Information sheet 34

Australian Government

Department of Infrastructure, Transport, Regional Development and Local Government

Bureau of Infrastructure, Transport and Regional Economics

Road and rail freight: competitors or complements?

Where and how do road and rail freight compete with or complement each other?

Up until the early 1960s, railways dominated all but the shortest land-based freight task. Since then, vast improvements in road vehicle productivity and road infrastructure quality, the gradual removal of regulations restricting road freight carriage and the exponential growth in interstate trade has broadened the range of freight tasks for which road is better suited than rail.

Yet both road and rail—and also sea and air—continue to play important roles in transporting Australia's diverse freight task. Each mode has attributes that render them more suitable, and generally less costly, for particular transport tasks. For example, the flexibility of road transport for urban goods distribution is unassailable; equally, the scale economies of rail over longer distances and for bulk commodities advantage it, over road, for these tasks.

There is a middle ground where both road and rail are used for carrying some goods, in some cases competing for freight and in other cases being used together as part of integrated 'logistics' operations. 'Intermodal' freight is one such area where road and rail work together, with road transport providing local pick-up and delivery (PUD) to and from the rail terminal.[1] Such 'intermodal' freight services are said to be 'complementary', in the sense that if the demand for one falls demand for the other also falls. However, such intermodal road–rail freight tasks can often be substituted by road-only freight services. Intercapital non-bulk freight is a prime example where road and rail (and also sea) compete for some freight traffic.

So where do road and rail compete for freight, and where do they provide complementary services? How large is the market in which road and rail compete in absolute terms and relative to the size of the total domestic freight task? This information sheet attempts to answer these questions—providing an overview of the role of road and rail (and, peripherally, sea and air) in domestic freight transport, the factors influencing mode choice, the responsiveness of road and rail freight demand to cost and service quality, and the implications for future freight growth.

1. Intercity rail freight is also commonly referred to as 'intermodal' freight.

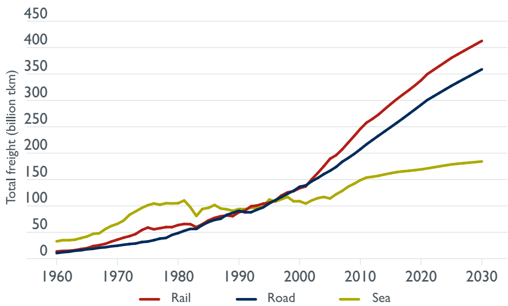
Australian freight task—size and characteristics

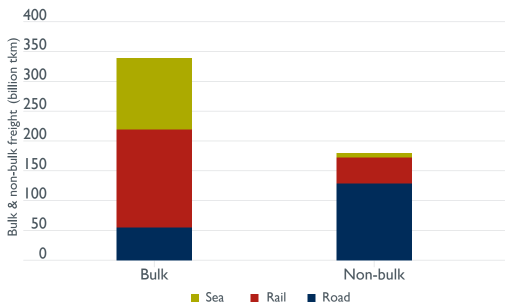
The Australian domestic freight task measured 521 billion tonne kilometres[2] in 2007, with 35 per cent carried by road, 40 per cent by rail and 25 per cent by coastal shipping. A very small volume (less than 0.1 per cent), of generally high value freight, is carried by air (BTRE 2006, p. 2).

The domestic freight task has doubled in size over the past 20 years—averaging growth of 3.5 per cent per annum (see Figure 1(a)). BITRE projections suggest this trend will continue, albeit with slightly slower growth into the future, growing by approximately 3.0 per cent per annum between 2005 and 2030. Over this period, both road and rail freight volumes are projected to more than double, with domestic demand for manufactured goods underpinning much of road freight's future growth and rail freight growth supported by expected mineral export growth. (The global financial crisis will dampen freight growth in the near term.)

