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POLITICS, FINANCE AND TRANSPORT – MEGAPROJECTS IN AUSTRALIA

This paper reviews the funding and delivery of transport infrastructure projects in Australia at the macro- and micro- (project) level. At the macro-level it identifies that Australia's transport infrastructure is rated low in international comparisons, despite funding levels that have varied from average to high. At the micro-(project) level the paper examines a sample of Australian projects to test whether cost and demand risks have been well controlled. It finds that overall cost risks have been well controlled, with lower cost overruns than other OECD countries. Demand risks have been poorly controlled for public private partnership (PPP) projects, which have greater forecasting errors than other projects by a significant margin. In conclusion reforms are proposed for the decision making, assessment and delivery processes for transport projects to increase transparency, independence and consistency. A statutory national infrastructure body with decision making powers is recommended.

1. Introduction

In Australia the past decade has seen the delivery of multiple transport megaprojects costing over a billion dollars each. However the success in delivery has been mixed. Four of the last six toll-road tunnels built in Australia, costing over ten billion dollars, have become bankrupt or suffered major capital loss within three years of opening. They also failed to deliver their stated transport objectives, in terms of patronage, and would have had benefit – cost ratios of less than one, making the decision to build them highly questionable. A 67% failure rate in a category of investment suggests a systemic flaw in decision making.

This paper considers major road and rail projects built in Australia in the period since 1990. It examines trends in project unit cost, delivery risk and demand risk, following a similar methodology to Flyvbjerg (2003). It also considers Public Private Partnerships (PPPs), these having been a particular source of debate. The trends are used to draw conclusions on the nature of project planning, assessment and delivery. Recommendations are made on the required reforms.

This paper updates and develops the themes in an earlier paper, Politics Funding and Transport, by Elaurant and McDougall (2014). The 2014 paper reviewed trends in transport infrastructure funding and delivery in Australia since 2000. Following the 2014 paper, I take it as a given that the infrastructure funding and decision making process (i.e. project selection) in Australia has become dysfunctional. The question is not whether reform is needed, but what are the causes of the problems, and what should be done to address them.

2. Transport funding – the macro level

2.1 Land transport infrastructure funding since 2001

The funding of land transport infrastructure in Australia has been erratic over the past two decades, despite sustained high growth rates in both population and economic activity. Infrastructure funding in Australia had been falling in real terms since the 1980s, as the focus of State and Federal budgets was to reduce debt and manage rising health costs. In the decade up to 2007 road and rail capital funding averaged 0.6% of GDP. This was average by OECD standards, but well below historical norms, and arguably inadequate given Australia's large distances and high growth rate. Funding increased to 1.1% of GDP (higher than OECD average) after the global financial crisis (GFC) (2008-2012), when road and rail projects were included as part of the stimulus package to respond to the GFC. Subsequently in State and Federal budgets transport funding had reduced to below trend again by 2014. Infrastructure funding in real terms from 2003 to 2017 (2013$, budget projection) is shown in Figure 2.1. This shows government funding, and does not include private capital used for public-private partnerships (PPPs) or privately used infrastructure, such as mining railroads.

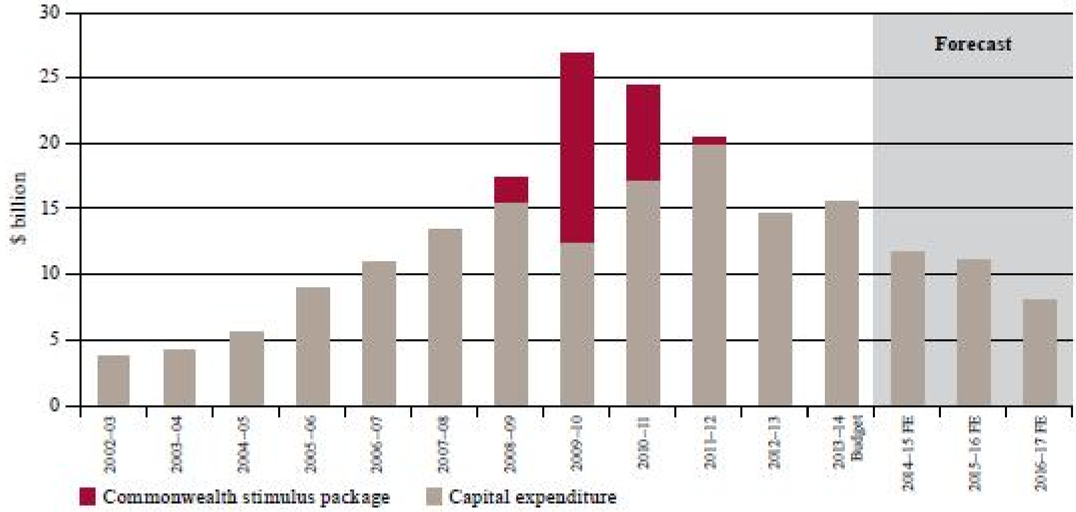

Figure 2.1 Australian infrastructure funding 2003 to 2017 ($billions, 2013 $)[1]

The comparatively high level of recent capital investment in Australia may be seen by comparisons with other OECD nations that report investment in a similar fashion. Australian transport investment as a percentage of GDP is shown in Figure 2.2, compared with eight other OECD nations. Investment levels dropped in many other countries after the global financial crisis of 2008-09, underlying the significance of the increase in Australian funding.

[1] Figure 15, Australian Infrastructure Audit Report, Infrastructure Australia, April 2015.

