markets or ports via refrigerated trucks or containers. Domestic beef consumption is dominated by meat purchased at retail outlets. According to Australian Competition and Consumer Commission (ACCC) estimates, more than two-thirds of domestically produced beef consumed in Australia is delivered to retail outlets, including supermarkets and butchers (ACCC 2007) (Figure 10). A significant volume (27 per cent) is delivered to the food service industry, including restaurants, while a small volume (5 per cent) is sent for further processing.

The ACCC (2007) also found that the retail sector accounts for a significant proportion of the retail price of beef, with retail services—including trimming, packaging, promotion, advertising and shopkeeping—making up roughly 30 per cent of the retail price of beef. The proportion may be higher for some outlets, such as independent butchers preparing boutique products.

Woolworths and Coles are significant buyers of Australian beef, purchasing 18 and 16 per cent, respectively, of domestically produced beef sold in Australia in 2005–06 (ACCC 2007). The major supermarkets operate vertically integrated supply and service agreements with producers, feedlots and processors (ACCC 2007). Despite the significant presence of Woolworths and Coles in the domestic market, the ACCC found that the larger export market limited the capacity of these supermarkets to influence the prices paid to producers, feedlots and processors.

Exports

Around two-thirds of Australia’s beef (by volume) is exported, with the remainder being consumed within Australia. In addition, around one million live cattle were exported for slaughter in overseas markets in 2013–14 (ABARES 2014).

When beef is exported, it is usually transported from the processing facility to port via road or rail in refrigerated containers. Some high-value beef is air-freighted to international markets, although the volume of these exports is relatively small (Hogan & Morey 2014). Containerised exports require access to specialised container ports (Map 8).
Queensland is the main beef exporting state, followed by Victoria and New South Wales (Figure 11). The Port of Brisbane is Australia’s main beef exporting port, with others located in Melbourne, Sydney, Fremantle and Adelaide (MLA 2013). These ports accounted for more than 99 per cent of Australia’s beef exports in 2012–13. They are also located in heavily populated areas, which can create problems in terms of access and traffic congestion.

Figure 11 Volume of beef and veal exports by state, 2013–14 (thousand tonnes)

Note: Shipped weight equivalent.
Source: ABS 2015d

Around three-quarters of Australia’s beef exports are frozen, with the remainder chilled (Figure 12). Victoria and Western Australia export a smaller proportion of chilled beef than the other states. Chilled beef is generally higher value beef and commands a premium in international markets. For example, the average price of a kilogram of Australian boneless chilled beef exported to Japan in the September quarter of 2014 was $7.25 (fob) compared with $4.47 for frozen beef (ABARES 2014).
Japan is Australia’s largest single beef export market, followed by the United States, the Republic of Korea and China (Figure 13).

The most significant recent development in Australia’s beef export market has been the increase in beef and veal exports to China, from less than 8 000 tonnes in 2009–10 to more than 90 000 tonnes in 2012–13 and 161 000 tonnes in 2013–14 (Figure 14). While the demand for beef in China has been increasing as incomes rise, domestic production has remained relatively static (Mifsud 2013). The increase in Australian exports to China followed an increase in the number of Australian processing facilities approved by the Chinese Government for export to more than 50, including 20 approved in the 12 months to June 2013. Other major exporters such as the United States and Canada have had either no access or extremely limited access to the Chinese market.
In the medium term, Australia is likely to face significant competition in the Chinese market from South America (Deards 2015). Argentina and Uruguay are already important suppliers of the Chinese beef market, and in January 2015 China lifted restrictions on beef imports from Chile. In addition, the Brazilian Ministry of Agriculture, Livestock and Food Supply announced in May 2015 that China had officially lifted the embargo on Brazilian beef that had been imposed following the discovery of BSE in late 2012. The US Government is also working with the Chinese Government to restore access to US beef imports, which were banned following the discovery of BSE in 2003.

While there are a number of factors influencing international demand for Australian beef, Australia’s proximity to Asia provides it with a shipping time advantage compared with some major competitors such as Brazil (Figure 15).

Because of its export orientation, Australia’s beef cattle industry is highly dependent on maintaining and improving access to foreign markets.
There has been recent progress on market access, with Australia entering into a free trade agreement with the Republic of Korea in December 2014 that will reduce tariffs on beef imports being reduced from 40 per cent to zero over the next 15 years (DFAT 2014a). Tariffs on beef imports to Japan will also fall under the Japan–Australia Economic Partnership Agreement (commenced in January 2015), while in June 2015 Australia signed a free trade agreement with China that will help support the competitiveness of Australian beef in the Chinese market. Moreover, in October 2015 the Trans–Pacific Partnership (TPP) agreement was signed. The TPP is a regional free trade agreement between 12 Pacific Rim countries. This agreement could provide significant benefits to Australian beef producers when it is ratified by member countries. In particular, the agreement reduces tariffs on beef imports to Japan below those contained in the Japan–Australia Economic Partnership Agreement. Box 2 identifies some of the main trade and domestic support policies in Asia that influence market access for beef.

Box 2 Beef-related trade policies in Asia

<table>
<thead>
<tr>
<th>Country</th>
<th>Policy Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>China</strong></td>
<td>Approves foreign abattoirs to import beef into the Chinese market. Around 50 abattoirs are approved in Australia. This is high compared with other exporters. Beef from the United States and much of Canada is not approved because of BSE. In May 2015 the Chinese Government lifted the embargo on Brazilian beef that had been imposed following the discovery of BSE in late 2012. China imposes a number of tariffs on beef imports. Chilled beef imports are subject to an applied tariff of 20 per cent for carcasses and 12 per cent for all other cuts, while frozen beef imports are subject to tariffs of 25 per cent on carcasses and 12 per cent on all other beef products. Under the terms of the China–Australia Free Trade Agreement the Chinese Government will remove these tariffs over a nine-year period, as well as tariffs on live animal imports (DFAT 2014b).</td>
</tr>
<tr>
<td><strong>India</strong></td>
<td>India is one of the world's largest beef exporters (mostly of buffalo meat), despite the prohibition on cattle slaughter in most states. As such, it is not a major destination for Australian beef. Although the volumes of imports of beef have been small over the past two decades, imports of beef to India are subject to applied tariffs of 30 per cent. Bound rates are much higher at 100 per cent (WTO 2013). India is unable to export to the major East Asian markets of the Republic of Korea, Japan and Taiwan because of its status as a foot-and-mouth disease endemic country.</td>
</tr>
<tr>
<td><strong>Japan</strong></td>
<td>Japan charges a 38.5 per cent tariff on beef imports. Under the Japan–Australia Economic Partnership Agreement tariffs on Australian beef will fall to 19.5 per cent over 18 years for frozen beef and to 23.5 per cent over 15 years for fresh beef, while Japan will have discretion to reintroduce the higher rate if growth in Australian beef imports exceeds certain thresholds (DFAT 2014c). Ratification of the TPP, however, would result in tariffs falling below these levels, with tariffs on chilled and frozen beef imports falling to 9 per cent within 15 years of the agreement coming into force (DFAT 2015). The Japanese Government provides significant support to domestic beef producers.</td>
</tr>
<tr>
<td><strong>The Republic of Korea</strong></td>
<td>As part of the Korea–Australia Free Trade Agreement, will progressively eliminate its 40 per cent tariff on Australian beef imports over 15 years (DFAT 2014a). The Government of the Republic of Korea also administers a number of subsidy programmes for producers.</td>
</tr>
<tr>
<td><strong>Association of Southeast Asian Nations (ASEAN)</strong></td>
<td>Member states operate a range of tariff policies. The governments of Brunei Darussalam, Malaysia and Singapore impose no tariffs on imports of beef. The governments of Indonesia, Myanmar and the Philippines impose tariff barriers on imports of beef of 5 per cent, 15 per cent and 10 per cent, respectively. Imports of beef in Cambodia, Laos and Thailand are subject to much higher tariffs of 35 per cent, 30 per cent and 50 per cent, respectively. Total ASEAN live cattle imports fell significantly in 2011 after the Indonesian Government imposed a substantially lower import quota. In Indonesia, achieving self-sufficiency in beef production has been government policy since 2000, although the target completion date has varied. Key reasons for the programme's implementation are to encourage increased domestic beef production and to reduce trade exposure to Australia. In 2013, the import quota regime in Indonesia was replaced by a reference price mechanism (ABARES 2014). When prices exceed the reference price, imports are allowed. When they fall below the reference price, imports are restricted. A number of ASEAN member states that have predominantly Muslim populations impose strict certification standards on imports of beef.</td>
</tr>
</tbody>
</table>

Source: Mifsud & Haylen 2013, except where otherwise noted
Australia’s beef supply chains: infrastructure issues and implications

Live export trade

While live cattle have been exported from Australia since 1885, volumes were relatively insignificant until the 1970s (Keniry 2003).

The live export process involves transporting cattle from farms (most are purchased in the paddock) by road to a registered premises, which is usually close to a port. At this point the cattle are checked for health and welfare, and for compliance with importing country requirements.

The main areas producing live export cattle are in northern Australia. Roughly half of Australia’s live exports come from the Northern Territory, followed by Western Australia and Queensland. Northern Australia is well located in terms of being able to supply feeder cattle to feedlots in South-East Asia, and to Indonesia in particular. Figure 16 shows Australia’s main live export destinations.

Figure 16 Live export destinations, 2013–14 (thousand head)

Live cattle are exported on specialised ships and require specialised loading facilities. Most of the major live cattle export ports are in northern Australia (see Map 8), with Darwin accounting for 37 per cent of live exports in 2013–14. Other major northern ports include Townsville (18 per cent in 2013–14), Broome (9 per cent) and Wyndham (4 per cent). The main southern ports are Fremantle (12 per cent) and Portland (9 per cent).

Live cattle exports have increased significantly in recent decades, although they can be volatile (Figure 17). Apart from being subject to market influences, they are also susceptible to biosecurity restrictions in the event of disease. In 2011 live cattle exports to Indonesia were suspended briefly because of reports of animal welfare issues, with total exports falling from 871 000 head in 2009–10 to 513 000 in 2012–13. The market has since recovered, with nearly one million head exported in 2013–14. Increased demand in South-East Asia, particularly Indonesia and Vietnam, contributed to this growth. In September 2013, Indonesia replaced its import quota regime with a reference price mechanism (ABARES 2014). When the domestic retail price of secondary beef cuts exceeds the reference price, the Indonesian Government issues live cattle import permits. Prices have not fallen below the reference price since its inception (ABARES 2015a).
The Australian and Chinese Governments finalised an import health protocol for feeder and slaughter cattle in August 2015. Australian exporters can now establish Exporter Supply Chain Assurance System–approved supply chains in China. The terms of the China–Australia Free Trade Agreement announced in November 2014 also commit the Chinese Government to removing tariffs on Australian live exports over four years (DFAT 2014b).
4 Supporting infrastructure

A range of infrastructure supports beef production and trade in Australia, including transport, energy, water and telecommunications.

Transport

Beef cattle production is Australia’s most extensive and geographically dispersed agricultural activity, with a significant proportion of the cattle herd located on large farms in remote areas (see Map 1). In contrast, most export-licensed abattoirs are located near cities, regional centres or ports in south-east Queensland and southern Australia (see Map 7). Some cattle are transported thousands of kilometres from a farm to abattoir or port.

The beef supply chain is heavily dependent on transport infrastructure to move cattle from farms to abattoirs or ports and to receive inputs such as grain, fodder, fertiliser and feed supplements. In terms of the mode of transport, Queensland is the only state to use rail to transport cattle. However, rail use in Queensland has declined in recent years, with most cattle now transported by road. Map 9 shows the extent of the major road networks used to transport beef cattle in Australia.

Transport is a significant cost for beef producers and live cattle exporters. For example, Goucher (2011) estimated that transport costs represent around 13 per cent of the average saleyard price for heavy export-grade cattle for farmers exporting beef from Surat in central Queensland via an abattoir near Toowoomba and the Port of Brisbane to Yokohama, and around 22 per cent for farmers exporting beef from Gnowangerup in the south-west of Western Australia via an abattoir at Harvey and the Port of Fremantle to Yokohama. In both cases road transport accounted for around 40 per cent of total transport costs and sea transport for around 60 per cent. The distance travelled from farm to abattoir to port was around 450 kilometres in both cases. These distances are relatively small compared with transporting cattle to port or abattoir from some farms in northern Australia.

The significance of transport costs and their effect on returns to cattle farming highlight the importance of having an efficient transport system if Australia is to take advantage of an expansion in demand for beef in Asia. However, according to Engineers Australia (2010a), much of Australia’s road network is in poor condition. This is especially the case for local roads, many of which are located in rural areas.