Figure 1 Domestic freight activity by mode

(a) Freight growth, 1960–61 to 2006–07 **(b) Bulk and non-bulk freight, 2006–07**





Note: Air freight activity is too small, in tonne kilometre terms, to be seen in the diagram.
Sources: BITRE (2008a, forthcoming) and BITRE estimates.

Freight task composition

Modal choice is strongly influenced by the characteristics of goods—including mass, density, type,[3] perishability and fragility of freight cargo. Freight is often simply categorised as 'bulk' or 'non-bulk':

- Bulk freight generally involves large quantities of homogenous product, typically liquid or crushed solid material, transported en masse, and without packaging.[4] It is easy to load and unload from freight vehicles as it is generally poured or pumped into transport holds. Apart from food products (such as wheat, milk and, to lesser extent, sugar) bulk freight tends to be relatively non-perishable and non-fragile. Much bulk freight is low unit value but high volume.

2. One tonne kilometre is equivalent to one tonne moved one kilometre.
3. Types of bulk freight include: dry/solid, liquid, slurry, melted, gas.
4. Bulk freight commodities include oil, gas, mineral ores, cement, fertiliser, sand and gravel.

- Non-bulk freight is generally characterised as any containerised or other unitised freight, such as: pallets; motor vehicles and trailers; laden transported vehicles and uncrated live animals (ABS 1994). It is generally placed or lifted into transport holds. It often involves heterogeneous goods being moved between dispersed locations. Non-bulk freight varies in density, perishability and fragility.

The next two sections provide some details of Australia's bulk and non-bulk freight tasks.[5]

Bulk freight

Australia's bulk freight task is dominated by rail (48 per cent) and shipping (36 per cent)—Figure 1(b). Road carries only a small proportion of bulk freight, with most of this aggregate building supplies, such as sand and gravel, generally carted short distances (less than 20 kilometres). Some bulk products are also moved by conveyor or pipeline—pipelines play a major role in transporting Australia's oil and gas output.

Rail's high share of the bulk freight task—and consequently the freight task as a whole—is due mainly to large volumes of coal and iron ore. For these commodities, rail transport is essentially integrated with mining operations. With streamlined loading/unloading systems and high volumes, commodity returns are sufficient to fund and sustain dedicated railway operations. Transporting many of these commodities by road would be vastly more expensive, and so there is effectively no competition from road transport.

For other bulk commodities, such as mineral sands, uranium, and paper, it is cost-effective to use rail where the infrastructure already exists. However, shipment volumes are often insufficient to finance and sustain dedicated rail infrastructure. Road transport is used where such infrastructure does not exist. For example, both road and rail are used to transport other metallic minerals—such as copper, zinc, lead and uranium—though use of rail appears to depend on the proximity of existing rail infrastructure. In some cases, a combination of both road and rail transport is least cost. For example, mineral sands mined in the Murray Basin (western NSW and Victoria) are shipped by road to Broken Hill for separation. The refined mineral concentrate is then shipped by rail to Port Adelaide. In this operation, road and rail provide complementary services.

Figure 2 provides a stylised overview of the major road, rail and sea freight tasks in 2006–07. The figure illustrates the relative significance of bulk freight in the total rail freight task. Iron ore, coal and grain together account for over 75 per cent of total rail freight (tonne kilometres). Other bulk rail freight comprises a further 10 per cent. Intercapital non-bulk freight accounted for 8 per cent of total rail freight in 2006–07.[6]

5. 'Bulk' type commodities may be carried either as bulk freight or non-bulk freight. For example, a small share of some bulk freight items—including grains and minerals—are carted in containers, generally where the market demands small shipment sizes and/or the transport costs are less for containerised movements. These are 'bulk' freight items, but when carted in containers are counted as part of the non-bulk freight task.
6. Movements of steel products between Port Kembla, Hastings, Whyalla and capital cities accounts for approximately 1 to 1.5 per cent of total domestic rail freight.

