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Impact of next generation infrastructure on Australian cities

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Abstract

The quality of the physical infrastructure in our major cities is just as critical as human capital development in terms of driving long-run growth in productivity and rising living standards. The provision of high-quality and reliable infrastructure network services (like roads, rail and telecommunications) can have significant social, environmental and economic payoffs. Notwithstanding the obvious intuitive connection between infrastructure investment and economic growth, the link between the two is still debated. One reason is that not all infrastructure investment supports growth over the long-term. Building a road or rail line that is not used for instance lowers productivity and economic growth in the long-term. A second reason is that establishing an empirical relationship between infrastructure and economic growth is confounded by a number of statistical issues. The most important of these relates to identifying the direction of causality between infrastructure and measures of aggregate output (GDP). This study takes a microeconomic (or case study) approach to understanding the impact of next generation infrastructure (NGI) on the effectiveness of our cities in supporting economic growth and higher living standards. We first look at the theoretical links between infrastructure investment, productive cities and economic growth. We then focus on a hotly debated infrastructure project - the South West Illawarra Rail Link, which could potentially better link the Wollongong region to Sydney.

Keywords

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This study takes a microeconomic (or case study) approach to understanding the impact of next generation infrastructure (NGI) on the effectiveness of our cities in supporting economic growth and higher living standards.

We first look at the theoretical links between infrastructure investment, productive cities and economic growth. We then focus on a hotly debated infrastructure project – the South West Illawarra Rail Link, which could potentially better link the Wollongong region to Sydney.

Key Words
Infrastructure, economic growth, productivity

Introduction
Infrastructure literally means *the structure beneath*. The services provided by our roads, rail lines, ports, telecommunications, electricity and gas networks largely set the practical limits of our living standards and economic growth potential. More efficient infrastructure means higher living standards and higher growth potential. Less efficient infrastructure means higher costs, lost productivity and lost opportunity.

That said, the relationship between *additional* infrastructure investment and *additional* growth is not straightforward. For instance, any infrastructure investment will, in the immediate, raise growth. That is simply a national accounting identity. Growth is comprised of consumption and investment and net exports[1]. If investment rises then, contemporaneously, so does growth. In other words, infrastructure investment *is* growth in this first instance.

The real question, however, relates to the long-run impact of infrastructure investment on the economy. This is more difficult to measure, not only because we are trying to pick up an enduring effect of the investment, but also because the causality could go the other way. For instance, increased growth can be a signal (and an impetus) to invest more in infrastructure, such as happened in Australia during the mining boom when both private and public infrastructure investment increased significantly.

[1] The reader might remember the EC101 formula Y = C + I + G + (X – M), where Y is GDP, C is Consumption, I is investment, G is Government spending and (X – M) is Net Exports.

The macroeconomic impacts of infrastructure are generally assessed in the context of how infrastructure facilitates market activity and therefore supports economic growth. The magnitude of this boost to growth is still debated, however, and a large range of estimates has been published in the literature. The more recent literature is more reliable as methodological issues have been addressed over time.

The more recent overall estimates of the impact of infrastructure investment on domestic output (the so-called infrastructure elasticity) are in the range of around 0.1. This estimate suggests that a 1 per cent increase in the infrastructure capital stock would increase aggregate output by around 0.1 per cent. Putting that in the Australian context, an AUD$51 billion increase infrastructure investment (i.e. a 1% addition to Australia's net capital stock of $5.1 trillion) would permanently increase output by $1.6 billion per year, (i.e. a 0.1% addition to Australia's GDP of $1.6 trillion). The return on the infrastructure investment then is around 3.1% (i.e. $1.6 b / $51 b), close to Australia's long-run GDP growth rate[2].

Of course, this estimate is, at best, a very generalised marker subject to wide variation depending on a myriad of factors related to the nature of the investment and structure of the economy. For instance, estimates of the output elasticity of infrastructure are generally higher in circumstances where:

- infrastructure investment is related to public capital installed by regional or local governments;
- infrastructure investment is related to 'core' services provided by roads, railways, airports, and utilities; and
- the benefits of infrastructure investment are measured over a longer-term time horizon, reflecting the fact that infrastructure outputs (benefits) occur over many years.