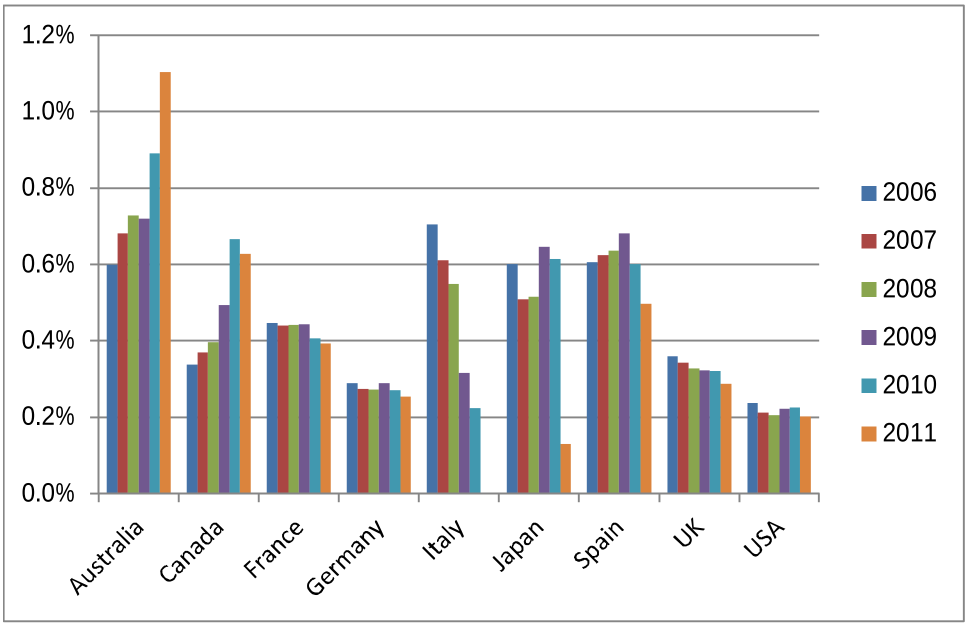

Figure 2.2 Road and Rail Funding as Percentage of GDP (2006 to 2011 OECD)[2]

The other element of infrastructure funding is for maintenance. Here Australia fares more poorly. Despite very long lengths of road and rail networks to maintain, Australia has spent an average of approximately 0.5% of GDP on maintenance. This is barely average by OECD standards, and compares poorly to Canada, another OECD nation of similar size. Road maintenance as a percentage of GDP is shown for OECD nations (where given) in Figure 2.3.

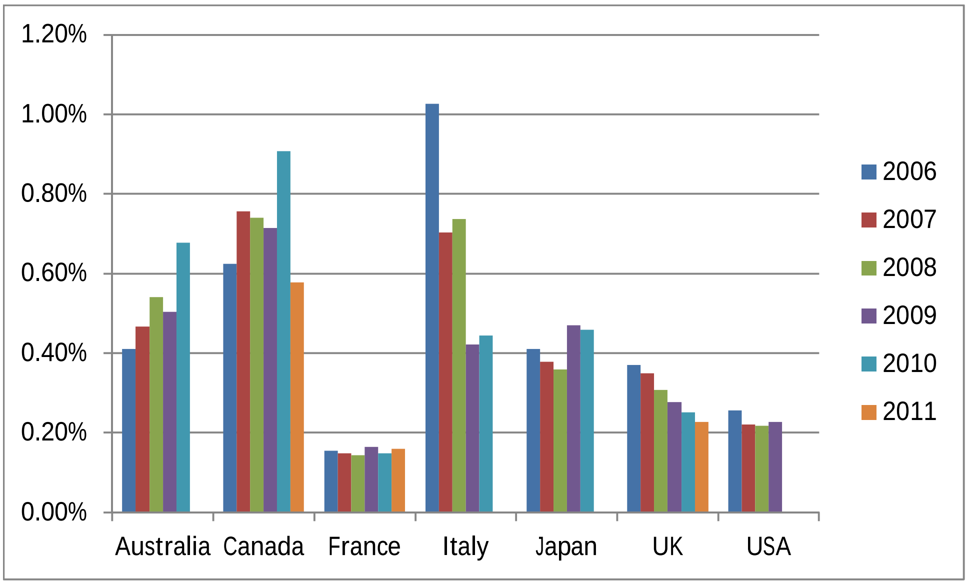

Figure 2.3 Road Maintenance Funding as Percentage of GDP (2006 to 2011 OECD)[3]

Spending on infrastructure does not necessarily correlate with quality. The World Economic Forum rankings of nations for quality of infrastructure are shown in Figure 2.4. Of the

[2] Data: OECD Summary Statistics: Transport Infrastructure, OECD StatExtracts, May 2015.

[3] Data: OECD Summary Statistics: Transport Infrastructure, OECD StatExtracts, May 2015.

nations in Figure 2.1, Australia had the highest expenditure, and the second lowest rated system quality. In part this is due to Australia's large distances, though note that Canada, has similar distances, lower spending, and yet higher quality infrastructure.

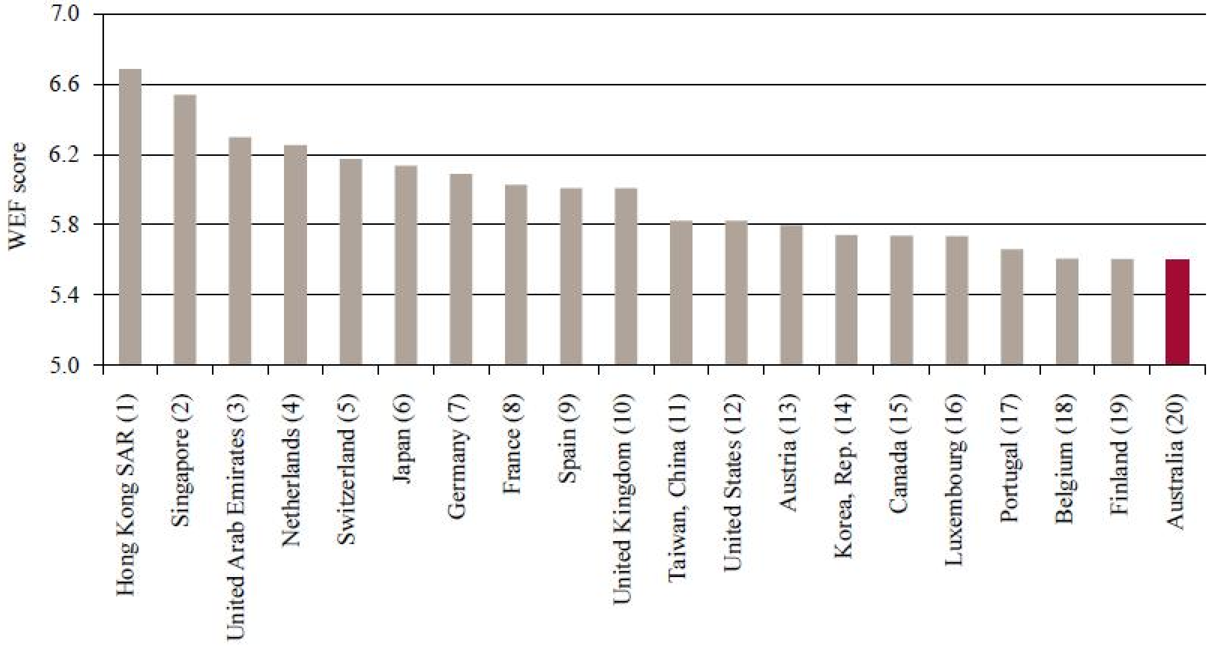

Figure 2.4 Infrastructure Quality Ranking 2014 (World Economic Forum)[4]

2.2 Population and economic growth since 2001

Funding and quality of transport infrastructure in Australia needs to be considered in the context of demand, which is driven by growth in population and economic activity. Australia has been one of the fastest growing countries in the OECD in the past decade, with population increasing 1.5% per annum between 2000 and 2010. Only four of the 34 OECD nations grew faster[5]. The world population growth rate averaged 1.1% per annum over the same period.