Box 1 Sea and air freight

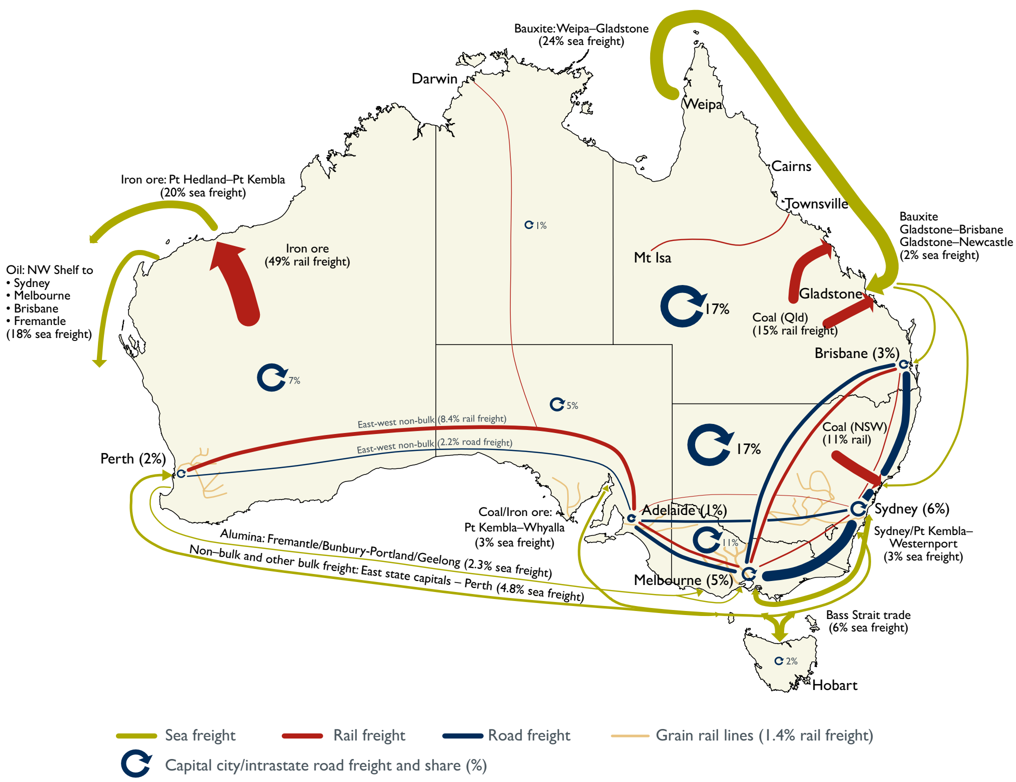
While this paper focuses on road and rail freight, sea and air are also significant freight transport modes in Australia.

Over 70 per cent of the domestic coastal shipping task involves four commodity movements: oil from the north west Western Australia to capital city refineries, iron ore from the Pilbara to Port Kembla and Whyalla, bauxite/alumina from Weipa and Bunbury and freight to and from Tasmania (see Figure 2). Bulk freight comprises over 90 per cent of domestic coastal freight.

A proportionately small volume of non-bulk freight is moved by coastal shipping between mainland ports, with freight from east coast capital cities to Perth comprising the majority of such freight. Approximately 65 per cent of such 'east–west' coastal freight is carried by international ships operating under permit (BITRE coastal shipping database).

Air freight is also significant for the movement of some goods which are usually highly time sensitive and high value per unit mass. Interstate newspapers, overnight parcels and mail are typical air freight cargoes. Air freight is less than 0.1 per cent of total freight volumes.

Figure 2 Major Australian domestic freight movements, 2006–07



Note: Lines widths indicate relative freight volume (tonnes), percentages are the share of total modal freight task (tonne kilometres)

Box 2 Grain transport

Road and rail both directly compete and operate cooperatively to transport Australian grain produce. Grain destined for bulk export, or supplied to local mills, is generally first consolidated in regional bulk storage facilities, with road handling movement from farm to storage facility. Rail is used for bulk haulage from regional storage sites to market.