Overall, the key (and for that matter common sense) conclusion is that public infrastructure investment can potentially contribute significantly to the growth of an economy, provided it is productive. In this context, it is worth drawing attention to analysis undertaken by Makin (2003, 2007) who investigates the nature of government spending in the context of a small open economy with floating exchange rates (as is the case for Australia).

Makin argues that a rise in infrastructure spending would increase the current account deficit, which must be financed. It follows that if higher infrastructure spending is likely to add to future productive capacity, the current account deficit would be willingly funded, and national production would eventually rise with an enlarged capital stock; the current account deficit would self-correct without significant exchange rate variation. However, if infrastructure spending only added to future net demands for foreign currency without that investment being productive, then the exchange rate would depreciate, resulting in inflationary pressures and higher domestic interest rates.

The fact that public infrastructure investment relies on the coercive powers of taxation (and, therefore, that investment is rarely considered in purely commercial terms) means that it is often the case that public infrastructure investment leads to higher debt, a lower dollar and higher interest rates. In other words, because of the coercive power of taxation, foreign lenders are quite happy to lend money to governments for bad projects at lower than commercial interest rates, knowing that they will get their money back.

In summary, the quality of the public infrastructure investment being contemplated matters in the long-run. Therefore, the 'infrastructure question' becomes one of finance, microeconomics and public policy.

[2] Unless otherwise stated all figures in this paper are in Australian dollars.

Microeconomic impacts of infrastructure investment

The finance, microeconomic and public policy literature in relation to infrastructure investment is extensive. Ultimately, the literature demonstrates that efficient infrastructure investment is determined on a case-by-case basis and there are a number of best-practice principles that make it more likely that the investment will be efficient. These principles include:

- rigorous ex ante cost benefit appraisal and business case analysis is undertaken independently of the project proponent, where alternative options are carefully considered (including the 'do nothing' option and incremental options);
- there is at least some significant private sector involvement in terms of funding, financing and ownership of public infrastructure (i.e. the private sector has 'skin in the game');
- there is at least some amount of cost reflective pricing of the services provided by the infrastructure and the stronger the price signal on demand/consumption the better; and
- decisions about infrastructure priorities are made at a local level and prioritised because the local government faces a binding fiscal constraint that forces it to consider many options and pick the best option (i.e. in Australia, local governments are generally prevented from borrowing for infrastructure and need state or national government approval).

Public infrastructure investment can potentially deliver significant productivity gains and associated opportunities for economic development and growth. However, achieving these gains presupposes that infrastructure investment is 'efficient', in the sense that a given project represents the best use of scarce resources. That is, if:

- the project is expected to yield benefits that exceed its (risk-adjusted) costs; and
- the project's net benefits exceed those of other investment alternatives (including doing nothing).

If these conditions are met, community welfare is unambiguously improved by undertaking the project. Notably, and unlike private sector investments, public sector investment criteria consider the broader ('social') costs and benefits of an investment decision, including positive and negative spillovers that are not captured in market prices. For instance, if a new road provides economic and social access to a low-income regional or remote community, these benefits would be included in a complete welfare analysis.

There are two other aspects of infrastructure efficiency that extend beyond the productive efficiency criterion described above, namely, how projects are initially financed and funded over time (for example, via pricing a mechanism).

Funding efficiency relates to how the ongoing provision of infrastructure services is paid for, in terms of the balance of user charges versus funding from general government revenues or borrowing. Although the price signal is vitally important to efficiently guide future investment, in some circumstances seeking 100% full cost recovery is not efficient. For instance, if public infrastructure delivers spillover or 'public good' benefit that is difficult or impossible to attribute to particular persons, user charges should not fully recover the cost of an investment (Chan et al. 2009). Common examples of positive spillovers for transport infrastructure are avoided congestion, pollution and accidents. Governments may also wish to subsidise services that could be self-financing in order to promote distributional objectives.