The Australian economy has also been growing faster than the OECD average for the decade since 2001. For the period 2001 to 2013, real GDP growth has averaged 2.6% per annum, well above the OECD average of 1.7%[6].

The population growth is located predominantly in Australia's largest cities. Aside from small city states Australia is the most urbanised country in the OECD, with more than 75% of the population living in cities. Australian major city population growth averaged 1.7% per annum from 2001 to 2011, higher than the national growth rate. Despite talk of "sea-changes" and "tree-changes", the proportion of population living in major cities continues to grow.

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[4] Graph of World Economic Forum Ratings, 2014. Figure 8, Australian Infrastructure Audit Report, Infrastructure Australia, April 2015.

[5] Department of Infrastructure and Transport, 2013.

[6] OECD, 2014.

Economic production is also centred in our major cities. Aside from the mining industry, the vast majority of Australia's production and services occurs in capital cities, generating 80% of national GDP[7]. The capital city share of our economic production per person is greater than average. Cities subsidise rural areas in Australia, not vice versa.

Australia's rate of economic growth has slowed markedly since the end of the mining boom in 2012-13, however the rate of population growth has not. It is forecast to remain high by OECD standards for the foreseeable future. This is due to a combination of a high immigration rate, average demographic profile, and high birth rate. Australia's population will exceed 30 million by 2031, on the ABS medium series projection. Our major cities will grow by another 45%, or almost six million additional residents, in this time (SOAC 2010). In this respect Australia is part of a world-wide trend towards urbanisation, and this outcome is not caused by government policy. The question is – how do we respond?

2.3 Australian Infrastructure Audit

The state of Australian infrastructure funding and performance was the subject of the Australian Infrastructure Audit Report, by Infrastructure Australia (April 2015). This reviewed all types of infrastructure, including transport, power communications and water. Common problems were identified in all sectors. Transport, being the largest sector in terms of both cost and economic contribution, was identified as a particular problem. Australian infrastructure now compares poorly within the OECD, even to other countries with large distances such as Canada.

The Audit identified numerous existing and future gaps in transport infrastructure quality and capacity. The combined cost of these gaps is congestion already costing $13 billion per annum (*less* than current capital investment of $15 billion in 2014/15). The cost of transport investment now exceeds revenue from transport charges (fuel levy etc). Motorists no longer subsidise other services, but rather motoring and public transport are both subsidised by other tax streams.

A criticism of the report is that demand management was considered only in capacity allocation terms, with no mention of policies such as road pricing, parking restrictions, land use policies or behavioural change. The Audit tends to look at the quantum of future needs and how they might be funded, not whether they can be avoided through a different approach to transport and urban planning. In this regard we should note from Figures 2.2 and 2.3 that Canada, France and Germany, all have better rated infrastructure, but spend less on transport than Australia in percentage terms. These criticisms aside, the conclusions of the report and calls for reform of transport institutional arrangements are supported.

2.4 Macro Level Conclusions on Transport Funding

Infrastructure investment levels in Australia were low prior to 2008/09, especially for a physically large country with high population growth. Infrastructure investment from 2008/09 to 2012/13 was high both by Australian historical and international standards. Investment has

[7] State of Australian Cities Report (SOAC), Department of Infrastructure and Regional Development, 2010.

dropped back to previous levels since 2013. Against this, population growth in Australia has also been higher than OECD norms, increasing demand. This has resulted in a growing shortfall of funds available against approved projects requiring funding. Maintenance funding, which has remained average to below average throughout, remains deficient.

Other macro-level issues besides funding shortfalls for capital investment exist, but have been given less attention. Alternatives to infrastructure investment, such as demand management, have been only peripherally considered. Transport is a derived demand, and increasing transport investment needs to be seen as a means to an end, and not an end in itself.

The underlying question of whether there should be an attempt to reduce population growth has been barely discussed in infrastructure policy papers. From the viewpoint of welfare of individuals, growth in income per capita is what is of ultimate benefit, not growth per se. Australia has high population growth and a high standard of living. This is rare, and arguably only achievable with a resource advantage. Other countries have achieved high standards of living with lower population growth, notably in northern Europe and Scandinavia. Of the ten highest ranked countries for overall standard of living in 2014, none of the other nine had as high a population growth rate as Australia[8].

In the next chapter we shall ask the question – how well has this money been spent? To do this we shall examine a sample of available evidence – such as it is – for project delivery.

3. Megaprojects in Australia

3.1 Defining Megaprojects and Data in Australia

The previous chapter identified the macro-economic context of transport infrastructure in Australia in terms of demand growth and variation in funding levels. This chapter examines the delivery performance of a database of road and rail projects in Australia to answer the question, was the money well spent? It will consider two metrics Flyvbjerg (2003) used:

1. Cost overrun, which I will define as *cost risk*, or *delivery risk,* and
2. Demand forecasting accuracy, which I will define as *demand risk*

To these are added a further metric, the *unit cost* achieved by the project:

3. Unit Cost, measured as real cost per lane or track-km.

A database has been compiled of 38 Australian major road or rail projects completed between 1990 and 2015, ranging in size from a real 2015 cost of $200 million to $5 billion (2015$). In this context "megaprojects' have been defined as capital values over one billion AUD$. The sample contains 21 megaprojects, including 13 road, 7 rail and one busway. The sample has been extended over a 25 year period to see whether there is any change over time.

A major difficulty in conducting such an analysis in Australia is the lack of publically available data at the project level. No agency publishes all details of planning studies that precede projects. Many of the details that are published are lost over time as Departmental websites are restructured and some information deleted with each change in government.

[8] Human Development Report 2014, United Nations Development Program, July 2014.

There are few instances in Australia of post-implementation reviews to test whether project objectives were achieved. Overall Australian practice in the publically accessible reporting of publically funded transport projects is very poor by OECD standards.