Poor road infrastructure can increase costs in a number of ways. For example, wet weather can close roads for long periods. In northern Australia, the road network is regularly disrupted during the wet season, reducing the capacity of farmers to muster cattle and to supply cattle to live export yards, finishing properties and abattoirs. These closures increase costs or delay revenues by preventing cattle movements or by forcing trucks to take alternative and more expensive routes (Higgins 2013). Only 41 per cent of the Australian road network is sealed, and the percentage of local sealed roads is much lower (BITRE 2009). According to Juturna Consulting (2010), some of these unsealed roads are not regularly re-sheeted with gravel, making them little more than ‘pathways cut into the soil at the mercy of the elements’. Some of these roads are the ‘first mile’ and ‘last mile’ logistics links facilitating the movement of agricultural products (Juturna Consulting 2010). First and last mile issues can occur when the level of access to a road is lower than on key freight routes. Local roads are often not built to a standard that meets the needs of heavy vehicles. This means that larger heavy vehicles with
access to the main arterial routes are often unable to access local roads off the arterial road at either the start or end of a journey, limiting the use of high-productivity vehicles (ALGA 2010).

Poor roads can also increase costs by increasing travel times, damage to trucks and the number of road accidents. If poor roads increase travel times to the point where the meat standards code is compromised or where animal welfare and driver fatigue laws come into play, additional costs could be incurred, including costs associated with the downgrading of meat, unloading and watering stock and additional labour. For example, under Meat Standards Australia beef cattle transported from a property to a processor must be processed within 48 hours of departing the property, with a maximum of 36 hours road transport and up to 12 hours of rest (MLA 2011). Moreover, the code of practice for land transport of livestock in Queensland (Animal Care and Protection Act 2001 (Qld)) states that the maximum time an animal can go without water is 48 hours (Queensland Government 2014).

Any expansion in beef production would be expected to put additional stress on the road network, particularly on local roads. However, there is an emerging problem in terms of funding the local road network, with many local governments finding it difficult to develop a sustainable income stream for maintaining their road and bridge network, many of which were not designed to take additional traffic and heavier axle loads (Engineers Australia 2010b).

An important source of revenue for most local governments is council rates. In 2008, the Productivity Commission found that rural local government areas generally have less opportunity to generate revenue than capital cities and other urban areas, where incomes are generally higher and council rates are correspondingly lower as a percentage of total income, and where revenue can be generated through a broader range of charges such as parking fees and fines (PC 2008). According to Juturna (2010), research suggests that unsealed local roads—the ‘first mile’ of much of Australia’s agricultural transport task—are usually the first victim of local government road budget pressures.

During consultations for this study, the Red Meat Advisory Council confirmed that the poor condition of much of the road network used to transport live cattle is a major issue for the industry, and that the decline in rail transport in Queensland has exacerbated the problem (R Keane (Red Meat Advisory Council) 2013, pers. comm., 26 November). According to the council, a major challenge for the industry will be transporting cattle to abattoirs if the slaughter rate goes up in response to an increase in international demand.

A further issue is that road access restrictions have the potential to limit the use of high-productivity vehicles in some areas, particularly on the east coast and in south-west Western Australia (Map 9). These restrictions can increase costs if transport operators use smaller trucks, split loads and make multiple trips or take detours that increase transport distances.
Road congestion is another problem that has the potential to impede the efficiency of the beef supply chain. This is particularly an issue when transferring processed beef to ports for export. Many ports that export beef are located in or near urban areas where traffic congestion can be an issue. Research commissioned by the Council of Australian Governments (COAG) for its 2006 review of urban congestion found that the costs associated with road congestion in Australia could more than double from $9.4 billion in 2005 to $20.4 billion in 2020 (BITRE 2007).

There are also signs of port capacity constraints. The ACCC (2013) has noted that the very high rates of return earned by Australian stevedoring companies (between 20 and 30 per cent on tangible assets) are likely to be the result of low levels of competition (Figure 18). The ACCC notes, however, that the recent entry of Hutchinson Ports Australia (HPA) into east coast container ports should help relieve constraints in port loading capacity (ACCC 2013). In 2013 HPA commenced stevedoring operations at the Port of Brisbane and Port Botany. The entry of HPA has in turn stimulated investments in new technologies and additional capacity by existing stevedoring firms.

The significant expansion in stevedoring capacity since 2011–12 (tangible assets more than doubled) has been reflected in a decline in rates of return to stevedoring assets, with returns declining from 29.2 per cent in 2011–12 to 21.9 per cent in 2012–13 and 13.3 per cent in 2013–14 (ACCC 2014). The average rate of return in 2013–14 was still significantly higher than for the S&P/ASX 200 Industrials Index, which was 7.9 per cent. The ACCC concludes that to the extent the increase in the number of stevedores provides an opportunity for more aggressive competition, ‘it is less likely that high profits, to the extent they might have previously reflected rents in an industry with low contestability, will continue’ (ACCC 2014).
Energy is an important input in the beef supply chain, particularly at the processing stage. ABARES farm survey data indicate that electricity is a relatively minor cost at the farm level, at around 1 per cent. High levels of energy use are required in meat processing for refrigeration and sterilising equipment. Thermal energy (steam and hot water) is used for cleaning, sterilising and rendering, and is produced from boilers powered by electricity, coal, oil or gas. Electricity is also used for refrigeration, ventilation, lighting and operating equipment. Refrigeration is the largest user of electricity in meat processing plants (MLA 2002b). Once meat has been processed and packed it is either stored in cold storage (0 to –4 degrees Celsius) or frozen (less than –18 degrees Celsius).

Little data are available on energy use beyond the farm gate. However, feedback from consultations with industry suggest that it is energy prices, particularly electricity prices, rather than access to energy that are likely to affect the ability of Australian meat processors to compete with overseas processors whose energy costs are lower.

Meat processors incur some of the largest utility costs in the manufacturing sector, accounting for 5.6 per cent of revenue in the meat processing industry in 2012–13 compared with 2.4 per cent in the broader manufacturing sector (Witham 2013). The Energy Users Association of Australia indicates that Australia’s electricity prices are high by international standards. According to that analysis, electricity prices in Australia in 2011–12 were substantially higher than in Canada and the United States, and higher than in Japan and 27 countries in the European Union (Mountain 2012).

Australia’s energy prices have increased substantially in recent years. For example, real electricity prices for manufacturing businesses increased by 60 per cent between June 2003 and June 2013 (Swoboda 2013). A number of factors have contributed to these increases, including investments in the distribution network to maintain or increase capacity and renewable energy and energy efficiency measures (Swoboda 2013).

Water

Water is a critical input to the beef supply chain. Beef cattle cannot be produced without water, and access to water is essential at the processing stage. Most beef cattle producers are likely to
harvest stock water in on-farm dams, extract water from aquifers or divert water from rivers or streams. They are unlikely to use town water supplies or to be located in reticulated irrigation schemes that require access to off-farm water storage and delivery infrastructure.

In contrast, many abattoirs are likely to be located close to towns, and to receive water from town or urban water utilities. According to the Australian Meat Processor Corporation, in 2003 the average volume of water used to process a cow was 1,480 litres, with around 1,400 litres of wastewater being generated in the process (AMPC 2010). Around half the water used in an abattoir is used on the processing floor, 20 per cent is used to clean plant and equipment and a further 15 per cent is used in stockyards.

The intensity of water use by processing facilities was mentioned several times during consultations. These discussions did not identify any significant impediments to access to water, although there were concerns about the extent of recent increases in water charges. Figure 19 shows recent water charges at some processing locations.

Figure 19 Cost of a thousand litres of water for selected towns and cities, 2013

<table>
<thead>
<tr>
<th>Town</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Townsville</td>
<td>2.67</td>
</tr>
<tr>
<td>Rockhampton</td>
<td>1.55</td>
</tr>
<tr>
<td>Brisbane</td>
<td>1.39</td>
</tr>
<tr>
<td>Ipswich</td>
<td>1.72</td>
</tr>
<tr>
<td>Tamworth</td>
<td>0.66</td>
</tr>
<tr>
<td>Wagga Wagga</td>
<td>1.83</td>
</tr>
<tr>
<td>Melbourne</td>
<td>2.60</td>
</tr>
</tbody>
</table>

Note: Many water authorities use increasing block tariffs by volume for non-residential users. Meat processors are high-volume water users, so the maximum tariff is presented. The Tamworth water price is exclusively for the Teys Australia meat processor. Other food processors pay $1.05 a kilolitre and other non-residential properties pay $1.67 a kilolitre. Sources: City of Wagga Wagga 2013; ESC 2013; Queensland Urban Utilities 2013; Rockhampton Regional Council 2013; Tamworth Regional Council 2013; Townsville City Council 2013

Telecommunications

Telecommunications are also widely used in the beef supply chain. The main forms of telecommunications that are relevant to this study are telephones (land line and mobile) and the internet. The geographically dispersed nature of beef cattle production suggests that access to and the quality of telecommunications is likely to be more of an issue for cattle producers than processors and exporters, which are likely to be located near towns and cities. There are significant areas across Australia where mobile phone coverage is not available. This restricted coverage can lead to delays in communications between buyers and sellers that can disadvantage some sellers in remote areas. Many farmers are also likely to rely on satellite or dial-up internet systems rather than the high-speed internet systems that exist in most cities and regional centres.

Some of these constraints were identified during consultations. For example, the Queensland Department of Agriculture, Fisheries and Forestry stated that, while some producers in Queensland had benefited from increased mobile phone coverage in areas where there had been an expansion in mining activities, mobile coverage remained poor in many remote areas (C Chilcott (Queensland Government Department of Agriculture, Fisheries and Forestry) 2013,
pers. comm., 17 December). Meat and Livestock Australia also stated that, while telecommunications had improved significantly over the past 10 to 20 years, many producers still experienced reliability problems with satellite internet access (W Hall (Meat and Livestock Australia) 2013, pers. comm., 27 November).
5 Beef supply chain and supporting infrastructure in Queensland

Queensland is Australia’s largest beef-producing state, has diverse production systems, is highly export-oriented and has potential to expand production. In 2013–14, Queensland turned off 4.2 million cattle for slaughter from a total of 12.8 million head (ABS 2015a). These cattle produced 1.2 million tonnes of beef and veal, 84 per cent of which was exported (Figure 20). The revenue earned from the turn-off of cattle for slaughter and live export was equivalent to 34 per cent of Queensland’s total gross value of agricultural production and 47 per cent of the total revenue earned from these activities in Australia.

Figure 20 Queensland beef and veal production and exports, 2004–05 to 2013–14

Note: Carcass weight equivalent.
Sources: ABS 2015c, d

Beef cattle production in Queensland includes all activities—from breeding, fattening and finishing on grass or grain, to exporting live cattle for finishing and slaughter in overseas markets.

Supply chain

Map 10 and Figure 21 show the density and distribution of the Queensland beef cattle herd based on the latest agricultural census (2010–11). Cattle density decreases when moving from south-east Queensland to north and west Queensland, although a significant proportion of the herd is located in the more remote Outback region.
The diversity in Queensland beef production systems is largely driven by the local environment. Queensland has three distinct rainfall zones that influence the type of cattle farmers can produce and the markets they can access. The harsh conditions in the wet summer/dry winter tropics in the north and the low rainfall arid areas in the south-west mean that farmers in these regions...
Australia’s beef supply chains: infrastructure issues and implications

are heavily dependent on cattle breeds that can adapt to these conditions, and for those above the tick line, cattle that are resistant to ticks. As a result, cattle with significant *Bos indicus* content tend to dominate, particularly in northern Queensland. These cattle are more suited to the manufacturing beef export market than to premium domestic and export markets. North Queensland’s proximity to South-East Asia and South-East Asian demand for feeder cattle mean that some of these cattle are destined for the live export market.

In contrast to northern farms, farms located in the summer rainfall subtropical zone in south-east Queensland have more options in terms of herd genetics and feeding regimes. This region has a more moderate climate and is largely tick-free, allowing for the production of British and European breeds that are suitable for the high-quality domestic market and premium export markets. These farms also tend to be more diversified than those in northern and western Queensland, with many farmers involved in cropping and livestock activities. This area includes the Darling Downs. A combination of easy access to quality cattle, proximity to grain supplies and the opening up of markets for grain-fed beef has contributed to a significant expansion in feedlot activities in south-east Queensland over the past 30 years. In 2010–11 there were 195 specialised beef feedlot businesses in Queensland, representing 41 per cent of feedlots in Australia. Around 70 per cent of Queensland’s feedlot capacity is located in the major grain-producing regions in south-east Queensland (Sd+D 2008).

Around 70 per cent of beef processing in Queensland occurs in south-east Queensland, with most beef processed by one of the three major processors: JBS Australia, Teys Australia and NH Foods Australia (known as Nippon Meat Packers before July 2014) (Sd+D 2008). JBS Australia has a combined slaughtering capacity of more than 6 000 head a day, with its Dinmore plant able to process 3 350 head a day. Teys Australia has a daily slaughtering capacity of around 3 900 head, while NH Foods Australia can slaughter around 2 500 head a day (Figure 22). Some cattle from the Northern Territory and northern New South Wales are also slaughtered in Queensland abattoirs.

Almost all Queensland beef and some beef from other states, principally from northern New South Wales, is exported through the Port of Brisbane. This port can also handle live cattle exports, although Townsville is the main port used to export live cattle from Queensland. Some live cattle produced in Queensland are exported via ports at Karumba in the Gulf of Carpentaria, Mackay, Mourilyan near Innisfail, and Weipa, and in years when there is very high demand, via the Port of Darwin.