Nonetheless, the complete absence of a price signal could mean that infrastructure is not being used effectively. For instance, the 'free' use of the road system has been identified by many scholars and commentators as contributing to congestion and additional, inefficient, investment requirements.

Funding efficiency therefore requires a balance to be struck between charges that reflect the benefits that users derive from infrastructure, and the amount of funding costs imposed on taxpayers as a whole,

noting that many taxpayers may not use a particular infrastructure service and that public funding decisions carry with them an opportunity cost (the money could be used for other purposes) and the 'deadweight loss' of raising taxes (the additional tax revenue could be used by citizens based on their own preferences).

In terms of the impacts of infrastructure investment on productivity, there are a number of microeconomic studies of the small-scale effects of infrastructure that attempt to trace through the mechanisms via which economic growth is supported. Two recent papers highlight the channels via which transport infrastructure affects productivity at the microeconomic level:

- Gibbons et al. (2012) study the impacts of road improvements on firms using administrative data on businesses in Great Britain from 1997 to 2008. They capture road improvements using an index of changing employment accessibility to measure the amount of employment reachable per unit of travel time along the major road network. The authors find strong effects from transport improvements on area employment and plant counts: a 10 per cent improvement in accessibility leads to about a 3 per cent increase in the number of businesses and employment up to 30 km from the site of the improvement. Evidence was also found for increases in labour productivity, output and wages amongst existing firms. Overall, the effect of the major new road schemes was to raise mean accessibility by 0.34 per cent, implying a 0.012 per cent increase in total employment from a year's investment in major road transport network improvements.

- Li and Li (2013) study 36 major Chinese cities over the period 1998 to 2007 to identify the improvement in productivity from reduced inventory holdings as a result of an improved transport network. They find that the inventory-output ratio of medium and large manufacturers decreased from 22 to 13 per cent (equivalent to 1.25 per cent of industrial output), and that over half of this decline was caused by road investment. The authors also identified strong evidence for spillover effects of roads on non-local firms by reducing inventory stocks in neighbouring provinces. Overall, transport infrastructure investment contributed significantly to the economic efficiency of the economy by directly reducing transport costs and indirectly reducing raw materials inventories by 25 per cent.

Overall, therefore, all of the above studies identify beneficial micro-level effects from wise investment in transport infrastructure. In particular Gibbons et al. (2012) and Li and Li (2013) highlight the importance of transport in improving productivity by reducing the costs of holding inventories at a broader regional level, and in enabling businesses access a greater labour pool and improving their productivity in this way.

Some issues

Regulation of public infrastructure

There has been a debate in Australia in recent years about whether we have the regulatory settings right in relation to large regulated monopoly infrastructure (such as our electricity and urban water networks). The question is – *have our regulators got the balance right between encouraging efficient incremental investment in networks against protecting consumers from wasteful spending and higher prices for little or no additional benefit?*

Beginning in the 1980s, the regulation of infrastructure began to change fundamentally from traditional rate of return regulation to incentive regulation, and more broadly, to regulatory systems whereby third party access and competition is actively promoted (Guthrie 2006). Whereas rate of return regulation was blamed for high cost infrastructure outcomes and indifferent service quality (overinvestment), incentive

regulation (intended to sharpen the focus on achieving greater efficiencies) has been associated with reduced investment incentives (underinvestment).

Fundamentally, regulation affects regulated infrastructure businesses' investment behaviour by changing the allocation of risk between their shareholders and customers.

Political institutions and the policy environment

It is well understood that the quality of political institutions has an important impact on economic outcomes by affecting the costs of bargaining, entering into contracts, and the monitoring and enforcement of outcomes. In this context, a government's ability to credibly commit not to interfere with private property rights is instrumental for enabling the long-term capital investments required for countries to experience strong economic growth.