Data has been obtained from public sources including State and Federal government agency annual reports, budgets and audit reports, as well as papers by Bain (2009), Martin (2011), and Wood (2010). Data was sought from State transport agencies on project performance, particularly forecast and actual demand levels. Two States replied within the timeframe required for preparing this paper. A list of the transport projects sampled is contained in Table 3.1, together with their type and cost[9] in 2015 $.

Table 3.1 Transport Project Database 1990 to 2015.

Project	Year Open	Cost ($m)	Real Cost (2015 $m)	Mode	Type	Length (km)	Real Cost/ Lane Km $m	Contract Type
Sydney Harbour Tunnel	1992	$554	$1,106	Road	Tunnel	2.8	$99	PPP
M2 Motorway Sydney	1997	$496	$914	Road	Surface	21.4	$11	PPP
Eastern Distributor Sydney	1999	$730	$1,310	Road	Tunnel	6	$55	PPP
City Link Melbourne	2000	$2,200	$3,947	Road	Surface	22	$30	PPP
Sydney Airport Rail	2000	$900	$1,615	Rail	Tunnel	10	$81	PPP
South East Busway Brisbane	2000	$520	$912	Bus	Surface	16.5	$28	Trad
Pacific Motorway SEQ	2000	$850	$1,491	Road	Surface	43	$4	Alliance
Airtrain, Brisbane	2001	$220	$362	Rail	Surface	8.5	$21	PPP
Yelgun Chinderah, NSW	2002	$348	$573	Road	Surface	29	$5	D&C
Alice Springs-Darwin Rail	2004	$1,200	$1,894	Rail	Surface	1420	$1	PPP
Cross City Tunnel, Sydney	2005	$680	$967	Road	Tunnel	2.1	$115	PPP
M7 Motorway, Sydney	2006	$1,800	$2,423	Road	Surface	40	$15	PPP
Regional Fast Rail, Vic	2006	$750	$1,066	Rail	Surface	240	$2	D&C
Perth Mandurah Rail, Perth	2007	$1,660	$2,133	Rail	Surface	70	$15	Trad
Lane Cove Tunnel, Sydney	2007	$1,100	$1,414	Road	Tunnel	3.6	$79	PPP
Liverpool Parramatta T-Way, Sydney	2003	$346	$546	Bus	Surface	30	$9	D&C
Inner Nth. Busway, Brisbane	2008	$493	$614	Bus	Tunnel	4.5	$68	D&C
Tugun Bypass, Gold Coast	2008	$543	$676	Road	Surface	7	$24	D&C
East Link, Melbourne	2008	$2,500	$3,114	Road	Surface	39	$13	PPP
Deer Park Bypass Melbourne	2009	$362	$426	Road	Surface	9.3	$11	D&C
Epping Chatswood, Sydney	2009	$2,350	$3,020	Rail	Tunnel	14	$108	D&C
Forrest Highway, Perth	2009	$705	$829	Road	Surface	70	$3	Alliance
Clem 7 Tunnel, Brisbane	2010	$3,200	$3,493	Road	Tunnel	4.8	$182	PPP
Gateway Upgrade, Brisbane	2010	$1,880	$2,212	Road	Bridge	20	$18	D&C
Go Between Bridge Brisbane	2010	$338	$369	Road	Bridge	0.7	$132	PPP
Monash-CityLink- Westgate, Melbourne	2010	$1,390	$1,517	Road	Surface	19.5	$13	Alliance

[9] Real cost is calculated by converting reported construction cost to 2015 $ using the BITRE Road Input Cost Index. Foreign projects have been converted to 2015 values using the reported consumer price indices for that country and then to Australian dollars.

Project	Year Open	Cost ($m)	Real Cost (2015 $m)	Mode	Type	Length (km)	Real Cost/ Lane Km $m	Contract Type
Northern Expressway, Adelaide	2011	$564	$621	Road	Surface	23	$7	D&C
Airport Link, Brisbane	2012	$4,800	$5,288	Road	Tunnel	6.7	$132	PPP
Western Ring Road, Melbourne	2013	$2,250	$2,407	Road	Surface	38	$32	D&C
Peninsula Link, Melbourne	2013	$760	$774	Road	Surface	27	$7	PPP
Butler Rail Extension, Perth	2013	$221	$225	Rail	Surface	7.5	$15	Trad
Ipswich Motorway, Brisbane	2014	$2,800	$2,996	Road	Surface	21	$24	Alliance
Seaford Rail Link Adelaide	2014	$291	$292	Rail	Surface	5.7	$26	D&C
South Road Superway Adelaide	2014	$930	$948	Road	Bridge	4.8	$33	D&C
Gold Coast Light Rail	2014	$949	$953	Lt Rail	Surface	13	$37	PPP
Regional Rail Link Melbourne	2014	$3,650	$3,719	Rail	Surface	47.5	$39	Trad
South West Rail Sydney	2015	$1,800	$1,809	Rail	Surface	11.4	$79	D&C
Legacy Way, Brisbane	2015	$1,500	$1,507	Road	Tunnel	4.6	$82	PPP

Contract type refers to the construction contract. These may be either PPP (Public Private Partnership), D&C (Design and Construct), Alliance or Trad. (Traditional = separate design and construction contracts)

3.2 Analysis

Project data for unit cost, cost risk (final cost versus planned cost), demand risk (actual opening patronage versus planned patronage) has been fitted to a statistical model (See Appendix 1 for details). Projects are compared over time by work type (road or rail; surface, bridge or tunnel) and contract type (PPP or other: alliance, D&C or separate contracts).

3.2.1 Unit Cost

From this analysis, the first point to make is that the real unit cost of the sampled projects has not varied greatly over time. There is no statistically significant trend of rising unit costs for each project type The individual trends are similar for both road and rail projects. Recent project costs have been high due to an increasing use of tunnels, which are consistently the most expensive construction type. Unit costs (real cost per lane-km in million 2015$) are shown in Figure 3.1. Tunnels are shown in red. PPP contracts are shown as solid data points.