Live cattle exports from Queensland are highly variable. Much of Australia’s processing capacity is located in Queensland, providing Queensland producers with more selling options than some other producers in northern Australia. This allows Queensland producers to more easily divert cattle from live export to domestic processing to maximise returns.

Just prior to the suspension of live cattle exports to Indonesia in 2011, Queensland exported more than 160 000 live cattle a year. The number fell to just under 7 000 head in 2012–13, which was less than 2 per cent of total live exports in that year. In 2013–14 Queensland exported 196 000 live cattle, or just under 20 per cent of total live exports. The main factors contributing to the increase were unfavourable seasonal conditions, which encouraged the early turn-off of cattle to the live trade as feeder cattle or lightweight slaughter stock, and strong import demand from Indonesia.
Infrastructure

Transport, energy, water and telecommunications are all critical inputs into Queensland beef supply chains. A scan of the available literature and feedback from stakeholder consultations suggest that the main infrastructure constraints exist in the transport sector.

Telecommunications was raised as an issue by some stakeholders. While there have been significant improvements in telecommunications in recent years, some believed that internet access via satellite could be unreliable. Moreover, mobile coverage is patchy in much of regional Queensland, which can constrain marketing activities for some beef producers.

Some stakeholders also commented that recent increases in energy and water prices have raised processing costs, and have the potential to adversely affect the international competitiveness of Queensland beef.

The extensive and dispersed nature of beef cattle production and the concentration of processing facilities in the south-east and coastal regions mean that many cattle travel long distances in Queensland to abattoirs or export ports. Some cattle are also transported from the Northern Territory for slaughter in Queensland, although some of these cattle will now be diverted to the new Australian Agricultural Company abattoir near Darwin. There may also be significant travel prior to slaughter for cattle that are sold as store cattle for grass or grain finishing, and inputs need to be delivered to farms to facilitate production. And finally, once beef cattle have been processed the final product is delivered to domestic customers or to the Port of Brisbane for export.
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Rail

Queensland is the only state in Australia where some producers have the option of transporting live cattle by road or rail. There has, however, been a significant decline in the number of cattle transported by rail in recent years. In 2008, Strategic design & Development (Sd+D) estimated the share of beef cattle transport by rail in Queensland to be around 5 per cent when measured in net tonne kilometres (140 million NTKs were by rail compared with 2.5 billion NTKs by road) (Sd+D 2008). NTKs take into account live weight and distance travelled. This estimate assumes that 400 rail services transported 350,000 cattle (175,000 tonnes live weight) an average distance of 800 kilometres.

The decline in rail transport is the result of a combination of rail deregulation, competition for rail services from the mining sector, competition from road transport and the deterioration in the condition of rail infrastructure. The main factor appears to be the commercial incentives associated with deregulation of the rail system, which has influenced investment and access to the rail network. Aurizon (a publicly listed company formerly owned by the Queensland Government) operates Queensland’s above-rail freight infrastructure (rolling stock) as well as some below-rail infrastructure (rail lines mainly servicing mines). Queensland Rail, a statutory authority, operates Queensland’s passenger trains and the rail network outside central Queensland.

The Sd+D study identified competition from road transport as a major contributor to the decline in rail’s share of cattle transport, ‘with low cubic utilisation rates for cattle on trains relative to technologies used by road transport that offset the distance and scale benefits of rail’ (Sd+D 2008). Road transport prices effectively cap the prices that rail operators can charge, with producers choosing the most cost-effective option.

In the absence of an explicit subsidy, deregulation has constrained the extent to which rail prices could be subsidised. In 2009, the Minister for Transport in Queensland stated that the Queensland Government was providing a $25 million a year implicit subsidy to the beef industry via the loss incurred by providing cattle rail services (Nolan 2009). Sd+D also identified the inflexibility of rail services, and the rail network more generally, as disadvantaging rail relative to road.

The high demand for rail services by the resources sector has also influenced rail’s share of cattle transport. According to Sd+D, the higher mass utilisation rates for bulk commodities such as coal are more lucrative for the rail operator than cattle (Sd+D 2008). A similar view was expressed by the Queensland Transport and Logistics Council (Q TLC) in a submission to the Queensland Parliament’s inquiry into rail freight use by the agriculture and livestock industries. Q TLC stated that livestock and other agricultural commodities are facing strong competition for access to common rail infrastructure from high-value commodities such as coal and minerals (Q TLC 2014).

In 2010 the Queensland Government introduced an explicit subsidy for cattle rail services. The Livestock Transport Services Contract (LTSC) is a contract between Aurizon, JBS Australia, Teys Australia and the Queensland Government for the provision of 325 cattle train services across six routes each year. These services operate from regional hubs in north-west, central west and south-west Queensland. They terminate at Brisbane (230 services) and Rockhampton (95 services) and operate during the dry season between February and November. The Queensland Government pays Aurizon (which owns the narrow-gauge locomotives and cattle train rolling stock) a fee that covers part of the cost of operating these services.
In 2013 the LTSC was worth $28 million (Queensland Transport, Housing and Local Government Committee 2014), with 230 rail services transporting nearly 220 000 head of cattle. This equates to a subsidy of $128 a head. No cattle were transported on the south-west line (Quilpie to Brisbane) in 2013 (Table 3). JBS Australia and Teys Australia are the only processors using the cattle train service, with JBS Australia’s Dinmore plant accounting for around 70 per cent of beef cattle moved by rail.

Table 3 Livestock Transport Services Contract—available services and usage

<table>
<thead>
<tr>
<th>Line</th>
<th>From</th>
<th>To</th>
<th>Livestock season</th>
<th>Contract services</th>
<th>2013 usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>Cloncurry</td>
<td>Brisbane</td>
<td>Mar to Nov</td>
<td>57</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Julia Creek</td>
<td>Rockhampton</td>
<td>Mar to Nov</td>
<td>57</td>
<td>54</td>
</tr>
<tr>
<td>Central</td>
<td>Winton</td>
<td>Brisbane</td>
<td>Mar to Nov</td>
<td>69</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Rockhampton</td>
<td>Winton</td>
<td>Mar to Nov</td>
<td>38</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Winton</td>
<td>Rockhampton</td>
<td>Feb to Nov</td>
<td>77</td>
<td>67</td>
</tr>
<tr>
<td>South-west</td>
<td>Quilpie</td>
<td>Brisbane</td>
<td>Mar to Nov</td>
<td>27</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>Feb to Nov</td>
<td>325</td>
<td>230</td>
</tr>
</tbody>
</table>

Source: A Spoto (Queensland Government Department of Transport and Main Roads) 2014, pers. comm., 27 June.

Despite the introduction of the LTSC, the number of cattle transported by rail has continued to decline, from 360 000 head in 2008 to 220 000 in 2013 (AgForce 2014). In its submission to the Queensland Parliament, QTLC stated that coal and minerals represent high-value opportunities to rail operators because of their high-volume and long-term take-or-pay contracts (QTLC 2014). It also noted that the LTSC is due to expire on 31 December 2015, and stated that if it is not renewed, or is substantially reduced, the rail operator may choose to focus on the coal market, leaving the rail sector without an above-rail operator to move livestock and other agricultural commodities (QTLC 2014).

Rail is also an option for transporting processed beef to port in some instances. For example, processed beef is transported from abattoirs in Townsville to the Port of Brisbane by rail. Rail can also be used to transport processed beef from processing plants at Dinmore and Beenleigh. However, this involves transferring beef by road to an intermodal facility at Acacia Ridge, where it is loaded onto a train for transport to the Port of Brisbane. There is also significant competition for access to rail lines from passenger services and the resources sector. As a result, most processed beef is transported to port by road.

Roads

According to Sd+D (2008), more than 10 million head of cattle are moved in Queensland in a typical year. This is 38 per cent of all cattle movements in Australia. When measured in NTKs, Queensland accounts for 55 per cent (2.5 billion) of beef cattle movements in Australia, indicating that cattle in Queensland are transported longer distances than cattle in most other states. About 40 per cent of cattle movements are between farms, while around 33 per cent are from farms, feedlots or saleyards to abattoirs (Table 4). Cattle movements to ports represent a relatively small proportion of total movements.

The main constraints in the road transport sector in Queensland relate to condition, access and congestion.
Australia’s beef supply chains: infrastructure issues and implications

Table 4 Beef cattle transported between farms, feedlots, saleyards, abattoirs and ports in Queensland

<table>
<thead>
<tr>
<th></th>
<th>Head Thousand</th>
<th>Net tonne kilometres Million</th>
<th>%</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-farm</td>
<td>3 895</td>
<td>974</td>
<td>37.9</td>
<td>39.2</td>
</tr>
<tr>
<td>Farm to feedlot</td>
<td>648</td>
<td>227</td>
<td>6.3</td>
<td>9.1</td>
</tr>
<tr>
<td>Farm or feedlot to saleyard</td>
<td>1 900</td>
<td>380</td>
<td>18.5</td>
<td>15.3</td>
</tr>
<tr>
<td>Farm or feedlot to abattoir</td>
<td>1 850</td>
<td>278</td>
<td>18.0</td>
<td>11.2</td>
</tr>
<tr>
<td>Saleyard to farm or feedlot</td>
<td>400</td>
<td>80</td>
<td>3.9</td>
<td>3.2</td>
</tr>
<tr>
<td>Saleyard to abattoir</td>
<td>1 500</td>
<td>525</td>
<td>14.6</td>
<td>21.1</td>
</tr>
<tr>
<td>All to port</td>
<td>80</td>
<td>24</td>
<td>0.8</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10 273</strong></td>
<td><strong>2 487</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Average weight of 500 kilograms a head. Source: Sd+D 2008

Condition

There are around 33 500 kilometres of state-controlled roads in Queensland, including national roads, and 147 000 kilometres of local roads. In 2010, Engineers Australia released an ‘infrastructure report card’ for Queensland that included an assessment of road infrastructure. It found that despite significant investment in Queensland road infrastructure, the overall quality of the road network had deteriorated because the increase in traffic volumes exceeded infrastructure improvements, and because of underinvestment in maintenance and renewals (Engineers Australia 2010b). In particular, the regional road network had deteriorated significantly, leading to an increasing backlog of roadwork. All road types (national, state and local) were rated lower than in 2004.

Funding the local road network is a significant problem in Queensland. Many beef farms are located in remote areas where few people live. This has implications for council rates, which can be an important source of revenue for road maintenance. In 2009–10, around 40 per cent of capital expenditure by local governments in Queensland was on roads (QDIP 2010). The road funding pressures facing these local councils is likely to increase with any expansion in beef production.

Access

Map 11 identifies where access restrictions apply to heavy vehicles using the Queensland road network. The restrictions tend to become more prohibitive when moving towards the coast and south-eastern Queensland, where most of the saleyards, feedlots and abattoirs are located.

Given these restrictions, a producer located in far western Queensland arranging transport for cattle to an abattoir near Brisbane has the option of transporting them the entire distance using a B-double, or using a higher productivity vehicle option that involves splitting loads at certain points along the road network. This load-splitting could involve breaking down a Type 2 road train to a Type 1 road train, and a Type 1 road train to a B-double (see Table B1 in Appendix B for the specifications of Type 1 and 2 road trains in Queensland. A B-double is equivalent to 1.5 trailers (QDTMR 2013)).

Sd+D (2008) provides a number of examples of how road access restrictions can increase transport costs in Queensland. One example involves transporting cattle for slaughter to an abattoir near Townsville. Type 2 road trains are not permitted to access the abattoir, so loads have to be broken down to Type 1 road trains at either Charters Towers, 120 kilometres west of Townsville, or Woodstock, around 10 kilometres west of Townsville (Sd+D 2008).
Transport costs vary depending on a number of factors, including the type of vehicle used and distance travelled. CSIRO has developed a matrix of road costs that shows per head-kilometre costs decline the longer the distance travelled and the larger the vehicle used (Figure 23) (Higgins 2013). This cost matrix shows that cost savings from using higher productivity vehicles can be significant. For example, a cattle producer transporting 120 cattle 1 000 kilometres could reduce transport costs by 27 per cent by using a Type 2 road train rather than two B-doubles. This assumes 3 trailers, 6 decks and 20 cattle per deck for a Type 2 road train and 1.5 trailers, 3 decks and 20 cattle per deck for a B-double. On this basis it would cost $4 700 to transport 120 cattle 1 000 kilometres using a B-double compared with $3 430 using a Type 2 road train.

Other benefits from the use of higher productivity vehicles include increased safety and productivity, as well as fuel and environmental savings (Hassall 2014).

However, the trade-off associated with using these vehicles is additional damage to roads and bridges. While the cost savings estimate in this example ignores these additional costs, it shows that the gross benefits from allowing higher productivity vehicles increased access to the road network could be significant, and that additional research identifying the costs associated with increased access may be warranted.
It is worth noting that roads that are limited to B-doubles tend to be located in heavily populated areas near the coast. It is likely that concerns about road safety and urban amenity will limit the extent to which authorities are prepared to extend access to these roads to higher productivity vehicles such as Type 1 road trains. However, population density tends to decline rapidly when moving inland, and much of the road network limited to Type 1 road trains is located in lightly populated areas. This suggests that there may be more opportunity to increase productivity in road transport by extending access to Type 2 road trains on roads currently limited to Type 1 road trains than by extending access to Type 1 road trains on roads limited to B-doubles.