The hypothesis that weak institutional environments can account for a lack of investment in economic infrastructure has been shown in a number of case studies. Henisz (2002) demonstrated this effect (for the telecommunications and electricity sector) by analysing data from up to 160 countries since 1800. The author also found that the credibility of a government's policymaking apparatus plays an important role in the diffusion process of infrastructure, and that the ability of a nation to credibly commit to a given policy environment is an important component in explaining investment levels within that country.

Australia generally has high-quality institutions, but is also not immune from institutional and policy settings that potentially detract from efficient infrastructure investment. In recent years, various states and the federal government have instituted infrastructure advisory bodies with differing levels of independence. It is fair to say that these new institutions, such Infrastructure Australia, Infrastructure NSW, and Building Queensland, are still coming to terms with their mandate. These new agencies have not yet reduced issues identified by Ergas (2014), including:

- an undue emphasis on 'ribbon cutting' opportunities, generally associated with very major projects, at the expense of periodic maintenance and of small-scale 'de-bottlenecking' options that could postpone or even avoid the need for costly asset expansions; and
- the fact that the Commonwealth provides funding for major projects, but not for ongoing improvements to asset condition, which accentuates the bias towards large projects and undermines the integrated planning of the road network, notably in urban areas.

Planning and execution risks

Arguably the major and ongoing concern with (large) infrastructure investment projects is the experience in practice that such projects are often inadequately planned and executed. The technical characteristics of such projects are generally such that projects (Flyvbjerg 2009):

- are inherently risky owing to long planning horizons and complex interfaces;
- require non-standard technology and designs;
- involve multi-actor decision-making, planning, and management processes that are characterised by conflicting interests;
- lead to 'lock in' or 'capture' of a certain project concept at an early stage, leaving analysis of alternatives weak or absent; and
- are characterised by significant changes in project scope or ambition level over time.

These and other technical factors are often not adequately accounted for, making cost and time overruns and/or benefit shortfalls during project implementation the norm rather than the exception (Flyvbjerg 2009). Analysis of global projects indicates that the average cost overrun for large-scale infrastructure

projects ranges from 20-40 per cent, with around 90 per cent of projects worldwide involving material cost overruns (Cantarelli et al. 2010, Flyvbjerg 2009).

In practice, the factors that are typically key in explaining cost overruns and benefit shortfalls relate to (Flyvbjerg 2009):

- 'Planning fallacy' and 'optimism bias', whereby planners make decisions based on delusional optimism rather than on a rational weighting of gains, losses, and probabilities. As a result, the benefits of projects tend to be overestimated, while the costs are underestimated.
- Poor project outcomes and delays are amplified where projects are 'megaprojects': large-scale, complex ventures that typically cost US$1 billion or more (Flyvbjerg 2014). Megaprojects are increasingly used as the preferred delivery model for goods and services across a range of businesses and sectors, including in Australia (Ergas 2014).
- Megaprojects are inherently risky due to their long-term planning horizon, technical complexity, and multiplicity of stakeholders involved in planning and decision-making processes. The results are cost overruns, delays, and benefit shortfalls that undermine project viability during project implementation and operations; for instance Flyvbjerg (2014) found that nine out of ten megaprojects had cost overruns with cost overruns of over 50 per cent not uncommon and no sign of improvements over time and geography.

South West Illawarra Rail Link (SWIRL)

The Issue

The South West Illawarra Rail Link (SWIRL) is a proposed dual track freight and passenger line connecting the satellite city of Wollongong (which is 80 km south of Sydney) to the growth region of southwest Sydney. Currently, the main rail line between the Illawarra and Sydney is the South Coast Line, which services both passengers and freight. The line is slow because of the steep and winding terrain of the Illawarra escarpment. Average train speeds are less than 60 km/h, well below best-practice in leading global cities.

This lengthy commute for workers, students and day-trippers reduces economic and social opportunities for both Illawarra and Sydney residents in terms of accessing a wider range of jobs, business, trade, education, leisure and housing choices.