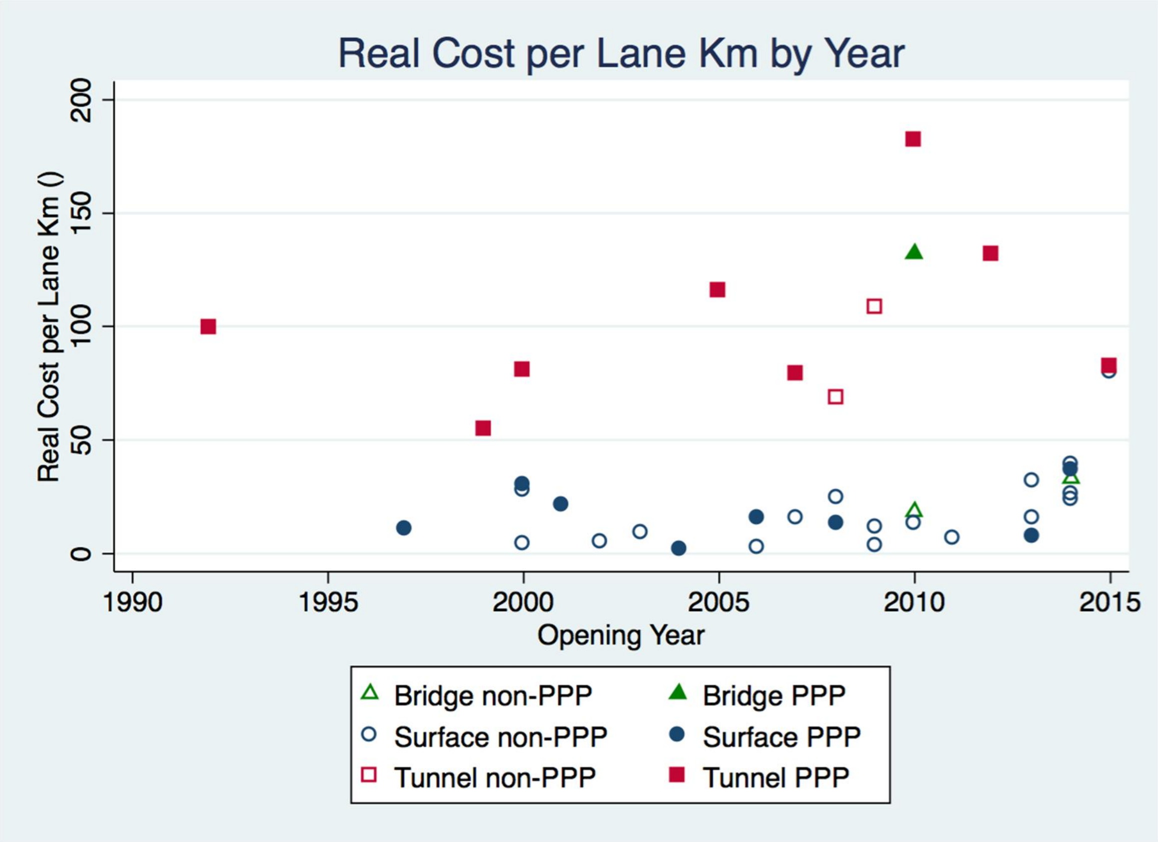

Figure 3.1 Project Unit Costs 1990 to 2015 (Real cost per lane/track km m2015$)

The clearest differentiator of project cost is whether the infrastructure is being constructed on surface, elevated (bridge structure) or in tunnel. Whether a road or rail project, infrastructure elevated on bridge structures ($61m/lane km) costs on average three times the cost of surface infrastructure ($21m/lane-km), while tunnels ($102m/lane km) cost on average five times surface infrastructure.

There is little difference between the unit cost per length by mode. The unit capital cost of rail projects in the sample is slightly lower than for road projects. However this is due to the large number of road tunnel projects. Within each type (surface, bridge or tunnel) the difference in average unit cost of road and rail projects is not significant.

A statistical model was fitted to test the effect of contract type (PPP vs non-PPP). The difference between PPP and non-PPP projects within each project type was not statistically significant. The primary driver of high average unit cost in recent PPP projects has been that they were mainly tunnels, not that they were delivered by a PPP contract.

3.2.2 Cost Risk

Cost risk has been measured by comparing the final construction cost per lane or track-km with the planned construction cost per lane or track-km, converting both to real 2015$. The results are shown in Figure 3.2. Tunnel projects are shown in red. PPPs are shown as solid data points.

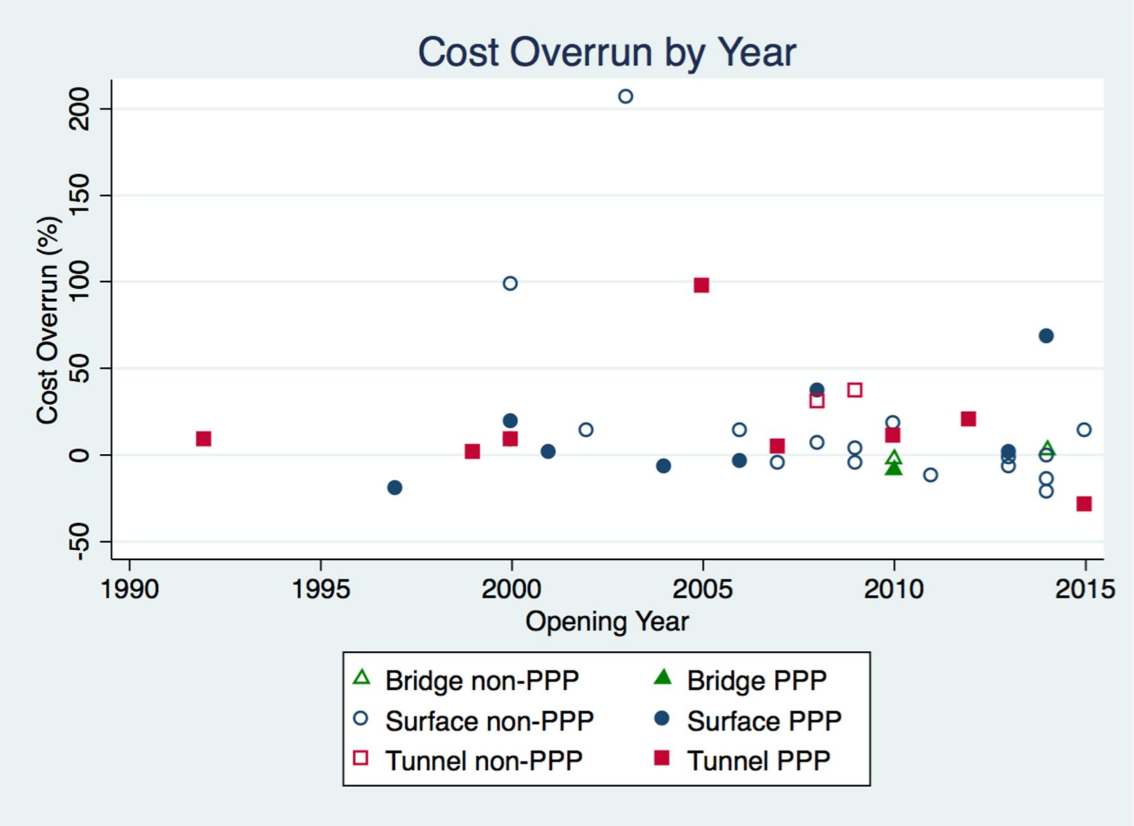

Figure 3.2 Cost Risk by Project Type

There is a marked skewing of cost overrun data by all project types and for each contract type. There are far more cost overruns than cost underruns, with the average project finishing +15% over the original budget in real terms.