Road and rail competition is more likely for existing branch line grain haulage, where relatively lower traffic volumes provide rail with less cost advantage over road freight.[7] Larger truck combinations have reduced average road haulage costs, and it has become cheaper to consolidate branch lines, replacing rail services with road transport, so that, in many cases, rail heads have become fewer and closer to ports. Additionally, the trend towards separate storage and handling of the increasing variety of different grain types grown in Australia also adds to road's relative attractiveness (GIAC 2004, Transport SA 2002).

Non-bulk freight

Long-distance non-bulk freight, predominately carried by rail for the first half of last century, has since largely shifted to road. Within urban areas, rail is an option for some port–terminal freight movements, but otherwise road is generally the only feasible transport option. Urban road freight accounts for around 28 per cent of all road freight — Sydney and Melbourne together account for almost half of total capital city road freight (see Figure 2). Outside urban areas, the relatively low volumes and dispersed nature of most freight tasks preclude rail from exploiting any scale-induced cost advantage, and in many cases road is the only available freight transport option.

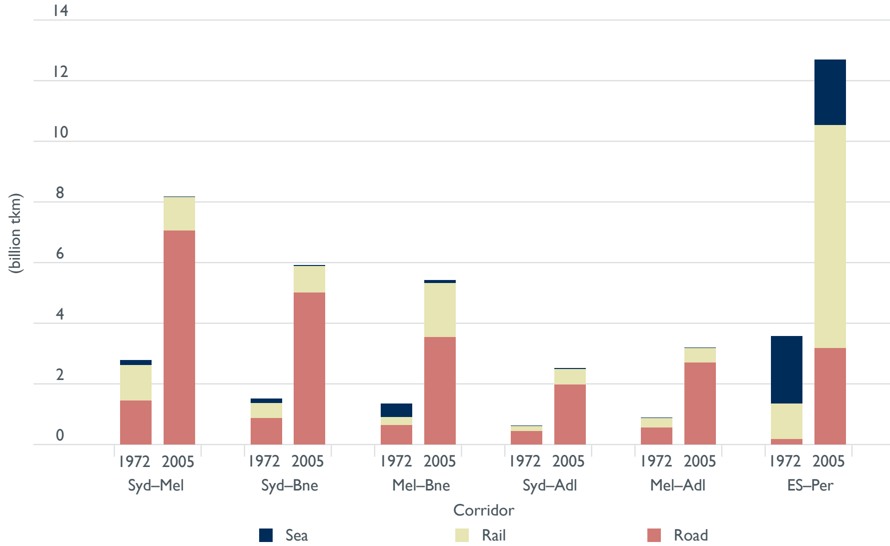
Non-bulk freight movements also exhibit significantly more diversity and complexity than bulk freight, in regard to distribution networks, packaging and delivery requirements. Non-bulk freight logistics chains can take many different forms—warehousing and some manufacturing activities can be combined with goods transport to varying degrees, and freight operations can be undertaken either in-house ('ancillary transport'), via direct contract, or through a freight forwarder. Most domestic non-bulk commodity logistics chains, because of the short distances involved and/or origin–destination requirements, only involve road transport.

Intercapital non-bulk freight

Apart from segments of the grain transport task (noted in Box 2), the principal market where road and rail compete is for carriage of non-bulk freight between capital cities. Figure 2 highlighted the relative size of the intercapital non-bulk freight task, between different capital city pairs with respect to other freight movements, and Figure 3 shows intercapital non-bulk freight volumes, by city pair, in 1971–72 and 2006–07, highlighting the strong growth in intercapital non-bulk freight over the last 35 years.

7. GIAC (2004) report that cost recovery on branch lines, at least in NSW, has been estimated to be 6 per cent or less, which would increase only to 9 per cent with line upgrade, so these lines would not be competitive with road in the absence of subsidisation.