The SMART Infrastructure Facility undertook an economic analysis of the potential benefits of the SWIRL for the Illawarra Business Chamber. We set out the results of our cost benefit appraisal (CBA) and economic impact analysis (EIA) below to highlight the kind of analysis required to address the public infrastructure investment issues raised in this paper (discussed above).

Background

The Illawarra region, despite its geographic proximity to Australia's largest city, has historically suffered from relatively higher unemployment, particularly youth unemployment, in part due to poor transport connectivity to Sydney and a lack of industrial diversification. Traditionally a large employer of mining, mining services, steelmaking and port services, the Illawarra economy has often struggled to maintain healthy growth and low unemployment during mining downturns. SMART found that improving rail transport connectivity to Sydney can assist in providing labour market diversification and improve workforce participation (SMART 2017).

The potential economic and social benefits of better connecting the Illawarra to Western Sydney in particular have been highlighted in several recent studies, including the Greater Sydney Commission in its Draft South West District Plan (2016). The Commission cited the objectives established by Transport

for NSW in relation to improving north-south transport connectivity in south-western Sydney, including: "*improved public transport and freight connectivity to Port Kembla and the Illawarra*" (p.50).

A sensible lower cost approach to regional development would be to first develop Australia's satellite regions that are immediately proximate to Sydney, Melbourne and Brisbane. Such regions include the Illawarra, Ballarat and the Sunshine Coast. For example, in the 1990s the Pacific Highway between Brisbane and the Gold Coast was significantly upgraded and the Brisbane rail network now extends into the heart of the Gold Coast. As a result, there is practically no difference in the respective unemployment rates, and thousands of commuters travel between the two cities each day for work, study or leisure. Similarly, better transport connectivity between the Illawarra and Sydney (particularly Western Sydney) has the potential to open up jobs, education, housing and leisure opportunities for the over two million residents of the Illawarra and Western Sydney.

The Options

SMART was tasked with first examining whether it was possible to improve the efficiency of the South Coast Line and at what cost.

In theory, rail commute times can be reduced by: (i) shortening the distance travelled (via line straightening, reducing steep gradients, and tunnelling), (ii) increasing train speeds safely (which often requires line straightening and/or investment in new signalling technology), or (iii) investing in line duplication to reduce bottlenecks and congestion. Often, a combination of these measures is required to make a significant difference to commuting times.

SMART found that reducing passenger commute times on the South Coast Line is severely challenged by the geological conditions of the Illawarra escarpment and the consequent engineering challenges, such as in relation to tunnelling. SMART's high-level cost benefit analysis indicates that, in order to achieve a significant reduction in commute times between Wollongong and Central stations, an investment in the order of AUD$2 billion is required. This high cost is driven by the fact that the South Coast Line is built on the Illawarra escarpment and significant line straightening by way of tunnelling is necessary to improve commute times. Previous work on infrastructure cost drivers by SMART indicates that tunnelling costs would be in the order of AUD$150 million per kilometre.

Given the likely costs and operational impact of investing in, and completing significant improvement to deliver greater efficiency on the South Coast Line, SMART investigated the potential for an additional passenger and freight line between the Illawarra and Sydney, by completing the 35 km Maldon-Dombarton line (referred to in this report as the South West Illawarra Rail Link (SWIRL)), which was partially built in the mid-1980s. The rail link would connect the Main South Line (at Maldon) and the Moss Vale-Unanderra dedicated freight line at Dombarton. The 7 km rail link from Dombarton along the Moss Vale-Unanderra Line to the junction of the South Coast Line would require electrification. In sum, the SWIRL would comprise:

- completion of the original 35 km Maldon-Dombarton rail line;
- making the line a dual passenger/freight track (except for the two main bridges and the 4km tunnel) with electrification; and
- electrifying the 7 km section of the Moss Vale-Unanderra Line.

Our central estimate for the total cost of constructed the SWIRL as specified above is AUD$1,689 million in 2016-17 dollars.