Other than the skewing, there is no obvious pattern of cost overrun. The risk of cost overrun was not statistically significant for project size, project type, or contract type. There was a cost risk of approximately 15% whether the project was built on surface, bridge or tunnel, and whether it was delivered as a PPP or public funded. This performance compares well with other countries and studies. Studies have shown typical road and rail project cost overruns of 34% (road) and 45% (rail) (Flyvbjerg 2003).

This result is also contrary to Flyvbjerg's European finding that larger projects have higher cost risks than smaller, and that rail projects have higher cost risks than road. Overall, construction cost overruns seem to be better controlled in Australia than in Europe for the reported examples.

Construction time overruns (actual opening date versus planned) were also compared for the project sample. Overall delivery time performance for the sampled projects was very good. Average delivery time performance was -1% compared to scheduled completion, compared to +13% for the international comparator projects. Only two of thirty eight projects were delayed by more than 30% and most projects were completed within 10% of the planned construction period. As many projects finished ahead of schedule as behind, indicating there is no evidence of bias or over-optimism in construction time forecasting. The majority of PPP projects finished ahead of schedule, though the difference was not statistically significant.

3.2.3 Demand Risk: Forecasting Accuracy

The final aspect of project delivery that we consider is demand risk, or the accuracy of demand forecasts. This is assessed by comparing the percentage difference between the actual patronage using the project and the reported forecast of future demand prepared in the planning stage. Opening patronage was taken as average daily patronage at the end of the first year after opening. A statistical model was fitted to test whether there were any patterns in demand risk by project type and contract type (see Appendix 1). Box plots showing the median (%) forecasting error, inter-quartile range and 1.5 times inter-quartile range (from the median) by project type and contract type are shown in Figure 3.3.

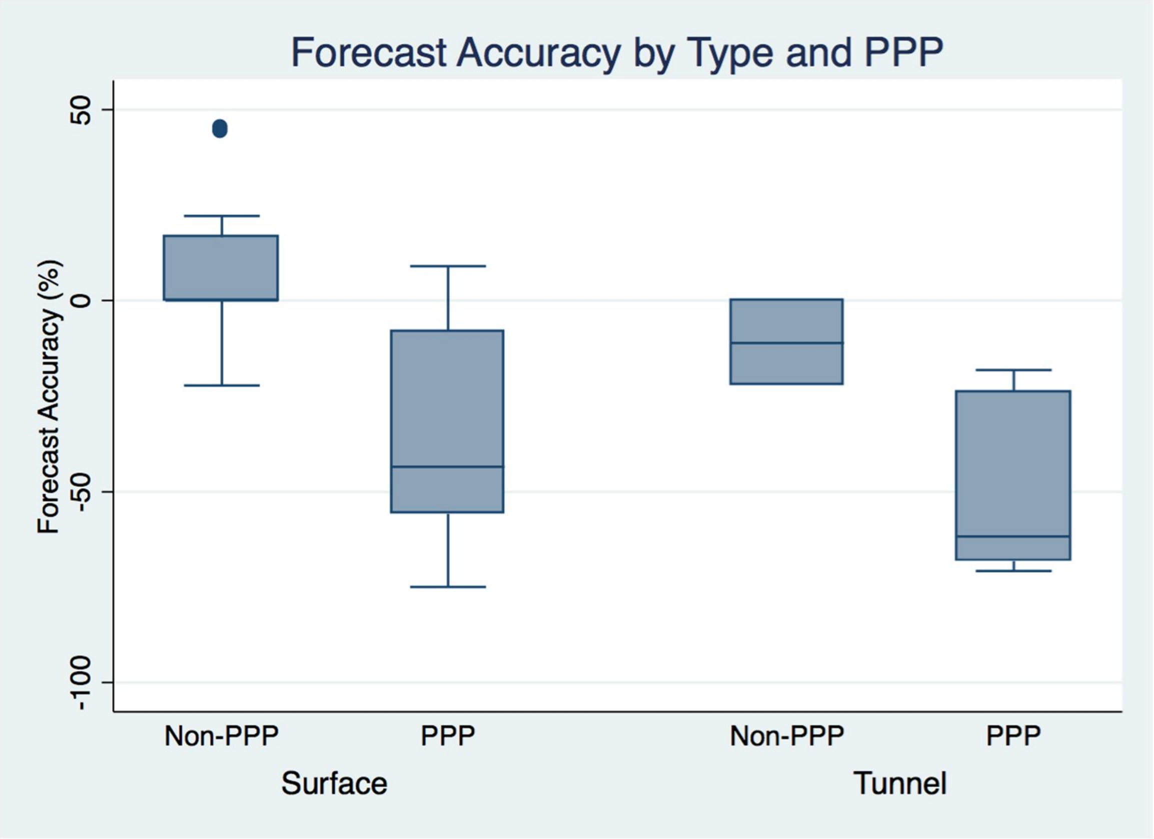

Figure 3.3 Demand Risk by Project Type

Overall average error in demand forecasting was approximately -15%. In this case the error was patterned by contract type to a significant degree. Average forecasting error was 44% greater for PPP projects than non-PPP projects, and consistently skewed (negative). This result was statistically significant for both surface and tunnel projects. That is, PPP projects tended to have greater demand forecast errors whether surface or tunnel. The error for Australian PPPs is comparable to European rail project forecasting errors (-39%) and the Australian non-PPP error is comparable to European road projects (-20%). The median error for PPP tunnels (>-50%) is within the -50% to -70% range identified by Flyvbjerg for European megaprojects.