Figure 3 Intercapital non-bulk freight task and mode shares, 1972 and 2005



Source: BTRE (2006).

Road is the predominant freight mode for most intercapital corridors. Rail is most significant on the long Eastern States–Perth corridor, where it currently moves around 57 per cent of total intercapital origin–destination non-bulk freight,[8] and the Melbourne–Brisbane corridor, where it has a 35 per cent share of intercapital non-bulk freight.[9] On other corridors, rail's mode share is less than 20 per cent, and less than 10 per cent on the two largest intercapital corridors: Sydney–Melbourne and Sydney–Brisbane. Additionally, a significant proportion of Sydney–Melbourne and Melbourne–Adelaide non-bulk freight is 'landbridged' freight through the Port of Melbourne in the case of Melbourne–Adelaide and Bass Strait freight in the case of Sydney–Melbourne (Ernst & Young 2006, BITRE 2007, Gheringhap Loop train sightings and BITRE estimates).[10]

While rail competes with road on the line-haul segment of long-distance non-bulk freight, it is reliant on road freight transport for the pick-up and delivery of freight to and from the rail terminal.

Urban freight

In urban areas, the combination of often dispersed origins and destinations, comparatively short distances and small shipment volumes means freight is most effectively carried by road. Consequently, rail freight is a negligible share of urban freight movements. However, with stevedoring firms, port authorities and governments planning to increase the use of rail transport between capital city ports and major terminals for a range of reasons including relieving road congestion,

8. Or approximately 80 per cent of total east-west non-bulk land freight, i.e. excluding sea freight.
9. Intercapital non-bulk rail freight share estimates exclude steel freight traffic.
10. International container ships limit port calls according to freight volumes, and a significant proportion of Adelaide-based import/export freight carried by rail to/from the Port of Melbourne, primarily on trains operated by stevedores. Stevedore-operated landbridging rail services comprise approximately half all Melbourne–Adelaide badged freight trains.

improving port land use and improving linkages with the interstate rail freight network, the capital city 'import-export' market is a small but growing task. In 2006–07, approximately 22 per cent of containers were moved to or from capital city ports by rail.

Factors influencing freight mode choice

The choice of transport mode generally involves a trade-off between cost and several service quality factors. The nature of the freight and the requirements of shippers influence the relative importance of cost and service quality—perishable and high value commodities tend to be more time and reliability sensitive than other freight. For any freight, it is the 'door-to-door' service, rather than just the 'line-haul' component, that matters to shippers. For intercapital origin–destination freight, road can provide a single-mode door-to-door service, whereas conveying non-bulk goods by rail typically involves transhipment between road and rail, adding to total freight costs and transit times.

Freight transport service requirements

Key freight service quality factors include transit time, reliability and service availability/frequency. The freight forwarding industry broadly delineates freight according to its transit time, reliability and/or other special requirements. Broad transit time offerings include:

- **Express:** Next day or earliest possible business day
- **Economy:** Day-definite door-to-door delivery (2–5 working days)
- **General:** Non-time-definite delivery
- **Customised:** Non-standard mass and/or dimension freight, dangerous goods, or special temperature control.

Foodstuffs, refrigerated and chilled freight and other perishables tend to be very time-sensitive. 'Economy' freight may include a wide range of commodities—goods required for 'just-in-time' manufacturing require reliable—day-definite or even hour-definite—delivery.

Road (or air for packages and parcels) is generally best for long-distance express freight. Rail can generally meet the delivery time requirements of long-distance economy freight.

Ernst & Young (2006) estimated that express freight is approximately 5 per cent of total east coast long-distance non-bulk freight, economy freight between 60 and 70 per cent and general freight between 25 and 35 per cent (Table 1). Coincident with rail's higher share of freight on those routes, price sensitive ('general') freight is generally a larger share of total freight on the longer Melbourne–Brisbane and Eastern Capitals–Perth corridors.[11] Modal competition is more pronounced for 'economy' freight where the transit time and cost requirements are more flexible.