Figure 23 Road transport costs per head-kilometre by vehicle class and distance travelled each day

![Graph](image)

Note: Assumes 20 head per deck.
Source: Higgins 2013

**Congestion**

In 2012–13, 651 100 tonnes of beef were exported through the Port of Brisbane, which is around 20 kilometres east of the Brisbane CBD. The Port of Brisbane is Queensland’s largest multi-cargo port and Australia’s third largest container port. There is an extensive road network leading to the port, while rail freight is supported by the Brisbane Multimodal Terminal. In 2012, 95 per cent of container movements to and from the Port of Brisbane were by road, while 5 per cent were by rail, which is low compared with other container ports in Australia (Victoria University 2013; PBPL 2013). Around three-quarters of containers exported through the Port of Brisbane originate from Brisbane and adjacent regions, principally Ipswich, the Gold Coast, Morton Bay and Logan–Beaudesert (Victoria University 2013). The main arterial roads used to access the port are the Gateway, Logan and Ipswich motorways. Two of the largest beef processing facilities in Queensland are located in Ipswich (JBS Australia’s Dinmore plant) and Logan (Teys Australia’s Beenleigh plant).

A report prepared for the Port of Brisbane Pty Ltd and QTLC indicates that the road network connecting the Port of Brisbane to importer and exporter locations is ‘approaching high levels of congestion’ (Victoria University 2013). It also contains forecasts suggesting that container movements could increase to 2.3 times current levels by 2040, while non-containerised import–export trade could increase by 85 per cent. The report concludes that the main impediments in the Port of Brisbane’s logistics chains are:
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- road congestion and infrastructure conditions on sections of the Brisbane regional road network, which increase travel times and operating costs
- the poor condition of some rail infrastructure and lack of connectivity, which restrict rail access to the port
- regulations for heavy vehicle operations on some regional routes, which results in some commodities attracting high port access costs.

According to the Port of Brisbane Land Use Plan 2013, the rail freight line to the port shares the same corridor as a number of Brisbane’s metropolitan passenger services, and the potential to maintain and/or grow rail freight using this line is constrained by the increasing frequency of passenger rail services. It also states that in the absence of improvements to the existing line and/or the development of a new line, trade through the Port of Brisbane will become increasingly constrained, because the long-term potential to accommodate additional trade on the road network is limited. One factor identified in the plan as having the potential to influence the demand for rail services to the port is a user-pays road freight charging system (PBPL 2013).

One component of a user-pays pricing system could be a charge for congestion. The introduction of a fee to reflect road congestion has the potential to spread the demand for access to the road network leading to the port more evenly throughout the day. It would also help to ensure that higher value activities receive access to the road network during peak periods, and would send a price signal that could result in an increase in the use of rail to transport containers to port, and in an increase in the use of intermodal terminals.

However, the efficiency gains from introducing a congestion fee could be limited in the current operating environment given the mismatch in operating hours between stevedores, transport yards and importers and exporters that causes significant numbers of containers to be moved during normal business hours on weekdays (Victoria University 2013).

**Ports**

In 2013 HPA commenced stevedoring operations at the Port of Brisbane. The HPA terminal has been commissioned in stages, and its second berth is now operating. When fully operational the HPA facility is expected to add 25 per cent to container handling capacity at the Port of Brisbane (ACCC 2013).
6  Beef supply chain and supporting infrastructure in New South Wales

After Queensland, New South Wales is the second largest beef producing state in Australia. It is also Australia’s second largest beef exporting state by value and third largest by volume. In contrast to northern Australia, the New South Wales beef industry is much more focused on the domestic market. Its production is also less geographically dispersed, and many producers are engaged in a wider range of farming activities.

In 2013–14, New South Wales turned off 2.1 million head of cattle for slaughter from a herd of 5.3 million, producing 541,000 tonnes of beef and veal (Figure 24). Fifty-seven per cent of this meat was exported. The revenue earned from the turn-off of these cattle was equivalent to 13.4 per cent of New South Wales’ total gross value of agricultural production.

Figure 24 New South Wales beef and veal production and exports, 2004–05 to 2013–14

Note: Carcass weight equivalent.
Sources: ABS 2015c, d

As in Queensland, New South Wales cattle production activities include breeding, fattening and finishing on grass or grain. Live cattle exports are minimal.

Supply chain

Map 12 and Figure 25 show the density and distribution of the New South Wales beef cattle herd based on 2010–11 agricultural census data. Most of the herd is located in the north and west of New South Wales. The New England – North West region is by far the most significant, carrying around 30 per cent of the herd, although the Far West – Orana and Central West regions also carry significant numbers of cattle. Important regions in southern New South Wales include the Riverina, Capital and Murray, which account for around a quarter of the herd.
The range of beef-producing activities undertaken in New South Wales is influenced by its climate, which is milder than in Queensland and not subject to the seasonality associated with the northern monsoon. There are four distinct rainfall zones in New South Wales: the wet summer, dry winter zone in the north (similar to southern Queensland); the uniform rainfall zone in the centre; the wet winter, dry summer zone in the south; and the arid zone in the west. The state’s milder climate and tick-free status allow producers to focus on British and European breeds, or cross-breeds, to produce high-quality eating beef. The climate also provides producers in the more fertile areas with the option of planting improved pastures and fodder crops.

While grass-fed beef still dominates in New South Wales, there has been a noticeable increase in the importance of the feedlot sector—feedlots accounted for 33 per cent of turn-off in New South Wales in 2013–14. A significant proportion of cattle in the ‘specialised breeding’ and ‘breeding and growing’ production sectors in all beef-producing regions in New South Wales are...
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destined for feedlots, with the ‘breeding and finishing’ of cattle on pasture occurring mainly on
better quality and/or higher rainfall country. The growth in the feedlot sector has provided an
important alternative for some growers who used to breed and finish cattle on grass, but were
located in areas where rainfall was less reliable (AusVet 2006).

The feedlot sector in New South Wales is more dispersed than in Queensland (Sd+D 2008). This
is likely to be because the grain belt in Queensland is largely confined to southern Queensland,
while the grain belt in New South Wales extends from the Queensland border to Victoria. Most
feedlots in New South Wales are located in or near the grain belt, and close to the major beef
cattle–producing areas (see Map 5).

The majority of beef processing facilities in New South Wales are located on the eastern side of
the grain belt or near the coast, close to domestic populations and export infrastructure (see
Map 7). The bulk of this processing capacity is located in the north, close to the highly productive
New England region, with road access to Brisbane and the major New South Wales population
centres via the New England Highway and the Pacific Highway. The largest beef abattoir in the
state is owned by the Northern Co-operative Meat Company and is located in Casino (Figure 26).
This abattoir has the capacity to process 520 000 head of cattle a year. The main beef abattoir in
southern New South Wales is the Teys Australia plant located in Wagga Wagga, which has a
capacity of more than 300 000 head of cattle a year. The importance of the domestic market
tends to support more small-scale domestic processing facilities in New South Wales compared
with Queensland, which is highly export-oriented (Sd+D 2008).

While New South Wales exports beef from Port Botany, a significant volume is exported via
ports in Brisbane and Melbourne.

Figure 26 Capacity of major beef abattoirs in New South Wales (head a day)

<table>
<thead>
<tr>
<th>Location</th>
<th>Capacity (head a day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Co-operative, Casino</td>
<td>2080</td>
</tr>
<tr>
<td>Bindaree Beef, Inverell</td>
<td>1300</td>
</tr>
<tr>
<td>JBS Australia, Scone</td>
<td>600</td>
</tr>
<tr>
<td>JBS Australia, Yanco</td>
<td>632</td>
</tr>
<tr>
<td>NH Foods Australia, Wingham</td>
<td>700</td>
</tr>
<tr>
<td>Teys Australia, Wagga Wagga</td>
<td>1248</td>
</tr>
<tr>
<td>Teys Australia, Tamworth</td>
<td>800</td>
</tr>
</tbody>
</table>

Note: Some values are derived from annual totals and an assumption of 250 working days a year.
Sources: JBS Australia 2014; MLA 2008; NH Foods Australia 2015; Teys Australia 2011

According to Sd+D (2008), the New South Wales beef supply chain is more complex than in
Queensland, where the general progression of cattle is from farms to feedlots or abattoirs in the
east and south-east and almost all processed beef is exported via the Port of Brisbane.

The New South Wales system comprises a local supply base for ‘demand centres’ such as
processing facilities, feedlots and saleyards, as well as an external supply base drawn from
across the state and interstate (mainly Queensland and Victoria) depending on markets and
seasons. For example, poor seasonal conditions in Victoria relative to New South Wales and
Queensland are likely to be reflected in Victorian producers sending stock to saleyards in Dubbo
in search of higher prices, while New South Wales and Queensland producers are likely to
purchase additional cattle, leading to the relocation of cattle to the north (Sd+D 2008).
Infrastructure

As in Queensland, the main infrastructure constraints in the New South Wales supply chain relate to transport, particularly with respect to condition, access and congestion. There are also constraints in telecommunications, including mobile phone coverage and internet access in rural areas, and ACCC monitoring of stevedores suggests that there may be a constraint at Port Botany.

Roads

The New South Wales beef supply chain uses road exclusively for transporting live cattle to and from farms, saleyards and feedlots, as well as to processors. Roads are also used to transport the majority of processed beef from abattoirs to domestic markets and ports.

The use of the road network by the New South Wales beef industry and the constraints on road use are broadly similar to those in southern Queensland, particularly in relation to the movement of live cattle. However, there are some differences in state regulations, and the greater variability in the New South Wales supply chain can complicate interstate movements and long-term planning for transport infrastructure.

According to Sd+D (2008), nearly eight million head of cattle are transported by road in New South Wales in a typical year. This is equivalent to 29 per cent of total cattle movements in Australia. It is also equivalent to around 130 000 B-double movements. When measured in NTKs, these cattle are transported 937 million NTKs, or 21 per cent of all such movements in Australia, indicating that cattle in New South Wales are transported shorter distances, on average, than in some other states, including Queensland.

Measured in NTKs, inter-farm movements account for around a third of all movements, while the transport of cattle to saleyards from farms and feedlots and from saleyards to farms and feedlots accounts for 37 per cent of total beef movements in New South Wales. This reflects the importance of saleyard auctions as a sales method in New South Wales. Around a quarter of all beef NTKs in New South Wales are from saleyards, farms or feedlots to abattoirs (Sd+D 2008).

Condition

There are around 4 300 kilometres of national roads, 13 500 kilometres of state roads and 163 000 kilometres of local roads in New South Wales. The local road network in turn consists of around 18 500 kilometres of regional roads and 144 800 kilometres of local access roads.

While Engineers Australia upgraded its rating for the national road network in New South Wales from C+ in 2003 to B- in 2010 because of improvements associated with significant investment in the network, it downgraded its ratings for the state and local road networks (Engineers Australia 2010c). The downgrading of state roads, however, was because of an increase in congestion rather than a deterioration in condition. Engineers Australia found that the physical condition of the state road network had actually improved between 2003 and 2010. In contrast, the downgrading of the local road network from C- to D+ was the result of a deterioration in physical condition because of an increase in demand and a rising backlog of maintenance.

As is the case in Queensland, this is likely to be significant for the transport of live cattle. Many local roads are located in rural areas, are likely to be unsealed and are poorly maintained. During consultations, stakeholders identified the condition of local roads as a significant issue.
Access

As in Queensland, there are a number of restrictions on heavy vehicle road use in New South Wales. Map 13 shows where different heavy vehicle combinations can be used. Much of the road network is restricted to B-doubles. There are very few roads where Type 2 road trains can be used, and Type 1 road trains are generally restricted to west of the Newell Highway. The bulk of the state’s saleyards, feedlots and processing facilities are located on the eastern side of this highway.

While these restrictions may be imposed because of inadequate road and bridge infrastructure and to protect amenity for other road users and local residents, they can increase costs.

There has been recent improvement in road access arrangements for the transport of live cattle. Until recently, New South Wales did not operate volumetric loading schemes for livestock such as those adopted in Victoria and Queensland. These schemes allow vehicles carrying livestock to carry greater masses, effectively allowing more animals to be transported in one movement. The lack of such a scheme in New South Wales limited the efficiency of vehicle movements and complicated interstate movements. It is estimated to have added $8 to the cost of transporting each animal compared with Queensland (Transport for NSW 2013).

A new livestock loading scheme commenced on all approved higher mass limit roads in New South Wales in late 2012, and was extended to state roads in early 2013. It has also been extended to local roads subject to council approval. The new scheme allows the transportation of higher masses on vehicles that have approved suspension and are driven by appropriately trained drivers (RMS 2013). The relaxation of mass limits, however, is limited by bridges that cannot carry the higher masses (RMS 2013).

Mass limit restrictions can also affect the movement of processed beef from abattoirs to domestic customers or ports. These restrictions can lead to beef being transported in smaller
containers, or in containers that are only partially filled, which increases the number of road movements required to transport a given volume of beef. The potential effect of these restrictions could be greater in the New South Wales export supply chain than in Queensland because New South Wales exports a higher proportion of frozen beef. Frozen beef can be packed more tightly into a container than chilled beef, which requires more space for air to circulate. An efficiently packed container of frozen beef is therefore heavier than a container of chilled meat.