Demand risk was not obviously patterned over time or by project size or type. Demand risk did not increase with project size whether for PPPs or non-PPPs. The problem of demand forecasting over-estimation for PPP projects has been persistent over time. Likewise PPP demand risk has been an issue with road and rail PPPs (the Sydney Airport Rail line and Brisbane Airtrain projects both also failing financially with below forecast demand).

3.2.4 Recent Australian PPP projects

Given that demand risk (forecasting error) for PPP projects has been a persistent problem over time, the question remains why the recent generation of PPP road projects has seen more financial collapses than the earlier generation of PPP projects built in the 1990s? The answer lies in the higher cost and economically more marginal nature of the recent projects. Earlier PPP road projects suffered patronage over-estimation, however being either surface projects with lower costs (City Link, M2, M5 East) or tunnels on high demand routes where drivers were willing to pay a toll premium (Eastern distributor) or demand risk was held by government (Sydney Harbour Tunnel) the projects were still viable. Where this was not the case (Sydney Airport Rail, Brisbane Airtrain) the earlier PPP projects also became bankrupt. The recent PPP toll roads that financially collapsed were all tunnels (Sydney Cross City, Lane Cove, Clem 7 and Airport Link). Melbourne East Link also suffered below forecast patronage, and suffered a capital loss but not bankruptcy. Of recent PPPs, only Go Between Bridge and Gold Coast Light Rail have opened near forecast demand.

The conclusion shows that there were two problems with the failed PPP projects. The first was demand forecasting bias and error. The second was the decision to build the high cost projects themselves. Even if the demand forecasting had been perfect, the actual levels of demand were not sufficient to justify building the scope as delivered. The projects' scope and form should have been reviewed. A PPP contract may assist government in delivering projects for which it does not have funds. However a PPP cannot make unviable projects viable. As the Productivity Commission (2014) noted, PPPs are not "a magic pudding".

This highlights weaknesses in the planning and delivery processes of major projects. Flyvbjerg saw PPPs as a solution to the problem of cost risk and demand risk in European major projects by introducing market discipline with private capital at risk. Several of Flyvbjerg's recommended governance measures were not present in the failed Australian PPPs. The project contracts were not transparent, with government agencies not independent, acting as promoters as well as regulators. The Australian PPP projects resolved cost risk but not demand risk. In other jurisdictions with different structural approaches to PPPs, including Canada, Chile and USA, PPPs have been successful (Cuttaree 2008). The technical causes of demand forecasting bias in Australian PPPs have been discussed by Smith (2011). In light of successful examples of PPP mechanisms in other jurisdictions, the structure of Australian PPP contracts should also be considered as a cause of failure.

This lesson appears not to have been learnt. One of the subsequently proposed Australian PPP projects (Melbourne East West Link) remained lacking in transparency with the government agency acting as promoter once again. Worse, government proposed to take patronage risk, meaning that the private capital would not have been at risk. The project structure was thus further removed from Flyvbjerg's recommendations than the previous round of failed PPP projects. Although now cancelled, the reason for the project cancellation was political, and did not reflect any institutional recognition of these weaknesses.

4. Improving Infrastructure Planning and Delivery

As was stated in Elaurant and McDougall (2014), transport planning and investment in Australia has a number of serious problems: lack of consistency in funding, lack of bipartisan support and focus on individual projects, with inadequate attention to systemic issues. To these problems may be added the evidence presented in this paper that there are now two levels to the problem:

1. At the macro level Australia has spent significant sums on transport projects but has achieved a comparatively poor outcome in terms of the quality of the transport system.
2. At the level of individual project delivery, current planning and assessment processes have been insufficient to prevent projects that did not represent good value for money for taxpayers or investors, and economically should not have been built as scoped.

Clearly, there is a need for systemic change in infrastructure planning and delivery. I will now propose some of the changes that might reduce the problems identified.

4.1 An *Effective* Independent Statutory Agency for Infrastructure

The need for a transparent and independent statutory body to make transport investment decisions was identified in Elaurant and McDougall (2014). Similar proposals have been repeated in a number of forums by organisations including the Grattan Institute, Engineers Australia and various industry lobbies. The question is: what is needed for it to be *effective*?

Infrastructure Australia became a statutory body in 2014 and has the potential to fulfil this role, as it already undertakes project assessment and prioritisation. However it has no power other than to make recommendations and that advice may be ignored. The need is for a statutory body in the style of the Reserve Bank of Australia, with decision-making powers:

1. the power to make binding decisions to approve or reject major infrastructure projects (with capital cost > $100 million AUS in 2015 $). It is important not to waste capital on unjustifiable projects as well as to fund projects that are needed.
2. the power to allocate a pre-determined stream of government revenue to deliver projects, and/or to raise funds to deliver them. Without the ability to fund approved projects, the body will remain ineffectual.

Ideally, the body should have a stable stream of funds to allocate, ensuring a more predictable level of activity. The rate of investment should be based on long term trends, and benchmarked to other OECD countries. Comparing the geographically similar case of Canada, an amount of 0.6% to 0.7% of GDP would appear sufficient, if efficiently spent.

Funding shares between States should be fixed in a similar fashion to Grants Commission decisions on the allocation of GST revenue. This would give each State an incentive to prioritise its most beneficial transport projects, rather than to identify projects that maximise funding and economic activity, as the current system appears to encourage.

The decisions of the body should be made public together with the reasons, in a similar manner to RBA board meeting notes on interest rate decisions. This ensures transparency, which appears to be a key requirement in preventing the worst cases of project failure.

Ideally this process would occur at a national level. Traditionally transport planning in Australia has been a State level activity, and agreeing reforms of Federal – State funding mechanisms has proven difficult. In the absence of a national body, State level independent statutory infrastructure bodies with these decision making powers would still be of benefit.

Many OECD countries place transport planning decisions in the hands of independent statutory bodies with approval and funding powers. This is done at a national level, such as in several European countries, or at state or metropolitan level, such as in the United States. In some cases these put major project approvals to a popular vote at municipal elections, together with the funding mechanism proposed to pay for them.