11. Ernst & Young (2006) also suggested that most of the rail freight carried between Sydney and Melbourne is actually freight to or from Tasmania, so road has less of a cost or time advantage because that freight requires transshipment to/from sea irrespective of land transport mode.

Table 1 Freight time-sensitivity market shares

Freight type	*Syd–Mel*	*Syd–Bne*	*Mel–Bne*
		(per cent)	
Express	*5*	*5*	*5*
Availability and reliability sensitive (‘Economy’)	*70*	*70*	*60*
Price sensitive (‘General’)	*25*	*25*	*35*

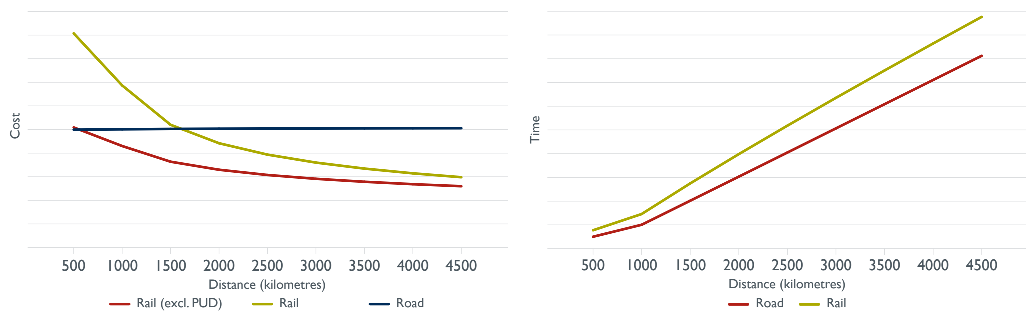
Source: Ernst & Young (2006).

Freight transport costs and service attributes

Modal cost structures and market volumes are also significant factors in mode choice. Figure 4 shows the general relationship between average freight costs and haulage distance (panel a), and between average transit times and haulage distance (panel b) for intercapital road and rail freight.

Figure 4 Average freight costs and transit times for Australian intercapital road and rail freight

(a) Freight costs[a] **(b) Transit time**



a. Rail freight costs excluding pick-up and delivery.
Note: Average freight costs for oil prices at approximately US$30–50 per barrel.
Sources: BAH (2001, Appendix C) and BITRE estimates.

Until the recent surge in world oil prices, to over US$100 per barrel in 2007–08, road freight was the lowest cost mode for low volume shipments over shorter distances. Ignoring differences between forward and back-haul rates, the average per kilometre road freight cost is more or less constant with respect to distance. Rail generally has lower line-haul costs than road, especially for large volumes and over longer distance, but pick-up and delivery and rail terminal costs add significantly to the average door-to-door cost of rail, particularly for short-haul freight. Consequently, average rail costs decline with increasing freight volumes and distances, such that rail is lower cost for door-to-door freight hauls above 1000 kilometres. With world oil prices averaging almost US$100 per barrel in 2007–08, three times average prices prevailing in 2000–01, however, rail temporarily experienced an absolute price advantage over road across almost all intercapital corridors (ARTC 2008).

However, because road freight can provide direct door-to-door services, it is faster and generally more reliable than rail. Figure 4(b) shows average road transit times are around 20 per cent less than line-haul rail for intercapital non-bulk freight. Allowing for pick-up and delivery, and within terminal operations, means the door-to-door transit time differential between road and rail can be much greater. For example, between Melbourne and Brisbane door-to-door rail transit times are up to 50 per cent above that of road (see Table 2), and rail services are less frequent and generally less reliable than road (Ernst & Young 2006).