**Congestion**

Most beef exported through New South Wales is exported through Port Botany, although Port Kembla can also handle containers. Port Botany is the second largest container port in Australia after the Port of Melbourne. Eighty-six per cent of container movements to and from Port Botany are by road (95 per cent for meat container movements) (Transport for NSW 2013). In 2007 the Bureau of Infrastructure, Transport and Regional Economics released a report that projected an increase in the cost of congestion in Sydney from around $3.5 billion in 2005 to nearly $8 billion in 2020 (BITRE 2007). Moreover, Engineers Australia downgraded the state road network in 2010 because of an increase in congestion over the review period. Given Port Botany’s location and the increasing population around it, congestion is likely to be a significant problem for importing and exporting containerised products to and from the port.

In the absence of additional investment in road infrastructure to help relieve congestion, one option could be to introduce a congestion fee to spread the demand for road access. This could create an incentive to use rail to transport containers to ports.

**Rail and intermodal facilities**

Only around 15 per cent of containers are transported to and from Port Botany by rail. This suggests that there is potential to increase the use of rail to relieve some of the stress on the roads leading to the port. Because most container movements to and from Port Botany originate in and are destined for locations within Sydney, the increased use of rail would be likely to require investment in intermodal facilities in Sydney to facilitate the transfer of containers from trucks to rail for transport to Port Botany and from rail to trucks for distribution within Sydney. A new intermodal facility is expected to begin operating at Enfield, 18 kilometres west of Port Botany, in 2015, and a major facility is planned for Moorebank in south-western Sydney. The Enfield facility will have an annual port–rail capacity of 300 000 twenty-foot equivalent unit (TEU) containers (HPA 2014), while the import–export terminal at Moorebank is ultimately expected to handle 1.2 million TEU shipping containers moving between Port Botany and western and south-western Sydney each year (Moorebank Intermodal Company 2014).

There are a number of factors that could influence the use of rail for transporting containers and the use of intermodal facilities. One factor is that stevedores charge a higher fee to load and unload containers from trains (Transport for NSW 2013). Other factors include the priority given to passenger rail services where freight and passenger services share the same rail line (Transport for NSW 2013).

While investment in intermodal facilities in cities such as Sydney may help relieve congestion on city roads, investment in regional intermodal facilities may reduce the cost of transporting beef from regional abattoirs to cities and ports. In Queensland a significant proportion of beef is processed in or near Brisbane, and is transported from the abattoirs to the Port of Brisbane on arterial roads that allow the use of high-productivity vehicles. For example, beef processed at the JBS Australia facility at Dinmore can be transported to the Port of Brisbane in 40-foot containers on trucks 30 metres long (40-foot containers are preferred by shipping companies). The geographically dispersed nature of New South Wales abattoirs means that the cost of upgrading...
road networks to allow high-productivity vehicles to transport beef to port is likely to be prohibitive in many cases. Under these circumstances, regional intermodal facilities may be a more cost-effective option if they facilitate the transportation of 40-foot containers to port using the rail network.

The NSW Freight and Ports Strategy aims to support intermodal terminals in regional New South Wales (Transport for NSW 2013).

In 2009 an intermodal facility was built at Dubbo by Fletcher International Exports, a meat processing company specialising in the supply of sheep meat, skins and associated products to international markets. Because Fletcher built the facility close to its processing plant, and constructed a road capable of taking quad axle trailers from the plant to the terminal, the terminal is able to receive fully loaded 40-foot containers that are then transferred to rail for transport to Port Botany (see Box 3).

The potential for intermodal facilities in other regional centres to help relieve some of the constraints in transporting processed beef to ports will depend on the location of processing facilities and rail lines, and on other industries using the facility. The commercial viability of these facilities will require significant and consistent utilisation. This suggests that other industries will have to use these facilities if they are to be viable. The Fletcher facility extends its services to other regional exporters wishing to export their products through Port Botany. The proposed inland rail network between Melbourne and Brisbane may be an important option for transporting processed beef from abattoirs located close to the rail line to ports in Brisbane and Melbourne at some point in the future.

Box 3 Fletcher International Exports intermodal terminal

The NSW Freight and Ports Strategy uses Fletcher International Exports (a firm exporting sheep meat, among other commodities) and its terminal at Dubbo as an example of the value of intermodal terminals in regional New South Wales.

The terminal is situated in Dubbo’s industrial precinct close to Fletcher’s plant, and is serviced by a high-grade road that allows quad axle semitrailer movements. The road allows the terminal to receive fully loaded containers. Previously, road weight restrictions had meant that containers leaving Dubbo were frequently underloaded.

According to Transport for NSW (2013), the terminal has ‘enhanced freight performance’ and ‘provided a viable train option for other regional exporters to move their freight to Botany’. The Australian Meat Industry Council also cited the terminal as an example of a successful intermodal facility in consultations.

Stakeholders noted, however, that the freight from Fletcher’s plant alone was not sufficient to make the terminal a viable investment, and that by serving other regional industries it had achieved enough volume to make it a commercial success.

Ports

There are only two ports in New South Wales that can export containerised beef, Port Botany in Sydney and Port Kembla in Wollongong. Port Botany handles almost all meat exported through New South Wales ports. Overall, meat exports represent only 3 to 4 per cent of exports from New South Wales ports (NSW Ports 2013).

An important aspect of the New South Wales supply chain is that some beef produced in New South Wales is exported though ports in Brisbane and Melbourne. In 2012–13 New South Wales exported 170 000 tonnes of beef (shipped weight), while New South Wales ports shipped only 84 800 tonnes of beef (Figure 27). More than 99 per cent of that beef was exported through Port Botany. Queensland and Victoria, in turn, exported 597 000 and 154 000 tonnes of beef, with
ports in Brisbane and Melbourne shipping 651,100 and 241,700 tonnes of beef. These figures suggest that a significant volume of beef produced in New South Wales is exported via interstate ports. This is likely to be partly the result of the proximity of the Port of Brisbane to the major beef-producing areas in northern New South Wales, but may also reflect some of the difficulties in accessing Port Botany.

Figure 27 Beef and veal exports by port, 2003 to 2013

Source: MLA unpublished data

There may also be a constraint on port loading capacity at Port Botany, with ACCC monitoring of stevedoring activities indicating that hourly container movements have historically been below the five-port average (includes ports at Brisbane, Sydney, Melbourne, Adelaide and Fremantle) since 2000–01 (ACCC 2014). The ACCC did note, however, that there had been recent improvements in hourly container movements at Port Botany, which are now similar to the five-port average.

According to the ACCC, the recent entry of HPA into the east coast port container market should help relieve constraints in port loading capacity at Port Botany. In late 2013, HPA opened a new terminal at Port Botany. This terminal has four shipping berths and is expected to handle more than one million TEUs when fully operational (ACCC 2013). Increased competition associated with the entry of HPA into the east coast market has also stimulated investment in additional capacity and productivity-enhancing technologies by existing stevedoring firms. An announcement by Patricks that it planned to redevelop its Port Botany terminal (including installing automated straddles and new cranes and extending the yard area) coincided with the impending entry of HPA at Port Botany (ACCC 2013).
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7 Impediments to efficient transport infrastructure

The preceding analysis shows that transport infrastructure may be a significant constraint in Australia’s beef supply chains. Much of the local road network is in poor condition, and congestion on roads leading to ports in or near major cities is a growing problem. There is also some evidence that road access for high-productivity vehicles is a significant issue, with restrictions increasing transport costs for live cattle and processed beef. The decline in the use of rail to transport live cattle to abattoirs in Queensland is also putting additional stress on the road network, while rail’s relatively small share of container transport to ports suggests that increased use of rail could help reduce congestion on roads leading to ports.

The objective of this chapter is to identify the main impediments to efficiency in the transport sector, identify potential solutions, and examine how use of existing data can inform policy decisions on road infrastructure, particularly in regional Australia, and how access to additional data could significantly enhance the quality of those decisions.

Pricing, funding and investment

The main impediment to efficient provision of transport infrastructure in Australia is that the prices charged for the use of transport infrastructure often do not reflect the cost of providing that infrastructure (CRRP 2011). This inevitably leads to the inefficient use of infrastructure and distorts investments within and across modes of transport. These inefficiencies and distortions are likely to have been exacerbated by the lack of coordination of reforms within the transport sector. While deregulating the rail sector has increased cost recovery for rail services, significant distortions remain in the road sector, with prices charged for road use not reflecting the cost of damage caused to specific roads or congestion imposed on other road users.

Currently, heavy vehicles are subject to the ‘pay as you go’ (PAYGO) pricing model. This pricing model is designed to recover the marginal costs of road wear and tear from heavy vehicle activity and to contribute to the common road costs benefiting all road users (NTC 2014). The charges for heavy vehicle road use include fixed annual registration charges and fuel-based road user charges (HVCI 2014). The National Transport Commission (formerly the National Road Transport Commission) determines levels of registration fees for major vehicle classes, including trucks. This revenue is added to the revenue from state-based driver registration fees and a proportion of Commonwealth-levied fuel taxes to closely match road system costs attributed to each vehicle class (GIAC 2004).

Funding for each class of road is independent of the revenue generated by fuel taxes and registration fees for the use of specific roads (GIAC 2004). According to the Productivity Commission (2006), the averaging of costs and charges under PAYGO and the allocation of funding in a way that is not directly related to road use do not support the efficient use and provision of the road network.

The National Transport Commission (2009) has also highlighted the importance of accurate pricing within and across transport modes, recommending the introduction of incremental pricing and mass–distance–location pricing for roads. An incremental pricing scheme would charge vehicles road use prices based on the weight of the vehicle and the road in question, rather than using blanket regulations to permit or prohibit certain classes in different areas. Incremental pricing would be an important first step towards the potential development of a comprehensive mass–distance–location charging model (NTC 2009). Mass–distance–location
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pricing involves a charge for road use based on the mass of the truck as it travels, the distance travelled and the location of road use (NTC 2009).

There has been some impetus to improve the efficiency of the road charging and funding system in Australia in recent years. For example, following recommendations contained in the Productivity Commission report, COAG established the Heavy Vehicle Charging and Investment Reform project to design a more efficient approach to charging and road provision for heavy vehicles (see Box 4). While the project concluded in June 2014, it considered various pricing options, including a national fuel-based price, a kilometre-based distance price, a distance–location-based price, a mass–distance-based price and a mass–distance–location-based price (see Box 5).

**Box 4 COAG Road Reform Plan and Heavy Vehicle Charging and Investment Reform**

In April 2007, COAG set up the COAG Road Reform Plan (CRRP) to conduct a review of current heavy vehicle user charges and to investigate the viability of alternative charging models for heavy vehicles.

A feasibility study into alternative charging and funding arrangements for heavy vehicles was conducted by CRRP in 2011. The main finding of the study was that reform would be feasible if charges were directly linked to road funding and investment charges (CRRP 2011). New direct charging arrangements were recommended to be developed for COAG consideration by December 2012.

In July 2012, COAG noted the recommendations of the feasibility study and approved the implementation of the reform project. The CRRP was then renamed the Heavy Vehicle Charging and Investment Reform (HVCI) project with broader scope.

The HVCI project proposed an integrated charging, funding and investment framework and identified the processes needed to implement the reforms. For more information, see HVCI (2014).

Setting road user prices to more accurately reflect the location of use, and ideally the timing of use, would also provide more appropriate price signals for use of and investment in alternative modes of transport, such as rail and coastal shipping. This is likely to be particularly important for the transport of processed beef. For example, applying a congestion fee for road use during peak periods should not only spread the demand for access to roads leading to ports more evenly throughout the day, but also increase the incentive to use alternative forms of transport, such as rail and coastal shipping. This would provide more appropriate incentives to invest in different types of transport infrastructure, as well as support infrastructure such as intermodal terminals. Currently rail accounts for only a small proportion of container movements to ports in Australia.

While a user-pays system that appropriately charges for the use of road infrastructure and allocates funding to where use and damage occur is theoretically the most efficient road pricing system, there needs to be more research into the practical implications of introducing such a system. For example, there will be distributional effects (winners and losers) in moving from the current road charging and funding allocation model. Additional research is needed to identify the extent of any gains and losses for different users, because this will influence the acceptability of the scheme to industry and the wider community. There are likely to be many local roads in rural Australia dedicated mainly to servicing the beef cattle industry that farmers cannot afford to maintain, let alone upgrade. Many of these roads are unsealed, remote and expensive to maintain. The extent to which the provision of these roads represents a community service obligation needs to be considered.

It would also be useful to demonstrate the benefits of a user-pays system. For example, a user-pays system would be expected to increase productivity by directing investment to where damage occurs and to relieve constraints on roads that currently restrict access by high-productivity vehicles. While some users would pay more under a user-pays system, they could also receive significant benefits, including better quality roads that reduce travel times and
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cause less damage to trucks, as well as increased access to the road network for high-productivity vehicles. Increased access could stimulate investment in high-productivity vehicles, which could reduce the unit costs of road freight over the long term.