4.2 Project governance reforms

Private capital via PPP projects was designed to manage project cost and demand risks. Reforms are required to improve Australian practice with contracting PPP projects:

1. Standardisation of the form of PPP contracts and financial structures to ensure that contracts are robust and protect investors, while reducing administration and bidding costs. Current Australian practice costs bidders up to $100 million to prepare a bid.
2. Guidelines for PPP projects need to be expanded to define acceptable governance arrangements. These need to mandate transparency, independence of decision making, and risk allocation, as well as financial parameters. The reported $1.2 billion "success fee" (Davies 2014) within the winning bid of the $6.5 billion Melbourne East West Link illustrates this problem. The success fee represented a 20% cost impost on the project, making an already marginal project almost certainly uneconomic.
3. Terms of PPP contracts do not appear to be in the public interest. PPP concessions have been granted in Australia with concession periods of 30 or more years. UK practice is to grant 20 year concession periods, or less if financial return targets are met sooner. Increasing concession periods beyond 20 years is unlikely to improve project viability.
4. Delivery mechanisms for publically funded (non-PPP) projects also require review:
    a. Contract terms for non-PPP projects should be standard across all States.
    b. Simpler contract forms such as separate or combined Design and Construct contracts should be preferred. Wood (2010) highlighted that Alliance projects tend to have higher outturn costs.
    c. In general, the public interest would appear better served by a delivery of a larger number of smaller projects, and fewer infrastructure "megaprojects". Smaller projects have on average higher benefit cost ratios (Infrastructure Australia, 2013), suggesting that several smaller projects will result in greater community benefits than the same funds being concentrated in one or two "megaprojects".
5. The desire to introduce large PPP projects appears to be driven in part by the need to obtain additional funding for project delivery. This skews the scoping and mode choice of the projects. It may be more efficient to deliver projects by conventional (public contract) means, and use alternative mechanisms to finance them.

4.3 Planning and Project Assessment Reforms

Planning of transport networks and assessment of individual projects also requires reform:

1. Australia's transport analytical capability has atrophied, due to agency budget cuts. Funding is focused on building, with very little focus on capability to know what should be built. The total budget for infrastructure data acquisition, modelling and strategic analysis is less than 1% of the infrastructure capital budget in every mainland State. Project level capital budgets are much larger than project level planning budgets; the latter are typically 2% or less of capital costs.
2. Transport agencies should be required to fund the development and regular updating of transport models of major urban areas. Models and calibration reports should be publically accessible, to inform public debate, and to improve land use planning.
3. Data acquisition should be systematically budgeted and carried out. Currently Australia has no regular freight or transport survey at national level. Australia lags in implementation of modern methods such as travel matrices from smart phone data.
4. Transport and land use agencies should be required to identify and preserve corridors that will be required for future transport infrastructure at the time of development. This was normal practice up to the 1970s. Failure to do so since has contributed to higher costs for surface projects, and the use of costly tunnels. The cost efficiency of Perth projects in the sample highlights the benefits of corridor preservation.
5. Project assessment including demand modelling should be undertaken by an agency independent of the proponent, to avoid the potential for conflict of interest and bias.
6. Assessment (benefit cost) guidelines should be revised to match international practice:
    a. Quantify and compulsorily include factors currently not required including wider economic benefits, health impacts, and environmental impacts (including emissions)
    b. Assessment of public transport project benefits is greatly deficient. In the absence of a commitment to quantify relevant factors in Australian practice, the New Zealand Economic Evaluation Manual or similar should be adopted.
    c. Revise discount rates to reflect long term government borrowing costs. The current 7% discount rate is biased towards projects with short term benefit streams; the UK uses 4%.
    d. A benefit-cost "hurdle rate" higher than 1 should be adopted. When cost risks (10%) and demand risks (15% up to 44% for PPPs) are taken into account, a project should have a benefit cost ratio of at least 1.5 at the planning stage to ensure that actual project benefits are likely to exceed actual project costs.

5. Appendix 1 – Notes on Statistical Analysis

1. Unit (Real) Cost per Lane Km: due to substantial right skew a (base 10) log transform was used. Linear regression models were then fitted to investigate the effect of PPP status (PPP vs non-PPP). Bridge projects were omitted from the analyses due to small number (n=3) of observations. Firstly, an interaction term was fitted to test for difference in the effect of PPP status by project type; however, this was not statistically significant (p=0.796) so it was dropped, and a model was fitted testing the overall effect of PPP status, adjusting for project type and year of opening. The difference in mean log(cost) between PPP and non-PPP

projects was not statistically significant (estimated difference on the log scale 0.05 (-0.23, 0.34), p=0700).

2. Cost Risk: this outcome also had substantial right skew; however a straightforward log transform was not possible due to the presence of negative values. Instead a range of approaches were used:

(a) The values were first transformed to be strictly positive (by subtracting the minimum value – 1) before log transforming, and fitting a linear regression model in the same manner as for real cost per lane km. There was no evidence for difference of PPP effect by project type (p=0.348), and in the multivariable model (effect of PPP adjusting for project type and year of opening) there was no significant difference between PPP and non-PPP projects (difference on log scale -0.16 (-0.47, 0.15, p=0.311).

(b) Wilcoxon rank sum (non-parametric) tests were used (with original Cost Overrun values, i.e. not log transformed) to test for difference between PPP and non-PPP projects separately by project type (i.e. PPP vs non-PPP for Surface projects, and PPP vs non-PPP for Tunnel projects). In neither case was the difference statistically significant (Surface: p=0.861; Tunnel p=0.117).

3. Demand Risk (Forecast Accuracy) %: this outcome had a sufficiently symmetric distribution that transformation was not judged necessary. Linear regression models were fitted as above. There was no evidence for different effects of PPP status by project type (p=0.949). In the multivariable model testing for the effect of PPP status adjusting for project type and year of opening, the effect of PPP status was highly statistically significant (p<0.001) with an estimated difference (PPP minus non-PPP) of -44.29 (-61.93, -26.64).

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7. Presenters' Bios

Dr SCOTT ELAURANT

Scott is an engineer economist who has worked for thirty years in transport planning in Australia, New Zealand and South East Asia. He has experience in network and concept planning, transport demand modelling, traffic capacity, business cases, wider economic benefits and financial analysis. He was head of discipline for transport planning in Queensland Main Roads prior to joining Jacobs. Recent projects Scott has worked on include the Adelaide South Road corridor, Glenelg Tram extension, and Auckland Light Rail. Scott gathered the project database and wrote the transport aspects of the paper.

Dr JENNIE LOUISE

Jennie Louise is a statistician at the Data Management and Analysis Centre (DMAC), University of Adelaide. Jennie has spent more than ten years as an academic. She is currently working mainly in clinical trials. Jennie undertook the statistical analysis and wrote the statistical reporting aspects of the paper