Table 2 Typical freight transit times (door-to-door)

Mode		Syd–Mel	Syd–Bne	Mel–Bne	Mel–Adl	Mel–Per
Road	*(hours)*	*11*	*15*	*23*	*9*	*43*
Rail	*(hours)*	*17*	*21.5–26*	*36.5–45*	*14.5–16.5*	*58–68 (3–4 days)*
Sea[a]	*(days)*	*2–3*	*2–3*	*4–6*	*2–4*	*5–7*

a. Typical port-to-port sailing time plus one day for pick-up and delivery.
Sources: BAH (2001), BITRE (2008b) and Lloyds ship movements database (2005).

Market structure and competition

With approximately 50 000 hire and reward road freight businesses, the road freight industry is highly competitive (BTRE 2003). Notwithstanding some consolidation within the industry, primarily through acquisition of smaller firms by larger operators (such as Toll and Linfox), the industry is dominated by small establishments, typically operating only one or two trucks—small firms comprise nearly 90 per cent of the fleet and have between 75 and 85 per cent of total industry turnover (BTRE 2003). The large number of independent operators ensures vigorous competition within the road freight sector.

The hire and reward rail freight industry, by contrast, comprises three larger operators—Pacific National, QR (Queensland Rail) and SCT Logistics—and several smaller niche operators that provide regional freight, port shuttle and maintenance services.[12] Pacific National and QR have significant coal haulage contracts and provide non-bulk intermodal haulage between capital cities. SCT Logistics also operates intermodal freight services between Melbourne–Adelaide–Perth. Despite the small number of intermodal rail operators, road freight and, between the east coast and Perth, sea freight exert competitive pressure on intermodal rail operators. Indeed, competitive pressure from road is such that the Australian Rail Track Corporation, which manages the national rail network, sets interstate network track access prices with a view to rail's competitiveness with road and sea (ARTC 2008, p. 17).

Empirical evidence of road–rail freight competition

The available empirical evidence bears out the nature of the Australian freight market—low substitutability (little competition) between road and rail in aggregate, but significant modal competition for intercapital non-bulk freight.

Aggregate freight elasticities,[13] encompassing both bulk and non-bulk freight, imply that road freight demand is relatively unresponsive to variations in road freight rates,

12. BHP Billiton and Rio Tinto's iron ore rail operations are the main ancillary rail operations.
13. That is, the responsiveness of freight demand to changed prices or service factors.

in the short run, and independent of changes in rail freight rates. The same holds for aggregate rail freight demand. For example, the Productivity Commission (2006) estimated the responsiveness of total rail freight demand to rail rate variations is –0.25—implying a 0.25 per cent increase in rail freight volumes as a result of a 1 per cent reduction in rail freight rates. Rail freight's response to road freight rate changes was statistically not significant—in other words, aggregate rail freight demand is independent of changes in road freight rates. Productivity Commission (2006) estimated a similar relation for aggregate road freight—relatively inelastic response to road freight rates (–0.43) and independent of rail.

Intercapital freight studies imply that road and rail are competitors, but that substitutability between road and rail modes is relatively low. Table 3 provides long-run price elasticity estimates for intercapital freight across short-, medium- and long-distance intercapital corridors. The estimates show road freight demand is relatively unresponsive to road and rail freight rates, except on long-distance corridors, where road has a minor share of freight. Rail freight demand is relatively more responsive to freight rate variations than road, but demand is still inelastic (i.e. less than 1 in absolute terms) for all but medium-distance corridors, such as Melbourne–Brisbane, where rail has greater potential to attract freight from road.

Table 3 Intercapital road and rail price long-run price elasticities, by corridor

	Short-distance corridors		*Medium-distance corridors*		*Long-distance corridors*		*All corridors*	
	Freight rate		*Freight rate*		*Freight rate*		*Freight rate*	
Mode	*Road*	*Rail*	*Road*	*Rail*	*Road*	*Rail*	*Road*	*Rail*
Road	*–0.36*	*0.35*	*–0.43*	*0.33*	*–1.08*	*0.66*	*–0.46*	*0.58*
Rail	*0.88*	*–0.93*	*1.08*	*–1.15*	*0.42*	*–0.78*	*1.04*	*–1.66*

Source: BITRE estimates.