Box 5 Options considered by the COAG Road Reform Plan feasibility study

The COAG Road Reform Plan feasibility study considered several pricing model options.

**Status quo**: The current road charging system. A fixed registration charge levied by the states and territories and a variable charge from a part of the diesel fuel excise.

**Fuel-based distance price**: Fuel excise taxes. These act as a proxy for pricing for distance and mass.

**Kilometre-based distance price**: Charges based on a system that measures the actual distance travelled.

**Distance–location-based price**: Charges based on a system that measures distance travelled and the type and location of the roads used.

**Mass–distance-based price**: Charges based on a system that measures distance travelled and the mass of the vehicle at the time of travel.

**Mass–distance–location-based price**: Charges based on a system that measures distance travelled, the mass of the vehicle at the time of travel and the type and location of the roads used.

Source: CRRP 2011 (Table 5.1)

Analysis of available data

The first step in addressing any inefficiency in the road charging and funding allocation system is to collect data on road use, road condition and the cost of maintaining or upgrading roads. There are currently significant gaps in the availability of these types of data. However, research prepared for the Australian Rural Roads Group suggests that many local governments already maintain records on condition, costs and long-run maintenance cycles for roads within their shires (Juturna Consulting 2011).

The Juturna study also demonstrates the potential to collect relevant data through a case study on four roads within the Gwydir Shire in northern New South Wales. The shire's main industry is agriculture, including dryland and irrigated cropping and livestock production (Juturna Consulting 2011). The roads selected were considered by local engineers to be ‘representative’ of the roads used in the shire's freight task. The data collected included data on road maintenance costs and road use. Estimates of vehicle movements were derived using mobile traffic count technology, which measures the axle groupings of each vehicle to determine vehicle type. All roads were B-double accessible.

While this research was limited to four roads, and the administration and compliance costs of collecting these data need to be considered, it does indicate that it is possible to collect data on road use, road condition and road maintenance costs from local councils. The Australian Rural Roads Group recommends that all local governments be required to provide regular condition and cost reports for their road networks (Juturna Consulting 2011). Even in the absence of road pricing reforms, these data could help increase efficiency by guiding road funding to better reflect road condition. It is also a necessary precondition for the introduction of a more efficient road pricing system.

In addition to collecting data, the study compared estimates of annual fuel excise fees generated by traffic movements along the four roads with annual maintenance budgets for the roads. When road user fees were compared with long-run annual maintenance costs, the analysis found that two of the four roads generated revenues that were higher than the maintenance costs. Understanding how the revenue collected from the use of specific roads relates to maintenance costs is important because it highlights the level of cross-subsidisation implicit in current arrangements and allows governments to make more informed decisions on the extent to which
they are prepared to subsidise particular roads as community service obligations. In assessing the potential impacts of moving to a user-pays system, it identifies which roads are likely to benefit from increased investment and which will require additional funding if their condition is to be maintained.

In this study, ABARES uses NLIS data on cattle movements within Australia for the period 2008 to 2012 to demonstrate how data can inform decision-making. The NLIS data include the timing, source and destination of live cattle movements, the approximate distance travelled and the average size of cattle consignments by region. They do not identify the actual route followed.

In the context of northern Australia, the data show that:

- a significant proportion of cattle movements originate from remote areas (Map 14)
- that many of these cattle travel long distances to abattoirs or feedlots located in the high rainfall zone near the coast or the sheep–wheat zone (Map 15 and Map 16)
- that many of these movements occur in consignments involving 100 head or more (significantly higher than in southern Australia) (Map 17)
- that a high proportion of movements occur during the dry season (Map 14).

Movements in the south are more evenly distributed throughout the year. The NLIS data reported in Maps 14, 15, 16 and 17 have been aggregated using ABARES Australian Agricultural and Grazing Industries Survey boundaries.

Map 14 Number of cattle transported by quarter and AAGIS subregion of origin, average between 2008 and 2012

AAGIS Australian Agricultural and Grazing Industries Survey subregions.
Source: National Livestock Identification System data
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Map 15 Intra-region and inter-region cattle movements, 2008 to 2012, annual average number of cattle

Map 16 Number of cattle transported by quarter and AAGIS subregion of destination, average between 2008 and 2012

k hd thousand head. AAGIS Australian Agricultural and Grazing Industries Survey subregions.
Source: National Livestock Identification System data
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Map 17 Number of cattle transported by consignment size and AAGIS subregion of origin, average between 2008 and 2012

The data also show that cattle tend to move from northern and western Queensland to the coast or south-eastern Queensland. The direction of movement is more variable in southern states, where cattle not only move towards the coast, but also to northern and southern destinations, including interstate destinations (Map 15). Around 15 per cent of cattle movements in New South Wales and Victoria are to interstate destinations, compared with only 5 per cent in Queensland. The data also identify the main interstate destinations for cattle, with the main interstate movements being from:

- New South Wales to Queensland and Victoria
- Queensland to New South Wales
- Victoria to New South Wales and South Australia
- South Australia to Victoria.

While there are some data on interstate movements from the Northern Territory and Western Australia, the exclusion from the NLIS of cattle movements from their property of birth to an abattoir or export in these regions up to the end of 2012 means that cattle movements are underrepresented in the NLIS data.

Several conclusions can be drawn from this simple analysis of the NLIS data. The seasonality of cattle movements in northern Australia suggests that road movements are affected by road closures during the northern monsoon, imposing costs on producers by requiring transport operators to take longer and more expensive routes, or by preventing movements altogether. Other factors also affect cattle movements during the wet season, such as the increased difficulty in mustering cattle on farms. The extent to which road connectivity is constraining cattle movements may be an area worthy of further investigation.
The long distances in transporting some cattle from farms in northern Australia to abattoirs, feedlots and ports also suggest that additional costs could be incurred if poorly maintained roads increase travel times to the point where the meat standards code is compromised, if animal welfare laws require stock to be watered or if occupational health and safety laws require drivers to take a rest break.

Furthermore, the high proportion of cattle transported in consignments of more than 100 head from remote areas towards the coast (Map 17) suggests that there may be significant opportunities to make use of high-productivity vehicles. However, when the NLIS data are combined with spatial data on road access regulations, it is obvious that many cattle are transported across boundaries that require transport operators to break down their loads into smaller units in order to comply with the regulations or to use smaller units for the entire journey. These restrictions have the potential to increase transport costs.

When the NLIS data are compared with data on population density (Map 18), it is obvious that many cattle are transported on roads in regions with low population density. This has implications for funding for local roads since some of this funding is dependent on rates collected by local councils.

**Modelling**

ABARES has constructed a cattle freight movement model that combines NLIS data on cattle movements with other data to quantify the use of road infrastructure by the cattle industry (see Appendix A for details on the methodology, assumptions, results and caveats). While NLIS data...
identify the origin and destination of each cattle consignment, the model estimates the route used to transport cattle by choosing the route that minimises transport costs. The model distinguishes between roads that are accessible to B-doubles (Performance-Based Standards (PBS) level 2), Type 1 road trains (PBS level 3) and Type 2 road trains (PBS level 4). Transport costs for each link in the road network are relative costs per kilometre that discriminate between different classes of road (dual carriageway, principal, secondary and minor roads) and surface types. PBS levels do not affect relative costs in the simulations undertaken in this study.

Map 19 illustrates road use by the cattle industry based on these cost-minimising assumptions. It also includes a cost penalty reflecting current regulations requiring cattle to be dipped, spelled and inspected before crossing from the tick-infested zone in northern Australia to the tick-free zone. CSIRO has estimated that dipping and inspecting costs around $6 a head, and cattle need to be rested for four days following dipping (Higgins 2013).

Map 19 Simulated network usage for 2012 (consignments with at least 20 animals)

The thickness of the lines in Map 19 represents the number of animals transported along each road segment, while the colour of the lines represents the maximum heavy vehicle configuration that can be used on these roads. The blue dots show the location and number of cattle that may be affected by a requirement to downsize a heavy vehicle to a smaller configuration (for example, from a Type 2 road train to a Type 1 road train). Map 19 shows that access to the road network for heavy vehicles generally becomes more restricted when transporting cattle towards the coast.

This approach is capable of estimating the impact of a number of factors likely to influence the movement of live cattle in Australia, including an increase in cattle production, changes in the regional pattern of production, technical innovation and the removal or imposition of a restriction on the spatial pattern of road use. The most relevant restrictions on the transport of live cattle include road access restrictions, such as regulations that limit access by high-
productivity vehicles or road closures due to flood events, as well as some biosecurity and animal welfare regulations.

To demonstrate how the cattle freight movement model can be used to identify potential changes in road use by the cattle industry, ABARES has simulated the impact of a hypothetical technical innovation that significantly reduces the cost of treating cattle for ticks when crossing from the tick infested zone into the tick-free zone in northern Australia.

How different assumptions on the cost of treating cattle for ticks affect transport decisions is most apparent in traffic-flow estimates for Queensland. Map 20 shows simulated cattle movements in Queensland in 2012 with the current regime for treating cattle for ticks prior to entry into the tick-free zone (high cost treatment routing scenario). These estimates show that a significant proportion of the cattle transport task occurs to the north of the tick-free zone along the Flinders Highway between Cloncurry and Townsville, and to the east of the tick-free zone along north–south routes leading to south-east Queensland. When the cost penalty for crossing the tick line is significantly reduced (low cost treatment routing scenario), there is an increase in traffic along the more direct route to south-east Queensland via Winton, Longreach, Roma and Toowoomba (Map 21).

Map 20 Simulated network usage for the 2012 high cost treatment routing scenario (consignments with at least 20 animals)

It is estimated that significantly lower tick treatment costs would have reduced transport by around 133 million head-kilometres in 2012, with 162 000 fewer cattle transported on roads that require transport operators to downsize their vehicles to meet PBS regulations. The results also show that, regardless of which scenario is considered, around 2.5 million cattle were carried on routes that went from PBS level 4 (Type 2 road trains) to lower level routes in 2012, while around 8.5 million cattle were carried on routes that went from PBS level 3 to lower level routes (see Table A3 in Appendix A).
Map 21 Simulated network usage for the 2012 low cost treatment routing scenario (consignments with at least 20 animals)

Map 22 illustrates the estimated average annual change in the cattle freight task by Local Government Area (LGA) under the low cost treatment routing scenario. It shows a reduction in traffic in LGAs above and to the east of the tick-free zone and an increase in traffic on the more direct south-east route inside the tick-free zone. Many of these LGAs are located in rural areas where councils have limited funding to maintain the road network.
Future work

The simulations undertaken for this study are limited by the precision of the NLIS Property Identification Code (PIC) data (used to identify the origin and location of cattle movements), the coverage of the NLIS database between 2008 and 2012 (the Northern Territory and Western Australia were exempt from reporting movements of cattle from their property of birth directly to export or abattoirs before 2013), and the use of qualitative relative cost information for cattle transport. Overcoming these limitations in future work should be relatively straightforward since much of the relevant data exists. The main exemptions for NLIS reporting in the Northern Territory and Western Australia ceased at the end of the period examined in this study. With more precise PIC location data and data on operating costs for transporting cattle, it may be possible to quantify the relative benefits from addressing particular bottlenecks such as bridge limits, heavy vehicle class restrictions or road upgrades. Another area that could be examined is the potential of rail to increase its share of cattle transport.

Some of these types of analyses have already been undertaken. For example, CSIRO recently used its TRAnsport Network Strategic Investment Tool (TRANSIT) (which also uses NLIS data) to estimate the benefits of upgrading the Carnarvon and Gregory highways between Roma and Clermont (Higgins 2013). This would allow the use of Type 2 road trains. The simulation also assumes that cattle travelling to an abattoir in south-eastern Queensland may travel through the tick-free area without penalty provided they are not unloaded until they reach the abattoir.

According to the CSIRO analysis, upgrading the highways and allowing cattle to travel through the tick-free area without penalty to an abattoir in south-east Queensland would have saved $75.6 million in transport costs alone in the period from 2007 to 2011 (Higgins 2013). CSIRO
also states that the savings would be higher if other heavy vehicle users were included in the analysis; cattle transport is estimated to be only 3 to 4 per cent of the total transport task between Clermont and Roma.

Improving the selection of road investments is a key objective of current road funding reforms. Given the complexity of multiple-use transport networks, analyses based on network models can help to identify a smaller number of possible investments for more detailed investigation. Rather than just using a network model to investigate a single road upgrade option, it would be useful to evaluate a broader set of possible upgrades. For example, since most cattle are carried beyond Roma, a variation on the CSIRO case study that upgrades the route from Clermont to Miles via Taroom may prove equally attractive. Investigation of longer term network upgrades that could permit Type 2 road trains to travel further to the east and south-east on the major freight routes could also be considered. Such longer term changes may have a large effect on the relative value of different upgrades in the shorter term. The Commonwealth Government recently announced in the White Paper on Developing Northern Australia that the CSIRO model will be used to test different scenarios, such as how sealing a road will influence transport time and costs, to target upgrades to the road network under the $100 million Northern Australia Beef Roads Fund (Commonwealth of Australia 2015).