In SMART's view, the SWIRL could meet the transport connectivity objectives set by the NSW Transport Department (TfNSW) at a lower cost and provide many economic and social benefits for residents of the

Illawarra and Western Sydney. For instance, the SWIRL and the South Coast Line operating together would increase total passenger and freight rail network capacity and open up jobs, business, trade, education, leisure and housing opportunities for both regions. A new line would also reduce the cost of congestion, short-term closures (for upgrades) or a catastrophic geological failure on the South Coast Line.

Key Findings

We found that there are potentially substantial net economic benefits that could accrue, in particular to the Illawarra and southwest Sydney regions, from completing the AUD$1.7 billion SWIRL. We have estimated a benefit-cost ratio (BCR) for a passenger-freight SWIRL to be between 1.02 and 1.24, with our central estimate at the standard 7% discount rate over 50 years being **1.13**. At a 4% discount rate over 50 years, which is the standard lower-bound estimate but in our view a more appropriate measure in the post-GFC world, our BCR central estimate is **1.56**.

It is important to note that whilst we recommend a discount rate of 4%, a standard rate of 7% is typically applied by Infrastructure Australia and Infrastructure NSW.

Table 1

DESCRIPTION (2016-17 DOLLARS)	LOW CASE $ MILLIONS	CENTRAL CASE $ MILLIONS	HIGH CASE $ MILLIONS
Freight travel time savings	111.786	124.207	136.627
Freight operating cost savings	296.233	329.148	362.063
Avoided externalities	169.294	188.104	206.915
Option value of South Coast Line failure	186.310	207.011	227.712
Passenger travel time savings and other benefits	835.223	928.025	1,020.828
Total private and social benefits (NPV, 7%, 40 years)	1,598.846	1,776.495	1,954.145
Total private and social costs (NPV 7%, 40 years) (Central estimate)	1,572.097	1,572.097	1,572.097
BCR (7%, 50 years)	**1.02**	**1.13**	**1.24**
BCR (4%, 50 years)	**1.40**	**1.56**	**1.71**

Source: SMART estimates.

SMART also estimated the economic impact on the Illawarra region of completing the SWIRL. Our detailed economic modelling identifies the benefit to the Illawarra region would be AUD$2.6 billion (in NPV terms at the standard 7%) and over 1,100 additional jobs per year on average (in FTE terms).

Table 2

ECONOMIC IMPACT ON… OVER THE PERIOD 2018 TO 2037	$ MILLIONS, REAL GRP 2016-17 DOLLARS (NPV, 7%)	EMPLOYMENT (ANNUAL AVERAGE 2018-2037)	EMPLOYMENT (AT PEAK)
Illawarra Region	2,579	1,119	1,367
Sydney Region	97	14	41
NSW	2,635	1,135	1,387

Source: SMART estimates.

Conclusions

There is no doubt that good next generation infrastructure can make our cities work better. The lessons that SMART has drawn together from both its theoretical, empirical and case study work is as follows:

- Commissioning new public infrastructure solely to boost short-term economic growth could have long-term negative economic consequences if that infrastructure is not fit-for-purpose and provide taxpayers with value-for-money.
- Public infrastructure investment needs to be considered on a case-by-case basis. Each project should be considered on its merits relative to a 'do nothing' and 'do incremental' case.
- Government infrastructure policies and institutional frameworks matter. How governments prioritise projects, seek independent advice on the best projects, manage demand with pricing and deal with distributional impacts all matter in terms of making NGI improve the functioning of our cities and our lives.
- In the Australian context, focussing on the regions closest to our major cities, such as Wollongong (Sydney), the Gold Coast and Sunshine Coast (Brisbane) is more likely to deliver greater benefits than first focussing on more regional and remote areas of Australia. This is because an overwhelming majority of Australians live in our 10 largest cities and this is where most of our GDP is generated. Improving the transport links into our major cities, such as by commissioning the SWIRL, will help both our major cities and their satellite towns operate more efficiently.

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