Unique amongst Australian empirical studies, Booz Allen Hamilton (2001) estimated the responsiveness of intercapital road and rail freight demand jointly with respect to prices and service quality attributes: transit time, reliability and service availability. BAH (2001) report intercapital rail freight price elasticities of –1.1, similar in magnitude to the price-only estimates in Table 4, and service quality elasticity magnitudes of between 0.3 and 0.6—again implying rail freight demand responsiveness to service quality changes is relatively limited.

The implications of the empirical evidence is that substantial and sustained improvements in rail freight rates and rail service quality, relative to road, would be required to significantly increase rail's share of intercapital freight.

Freight outlook

Not considering the current slowdown in world economic growth, long-term domestic rail freight is projected to grow by 3.2 per cent per annum (between 2005 and 2030), underpinned by strong growth in bulk commodity freight, particularly iron ore and coal production and exports. Road freight is projected to grow by 3.1 per cent per annum over the long term, with similarly strong growth in urban and long-distance road freight. Across many markets, freight growth depends most critically upon growth in industry activity.

Where the two modes compete, road and rail freight growth will depend not only on economic activity, but also relative modal costs. ARTC's $2.1 billion planned investment on the North–South interstate rail line will reduce transit times, improve reliability, increase capacity and reduce ongoing track maintenance costs (ARTC 2008), helping rail compete with road. ARTC (2008) estimates these investments have the potential to double rail's share to almost 20 per cent of Sydney–Melbourne and Sydney–Brisbane non-bulk freight and 60 per cent of Melbourne–Brisbane non-bulk freight. However, continued investment on the Hume and Pacific Highways will help improve transit times and reduce road freight operating costs, countering somewhat the improvements on rail.[14]

Freight transport input cost trends are likely to be even more influential on future modal competition; most especially fuel prices, since fuel is generally over 30 per cent of total long-distance road freight operating costs—the single largest cost item—and almost 20 per cent of rail freight operating costs. The prospective introduction of greenhouse emission based charges for carbon in transport fuels will likely increase fuel's share of freight transport costs. In comparison, infrastructure charges are typically less than 5 per cent of total annual road freight operating costs—noting that infrastructure cost are allocated to light vehicles users as well as heavy vehicles—but can be up to 20 per cent of rail operating costs. For oil prices around US$100 per barrel, road freight costs are above door-to-door rail freight costs across all Australian intercapital corridors, including on the shorter Sydney–Melbourne and Sydney–Brisbane intercity corridors. Sustained oil prices at around this level would significantly boost rail's competitiveness and intercapital modal share.

Conclusions

In many freight markets, there is little direct competition between road and rail: typically, one mode is significantly more efficient and effective, and consequently has a majority market share. Rail is generally best suited to bulk consignments between few locations; rail's large share of the total domestic freight task is mainly accounted for by the movement of coal and iron ore. By contrast, road freight is well suited to the carriage of smaller consignments to dispersed locations. Line-haul intercapital non-bulk freight is the primary market segment where road and rail compete, but there are other competitive market segments, such as branch line grain movements.

Domestic economic activity and world commodity demand will largely drive future growth in aggregate road and rail freight. Infrastructure investment will improve the efficiency of freight transport and have some impact on modal demand. Because fuel is such a large share of road freight costs, long-term oil prices are likely to be even more influential on future modal shares where road and rail compete. Nonetheless, the efficient and effective movement of Australia's freight task will continue to involve a mix of road, rail, sea and air transport services.

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14. When completed Melbourne, Sydney and Brisbane will be linked entirely by four- (or more) lane dual carriageway.

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ISSN 1836-697X
April 2009/INFRASTRUCTURE08470

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Desktop publishing by Paul Gunning.

Printed by Union Offset Printers.

Typset in Optima Ltd Std and Gill Sans MT [Mac].

Paper: Sovereign Silk.