If road cost data were also available, analysis could be extended to estimating partial measures of the net benefits of relaxing constraints in the road network. Collecting or extending access to these data could facilitate analysis that allows decision-makers to rank investment options based on their net benefits; this would be a substantial advance on comparing the relative benefits of projects. Targeting investments in this way could significantly increase efficiency across the road network, even in the absence of road pricing reform.

There is a strong case for governments to coordinate and contribute to the collection of a range of data, including road use and road cost data, given that governments own most of the road network and that there is little opportunity for individuals or private entities to negotiate specific upgrades to the network. As investments in road infrastructure are expensive, some investment in improved data to assist decision making is likely to be beneficial. Such data could also be used to investigate the sectoral impacts of road pricing reforms.
8 Conclusion

Increasing food demand in Asia represents a significant opportunity for the Australian beef industry. The potential of this market is reflected in the significant increase in the volume of Australian beef exported to China, with exports rising from less than 8,000 tonnes in 2009–10 to more than 160,000 tonnes in 2013–14. While Australia currently dominates this market, it faces strong competition from other suppliers. The Chinese Government recently lifted the restrictions on Brazilian imports that were imposed after BSE was detected in 2012, and the United States is working with the Chinese Government to try to restore access for US beef imports that were banned following the detection of BSE in 2003.

Given that competitive pressures are likely to increase, Australia will need to resolve any inefficiencies in its beef supply chains if it is to maximise the opportunities presented by growth in Asia. This study has identified transport as a potentially significant constraint in some beef supply chains, with much of the rural road network in poor condition, significant restrictions imposed on heavy vehicle access, and congestion on roads leading to ports in urban areas.

The major causes of inefficiency in road transport are institutional arrangements that inappropriately price road use (the road sector remains heavily regulated, with prices charged for road use not reflecting actual use or externalities such as congestion), fail to return funds to where road damage occurs, and fail to provide a simple mechanism for road users to invest in improving the road network.

The most efficient model for road pricing and funding allocation is one that charges users for actual use and returns funds to where use and damage occur. Ideally, this model would reflect vehicle mass, distance travelled, location of use and any externalities such as congestion. User-pays pricing and funding allocation models that take into account mass, distance and location have been recommended by the Productivity Commission, the National Transport Commission and, more recently, the National Commission of Audit (PC 2014; NTC 2009; NCA 2014).

While the user-pays model is theoretically appealing, there needs to be more research into the practical implications of introducing such a model. For example, there are likely to be local roads in rural areas dedicated mainly to servicing the beef cattle industry that farmers could not afford to maintain under a full user-pays system.

Given the sensitivities surrounding the distributional effects of introducing a user pays road pricing system, and the need to better identify these effects, an interim measure that could significantly improve productivity would be to allocate road funding to better reflect where road use and road damage occur. This would require access to spatial data on road use, condition and maintenance costs. While these data are generally not available, analysis in this study and by CSIRO indicates that modelling can provide information to guide policy development and investment decisions. For example, by combining data on cattle movements with road transport cost data, it is possible to simulate road use and then estimate the benefits (in terms of reduced transport costs) to the cattle industry of removing restrictions that affect the transportation of cattle.

The usefulness of this modelling approach would be significantly enhanced if actual data were available on road use and road maintenance costs. Road use data would be used to ‘ground truth’ road use simulations to improve the accuracy of benefit estimates while road cost data should allow the net benefits of removing constraints to be estimated. Ranking investments according to their net benefits would be a substantial advance on comparing the relative benefits of projects.
There is a strong case for governments to coordinate and contribute to the collection of transport related data given that governments own most of the road network and that there is little opportunity for individuals or private entities to negotiate specific upgrades to the network. As investments in road infrastructure are expensive, some investment in improved data to assist decision making is likely to be beneficial. Such data could also be used to investigate the sectoral impacts of road pricing reforms.
Appendix A: Simulating long-distance road transport of cattle

As discussed in this report, transport accounts for a significant proportion of beef supply chain costs, and infrastructure bottlenecks can affect the efficiency of moving cattle to their final destinations. The National Livestock Identification System (NLIS) records most cattle movements, and these data are used here to quantify the use of road infrastructure by the cattle industry.

In this appendix, simulations are used to illustrate the spatial patterns of cattle transport in Australia from 2008 to 2012. Since the NLIS data used in this study only identify the number of animals in each consignment, most results are measured as numbers of cattle or head-kilometres. In addition, only approximate locations are used for the majority of NLIS locations. As a result, local cattle movement estimates are imprecise. These data are potentially available for more detailed analysis in future work. Furthermore, a number of additional scenarios reflecting the seasonal pattern of road use and specific infrastructure issues discussed in this report, such as the potential for greater use of rail transport, could be examined using this simulation model in future research.

Methodology and data

Since the NLIS data only identify the origin and destination of each cattle consignment, the actual route used needs to be estimated. The cattle freight model chooses the route that minimises a transport cost index. The model implements Dijkstra’s algorithm in C++ to find the least-cost path and estimate the number of cattle transported along each road link.

Road network

The road network is based on Geoscience Australia’s GEODATA TOPO 250K Series 3 product (Geoscience Australia 2015). All roads accessible by B-double (Performance-Based Standards (PBS) level 2) vehicles are treated as available and roads accessible by Type 1 (PBS 3) and Type 2 (PBS 4) road trains have also been identified. The attribution is based on data from the National Heavy Vehicle Regulator’s Journey Planner (NHVR 2015), supplemented with data from Queensland (QDTMR 2015), New South Wales (RMS 2015) and Western Australia (Main Roads Western Australia 2015).

The transport costs for each link in the road network are relative cost rates per kilometre that discriminate between different classes of road (dual carriageway, principal, secondary and minor roads) and surface types as identified in the Geoscience Australia data. These cost parameters were chosen to reflect broad patterns of road freight movements and are kept fixed across the scenarios.

The tick zone of each road segment in Queensland (QDAF 2015), the Northern Territory (NTDPIF 2015) and Western Australia has also been identified.

NLIS locations

Consignment origins and destinations are identified by Property Identification Codes (PICs), which are eight-digit character strings (Durr, Graham & Eady 2010). The consignment data in most cases also include a postcode, a date and the type of PIC, such as producer, saleyard or abattoir (see Map A1 for regions used to locate PICs). For producer PICs and in some other cases, a two-digit or three-digit sub-string of the PIC is a region code. These are generally shires,
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parishes or districts, and spatial boundaries were obtained from the relevant state agencies. In many cases the region boundaries are not uniquely defined and include overlaps associated with changes in boundary definitions across time. However, they provide an accurate, if coarse, location for each PIC. The postcode information is less reliable because a postcode may be associated with a postal address of a business rather than the location of its operations. Where the postcode area intersects the region identified by the PIC, this intersection is treated as the first approximation of the PIC location. Where they do not intersect, the region alone is used. If no region code is available, the postcode area is used. In a small number of cases neither region nor postcode is available and these PICs are excluded from the analysis.

Map A1 Regions used for locating Property Identification Codes

Source: ABARES and state government agencies

Additional information for locating PICs includes areas identified as grazing land in the national land use maps (Commonwealth Government Department of Agriculture 2015) and maps of abattoirs, saleyards and feedlots. For producer PICs, the region, region–postcode intersection or postcode area is further reduced by excluding non-grazing areas. In each case a representative node on the road network that is close to (generally within) the relevant area is used as the PIC location in the simulations. The Northern Territory Government Department of Primary Industry and Fisheries provided additional information to help locate PICs given the large size of Northern Territory regions and postcode areas.

Where a PIC is identified to be an abattoir, saleyard or feedlot and at least one entity of the relevant type exists within the region, region–postcode intersection or postcode area, the node on the road network closest to one of these entities is used as the PIC location in the simulations. Where no such match can be found, a representative node based on the region and postcode
information is used. Note that feedlots are not distinguished from producer PICs in New South Wales.

The NLIS also includes a number of imputed transfers that use a PIC of 'XXXXXXXX'. These generally only involve a small number of animals (usually one) and are likely to be the result of data entry errors. These imputed livestock movements are not included in the analysis.

**Qualifications**

The model assumes that all movements are by road and the details of switching vehicle configurations and spelling of stock are not represented. For example, the restrictions on which vehicle types are permitted on each road segment can affect routing decisions for larger consignments. However, this has not been modelled. Similarly, seasonal or temporary road closures such as closures because of flooding are not included in the current analysis.

Given the approximations involved in locating PICs, simulated local movements have no precision. In most years these approximations mean that the modelled origin and destination of consignments involving several hundred thousand animals are the same and are thus below the resolution of the transport simulations. This represents around 4 per cent of animals moved and reflects the fact that the consignment–distance distribution is highly skewed with decreasing numbers of animals being transported longer distances.

Given the focus on long-distance movement of cattle by heavy vehicles, the multi-year analysis focuses on consignments of at least 20 animals. Smaller consignments would generally use smaller vehicles, which would face fewer routing constraints. For 2012 the effect of including all consignments is compared.

The effect of the tick zone requirements is simply represented by imposing a large penalty for movements where they cross from tick-infected or tick control zones to tick-free zones. This has the effect that, where feasible, the simulation will find the least-cost route that avoids crossing into the tick-free zone from the other zones. This may exaggerate the effect of cattle tick control policies on vehicle routing in some cases, but it identifies areas where these policies may have a large impact that can be investigated more closely.

While the coverage of the NLIS has increased over time, some types of movements may have been consistently excluded, particularly in the earlier years. Of particular note here is the exclusion for movements of cattle from their property of birth to abattoir or export in the Northern Territory and Western Australia. This exclusion ceased at the end of 2012. Movements within these states are thus underrepresented. Movements across Bass Strait and to or from Kangaroo Island were also not simulated.

The analysis only uses indicative relative costs of different roads and does not account for the cost of maintaining roads.

**NLIS data**

NLIS is Australia's system for the identification and tracking of livestock. It is a permanent whole-of-life identification system that enables individual animals to be tracked from property of birth to slaughter for food safety, disease control, product integrity and market access purposes.

Map A2 illustrates the average from 2008 to 2012 of the distributions of the number of cattle in consignments by Australian Agricultural and Grazing Industries Survey (AAGIS) subregion of origin. The larger consignment sizes account for a greater proportion of the consignments originating in the pastoral zone and a smaller proportion of the consignments originating in the
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High rainfall zone. Over the five years the median consignment size ranges from 76 to 78, with mean sizes generally around 200.

Map A2 Number of cattle transported by consignment size and AAGIS subregion of origin, average between 2008 and 2012

Map A3 presents the average from 2008 to 2012 of the total number of cattle moved by quarter by AAGIS subregion of origin. As expected, the March and, to a lesser extent, December quarters account for a smaller proportion of movements in northern Australia than in southern Australia.

Map A4 similarly aggregates consignments by destination. The high rainfall zone regions contain most abattoirs and account for a larger proportion of destinations, such as in region 331 in southern coastal Queensland, although there are still significant proportions of consignments between farms and between farms and saleyards, as reflected in the distribution of destinations.
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Map A3 Number of cattle transported by quarter and AAGIS subregion of origin, average between 2008 and 2012

AAGIS Australian Agricultural and Grazing Industries Survey.
Source: National Livestock Identification System data

Map A4 Number of cattle transported by quarter and AAGIS subregion of destination, average between 2008 and 2012

AAGIS Australian Agricultural and Grazing Industries Survey.
Source: National Livestock Identification System data
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Map A5 illustrates the average cattle movements between AAGIS subregions over the five years. Within-region movements are shown with blue diamonds and aggregate flows greater than 25,000 animals are shown with arrows. To avoid potential confidentiality issues, flows of fewer than 1,000 animals are not shown. The omission of flows within the Northern Territory from the NLIS database for these years is readily apparent. Table A1 reports the state-level average movements. Other than the Northern Territory, most movements are within states.

Map A5 Intra-region and inter-region cattle movements, 2008 to 2012, annual average number of cattle

Table A1 Average intrastate and interstate cattle movements, '000 head, 2008 to 2012

<table>
<thead>
<tr>
<th>Origin</th>
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<th>Northern Territory</th>
<th>Queensland</th>
<th>South Australia</th>
<th>Tasmania</th>
<th>Victoria</th>
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<td>439</td>
<td>0</td>
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<td>382</td>
<td>3 522</td>
<td>1 662</td>
<td>22 768</td>
</tr>
</tbody>
</table>

k hd thousand head. AAGIS Australian Agricultural and Grazing Industries Survey.
Source: National Livestock Identification System data

Table A1 Average intrastate and interstate cattle movements, '000 head, 2008 to 2012

Note: Movements of cattle from their property of birth directly to export or abattoir were exempt from NLIS reporting requirements before 2013 in the Northern Territory and Western Australia.
Source: National Livestock Identification System data

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Simulations

Two scenarios were investigated for each of the years from 2008 to 2012. These scenarios used different assumptions on the cost of treating cattle ticks:

- **high cost treatment routing scenario**—a large cost penalty is incurred when crossing from the tick-infected zone to the tick-free zone, with movements into the tick-free zone being avoided where possible. This cost penalty reflects the cost of treating, spelling and inspecting cattle prior to transport.

- **low cost treatment routing scenario**—a low cost penalty is incurred when crossing from the tick-infected zone to the tick-free zone. This scenario assumes a technical breakthrough that significantly reduces the cost of treating cattle for ticks.

For each scenario a number of statistics are calculated, including:

- the number of cattle transported across each road segment in either direction
- the number of head-kilometres transported on each road segment in either direction
- the number of cattle being transported from the tick-infected zone to the tick-free zone at each intersection of the road network with the tick-free zone boundary
- the number of cattle being transported from PBS 4 road segments to PBS 2 or 3 segments and from PBS 3 segments to PBS 2 segments, wherever these occur
- Local Government Area (LGA) level total head-kilometres
- a histogram of numbers of cattle moved by transport distance.

Again, to avoid potential confidentiality issues, flows of fewer than 1 000 head of cattle are not represented in the following maps. Map A6 and Map A7 show flows by PBS level for 2012 for the high cost treatment and low cost treatment routing scenarios, respectively. Also depicted are locations where the simulated routes decrease in PBS level. If cattle are being transported on road trains, the configuration of the vehicle may need to be changed at these points. The maps clearly illustrate the importance of a few routes, particularly in Queensland, in the beef supply chain.
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Map A6 Simulated network usage for the 2012 high cost treatment routing scenario (consignments with at least 20 animals)

k hd thousand head. PBS Performance-Based Standards. Source: ABARES modelling
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Map A7 Simulated network usage for the 2012 low cost treatment routing scenario (consignments with at least 20 animals)

k hd thousand head. PBS Performance-Based Standards.
Source: ABARES modelling
The difference in assumptions between the two scenarios is most apparent in the changed pattern of flows in Queensland, with an increased proportion of the transport task in the low cost treatment routing scenario occurring on the route between Winton, Longreach, Roma and Toowoomba and a lower proportion travelling across the Flinders Highway between Cloncurry and Townsville and along north–south routes to the east of the tick-free zone such as the Gregory Developmental Road and Highway to the south of Charters Towers. The route between Mount Isa and Longreach via Cloncurry briefly leaves the tick-free zone around Cloncurry, so in the high cost treatment routing simulation much of the flow of cattle is diverted to the south. Some flows between the Northern Territory and Queensland remain outside the tick-free zone in the high treatment cost routing scenario along routes along the Carpentaria Highway that would be impassable in wet periods. Similarly, since New South Wales is assumed to be in the tick-free zone, cattle being transported between the far north coast of New South Wales and the Darling Downs travel across the escarpment on the Gwydir Highway in New South Wales in the high cost treatment routing scenario rather than the more direct route through the far south-eastern corner of Queensland.

Figure A1 presents the distribution of transport distances for the 2012 simulations. The high cost treatment routing scenario shifts the histogram a little to the right, with some cattle being carried greater distances. Consignments with fewer than 20 animals account for a decreasing proportion of animals carried longer distances, with the greatest difference in the number of animals carried up to 100 kilometres.

Table A2 summarises the use of the PBS network in the 2012 simulations, with similar proportions of cattle transport occurring on each of the PBS 2, 3 and 4 levels. Around 2.5 million cattle are carried on routes that cross from PBS 4 to lower level routes, and around 8.5 million cattle are carried on routes that cross from PBS 3 to lower levels. Higgins (2013) assumes that maximum size vehicles travelling on PBS 2, 3 and 4 routes transport 3, 4 and 6 decks of cattle, respectively, with 18 to 38 animals per deck depending on the size of the animals. Since the median consignment size in 2012 is 78, it is possible that a significant proportion of these...
animals could be carried on higher productivity vehicles if these routes were extended. The PBS 4 route that is assumed to end at Mitchell is currently being extended about 80 kilometres further east to just west of Roma.

### Table A2 Network usage by PBS class, 2012 (consignments with at least 20 animals)

<table>
<thead>
<tr>
<th>PBS route class</th>
<th>PBS network usage (million head-km)</th>
<th>PBS class reduction (thousand head)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low cost treatment routing</td>
<td>High cost treatment routing</td>
</tr>
<tr>
<td>PBS 4</td>
<td>2 084</td>
<td>2 120</td>
</tr>
<tr>
<td>PBS 3</td>
<td>2 100</td>
<td>2 025</td>
</tr>
<tr>
<td>PBS 2</td>
<td>2 152</td>
<td>2 292</td>
</tr>
<tr>
<td>Other</td>
<td>387</td>
<td>419</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6 723</strong></td>
<td><strong>6 856</strong></td>
</tr>
</tbody>
</table>

Source: ABARES modelling

### Local Government Area–level results

Most road maintenance is the responsibility of state and local governments. Figure A2 and Table A3 illustrate cattle transport by state from 2008 to 2012. Although the NLIS exemptions mean that the Northern Territory and Western Australian totals are underrepresented, Queensland accounts for the largest share, followed by New South Wales. The reduction in transport distances in the low cost treatment routing scenario amounts to 133 million head-kilometres (1.9 per cent) in 2012 and ranges from 1.4 per cent to 1.9 per cent over the five years.

Figure A2 State-level cattle freight task, 2008 to 2012 (consignments of 20 or more cattle)

Source: ABARES modelling
### Table A3 State-level cattle freight task, 2008 to 2012 (million head-kilometres for consignments of 20 or more cattle)

<table>
<thead>
<tr>
<th>High cost treatment routing scenario</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qld</td>
<td>3 514</td>
<td>3 289</td>
<td>3 698</td>
<td>3 847</td>
<td>3 936</td>
</tr>
<tr>
<td>NSW</td>
<td>1 550</td>
<td>1 649</td>
<td>1 518</td>
<td>1 479</td>
<td>1 440</td>
</tr>
<tr>
<td>WA</td>
<td>494</td>
<td>568</td>
<td>759</td>
<td>570</td>
<td>481</td>
</tr>
<tr>
<td>Vic.</td>
<td>523</td>
<td>454</td>
<td>472</td>
<td>442</td>
<td>456</td>
</tr>
<tr>
<td>SA</td>
<td>257</td>
<td>243</td>
<td>408</td>
<td>362</td>
<td>330</td>
</tr>
<tr>
<td>NT</td>
<td>242</td>
<td>213</td>
<td>242</td>
<td>236</td>
<td>208</td>
</tr>
<tr>
<td>Tas.</td>
<td>28</td>
<td>25</td>
<td>26</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>ACT</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>6 613</td>
<td>6 447</td>
<td>7 128</td>
<td>6 966</td>
<td>6 883</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low cost treatment routing scenario</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qld</td>
<td>3 415</td>
<td>3 212</td>
<td>3 601</td>
<td>3 749</td>
<td>3 832</td>
</tr>
<tr>
<td>NSW</td>
<td>1 530</td>
<td>1 625</td>
<td>1 497</td>
<td>1 457</td>
<td>1 412</td>
</tr>
<tr>
<td>WA</td>
<td>493</td>
<td>568</td>
<td>755</td>
<td>569</td>
<td>480</td>
</tr>
<tr>
<td>Vic.</td>
<td>523</td>
<td>454</td>
<td>472</td>
<td>442</td>
<td>456</td>
</tr>
<tr>
<td>SA</td>
<td>257</td>
<td>243</td>
<td>406</td>
<td>359</td>
<td>328</td>
</tr>
<tr>
<td>NT</td>
<td>251</td>
<td>226</td>
<td>244</td>
<td>236</td>
<td>210</td>
</tr>
<tr>
<td>Tas.</td>
<td>28</td>
<td>25</td>
<td>26</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>ACT</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>6 502</td>
<td>6 358</td>
<td>7 005</td>
<td>6 841</td>
<td>6 750</td>
</tr>
</tbody>
</table>

Source: ABARES modelling

Map A8 illustrates cattle transport across Local Government Areas (LGAs) under the high cost treatment routing scenario, and Map A9 illustrates the net change in cattle transport under the low cost treatment routing scenario. Map A9 shows a reduction in traffic in LGAs above and to the east of the tick-free zone and an increase in traffic on the more direct south-east route inside the tick-free zone. Many of these LGAs are located in rural areas where councils have limited funding to maintain the road network.
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Map A8 Local Government Area–level average annual cattle freight task, 2008 to 2012, under the high cost treatment routing scenario

Source: ABARES modelling
Relaxing tick controls

The recent CSIRO analysis of modelling livestock movements in northern Australia (Higgins 2013) describes a model in which cattle tick restrictions are relaxed for cattle destined for slaughter at an abattoir so long as they are not unloaded until they reach the abattoir. In this study, ABARES has undertaken a similar simulation. While it is important to understand the risks associated with relaxing tick restrictions, it is also important to understand the benefits, including any transport related benefits.

Map A10 and Map A11 show the simulated network usage associated with all consignments from 2012 with destinations identified as abattoirs for tick control and tick-free routing scenarios. The tick control routing scenario assumes current tick clearing arrangements remain in place while the tick-free routing scenario assumes cattle do not need to be treated when crossing into the tick-free zone if they are destined for an abattoir and not unloaded until they reach the abattoir. For the purposes of modelling, the tick control and tick-free routing scenarios use the same assumptions as the high cost and low cost treatment scenarios, but in this case only cattle destined for abattoirs are included.

Under the tick-free routing scenario, with no tick control penalty, around 1.1 million animals move into the tick-free zone from outside on their way to an abattoir. When such crossings are minimised in the tick control routing scenario, only a little over 100 000 animals are moved into the tick-free zone. However, this requires an additional 70 million head-kilometres of cattle transport. This example provides an upper bound on the benefits to the cattle supply chain of this change. If the tick control routing scenario is taken as the baseline, the savings would be the...
reduction in cattle transport of 70 million head-kilometres plus the reduction of 100,000 tick inspections and/or treatments. These upper bounds on the benefits would need to be compared with the likely costs of any increased risks and alternative control measures that may be required.

The CSIRO report and the Queensland Government's submission to the Agricultural Competitiveness issues paper raise the possibility of upgrading the route between Clermont, north of Emerald, and Roma from PBS 3 to PBS 4 standard. For stock being transported south, this route crosses into the tick-free zone. The simulations indicate that the value of this upgrade may be partially dependent on the relaxation of the tick restrictions for cattle destined for slaughter. In the tick control routing scenario, the number of cattle moving across the tick-free zone south of Emerald is markedly lower. Also, many of the cattle using this corridor are not being transported to or from Roma, with many travelling further to the south-east. This is why much of the flow identified in the simulations travels via Taroom to Miles rather than via Injune to Roma and then on to Miles and beyond. This alternative route from Clermont to Miles is almost 50 kilometres shorter with slightly lower maximum gradients and so could prove a more attractive option.
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Map A10 Simulated network usage for all consignments to abattoirs in 2012, tick control routing scenario

k hd thousand head. PBS Performance-Based Standards.
Source: ABARES modelling
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Map A11 Simulated network usage for all consignments to abattoirs in 2012, tick-free routing scenario

*Map showing network usage for all consignments to abattoirs in 2012, tick-free routing scenario.*

**Source:** ABARES modelling

**Note:** Thousand head. PBS Performance-Based Standards.
## Appendix B: Road trains in Queensland

### Table B1 Maximum lengths of road trains in Queensland

<table>
<thead>
<tr>
<th>Vehicle combinations</th>
<th>Max length (metres)</th>
<th>Vehicle category</th>
<th>Combination diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>A rigid truck towing one trailer (total length exceeding 19 m)</td>
<td>31.5</td>
<td>Type 1</td>
<td></td>
</tr>
<tr>
<td>A prime mover towing two semitrailers connected by a drawbar</td>
<td>36.5</td>
<td>Type 1</td>
<td></td>
</tr>
<tr>
<td>B-triple: A prime mover towing 3 semitrailers connected by turntable couplings</td>
<td>36.5</td>
<td>Type 1</td>
<td></td>
</tr>
<tr>
<td>AB-triple: A prime mover towing a single semitrailer and a set of B-double trailers, connected by a converter dolly</td>
<td>36.5</td>
<td>Type 1</td>
<td></td>
</tr>
<tr>
<td>Longer AB-triple: (as described above)</td>
<td>44.0</td>
<td>Type 2</td>
<td>(as depicted above)</td>
</tr>
<tr>
<td>A rigid truck towing two semitrailers connected by a drawbar</td>
<td>47.5</td>
<td>Type 2</td>
<td></td>
</tr>
<tr>
<td>BAB-quad: A prime mover towing two sets of B-double trailers, connected by a converter dolly</td>
<td>53.5</td>
<td>Type 2</td>
<td></td>
</tr>
<tr>
<td>ABB-quad: A prime mover towing a single semitrailer and a set of B-triple trailers, connected by a converter dolly</td>
<td>53.5</td>
<td>Type 2</td>
<td></td>
</tr>
<tr>
<td>A prime mover towing three semitrailers connected by drawbars</td>
<td>53.5</td>
<td>Type 2</td>
<td></td>
</tr>
</tbody>
</table>

Note: Drawbar connections may be part of a fixed or converter dolly. A dog trailer has a fixed dolly unless a converter dolly is used to convert a semitrailer to a dog trailer.

Source: QDTMR 2013
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