THE SOCIAL LOSSES FROM INEFFICIENT INFRASTRUCTURE PROJECTS: RECENT AUSTRALIAN EXPERIENCE

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STRENGTHENING EVIDENCE-BASED POLICY IN THE AUSTRALIAN FEDERATION

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Abstract:

Australian Government spending on infrastructure projects has increased rapidly in recent years, and especially so over the course of 2009. In this paper, we examine the processes for project evaluation, in the light of the Government's commitment, in the 2008-09 Budget, to "(infrastructure) decision making based on rigorous cost-benefit analysis to ensure the highest economic and social benefits to the nation over the long term .. (and to) transparency at all stages of the decision making process." We find that contrary to this commitment, significant projects have been approved either with no cost-benefit analysis or with cost-benefit analysis that is clearly of poor quality. Moreover, despite the commitment to transparency, very little information has been disclosed as to how most projects were evaluated.

To better assess the quality of project evaluation, we examine the largest single project the Commonwealth Government has committed to – the construction of a new National Broadband Network – and find that in present value terms, its costs exceed its benefits by somewhere between $14 billion and $20 billion dollars, depending on the discount rate used. We also find that it is inefficient to proceed with the project if its costs exceed $17 billion, even if the alternative is a world in which the representative consumer cannot obtain service in excess of 20 Mbps and even if demand for high speed service is rising relatively quickly. This amount of $17 billion is well below current estimates of the costs the NBN will involve, especially if (as the Government has pledged) the NBN is to serve non-metropolitan areas.

We also examine the cost-benefit assessment undertaken for the second largest infrastructure project the Government has committed to, which involves the construction of a rail link in Victoria. We find that lower-cost alternatives to the project were not taken into account in the evaluation, in particular the option of increasing capacity through improved efficiency and better governance of the rail network. Even taking that exclusion on board, we find that the appraisal that was approved by Infrastructure Australia (or at least, the only version of that appraisal that has been made available) is seriously flawed, including errors of double counting and manifestly incorrect estimates of project benefits. Absent these errors, the project would generate benefits that fall well short of its costs.

We conclude by noting that high quality project evaluations will not be made if governments do not see value in them. This appears to be the case in Australia, especially with respect to major projects. Nonetheless, we advance a number of proposals for improving the process, including transparency (which is now largely lacking), serious audits and reappraisal of projects at predetermined milestones and steps to introduce greater rigour into key aspects of the analysis.

"The core of public finance", as Jurgen von Hagen has succinctly put it, "is that some people spend other people's money"[1] This separation between spenders and payers gives rise to a wide range of problems of accountability and control (which economists typically analyse under the rubric of 'principal-agent' problems), reflecting divergences of interest between these parties and the inability of voters and taxpayers to costlessly and perfectly discipline the behaviour of those who spend money on their behalf. These problems are aggravated by the fact that the spenders themselves are not a monolithic entity. Even if spenders as a whole face the collective consequences of their decisions, each individual spending unit (such as a Minister, a Department or a territorial level of government) may view the stock of available public funds as a 'common pool' (like an open seas fishery), which it can draw on at a fraction of the resulting opportunity cost while still garnering for itself all or the bulk of the political benefit. The scope to transfer the costs of wasteful projects to future generations, which have little or no voice in the political process, as well as to future governments (which will bear the political consequences of 'pulling the plug' on failed ventures), then makes the risks of inefficient outcomes all the greater.

There are broadly three sets of control mechanisms that are commonly used to limit these risks: *ex ante* rules that shape taxing and spending powers; budget processes, that signal the opportunity cost of public funds and manage resource allocation so as to control, if not prevent, externalities between spending agents (including those associated with common pool problems); and political competition and accountability, that, however effectively or ineffectively, discipline 'poor' uses of resources and reward 'good' uses. The role of formal project appraisal within these control mechanisms, and the effectiveness with which it is implemented within the Australian Federation, is the central concern of this paper.

The specific focus is on the processes used in the economic evaluation of major infrastructure decisions. Particularly since the election of the Rudd Labor Government in 2007, very significant increases have occurred in public infrastructure outlays. According to the Minister for Infrastructure, Transport, Regional Development and Local Government, Anthony Albanese:

> *.. for the six year period up to 2006-07 total road expenditure by the Commonwealth totalled $16 billion. In comparison, this Government has committed $28 billion to road investment over the six years – the biggest road investment program in our nation's history. On top of this, we are spending $7.9 billion over 6 years on passenger and freight rail .. All up, we are spending more on rail in the next 12 months than the previous government did in 12 years.*[2]

And to these amounts must be added the Government's commitment to the construction of a new national broadband network, which could involve a cost of up to $43 billion.

Many of these decisions involve individual projects whose costs exceed a billion dollars; if those projects' costs exceed their benefits, the result is to make future generations poorer. The public stake in proper project evaluation is therefore great and indeed, has been stressed by the Government itself. Thus, in its 2008-09 Budget, the Government committed to "(infrastructure) decision making based on rigorous cost-benefit analysis to ensure the highest economic and social benefits to the nation over the long term .. (and to) transparency at all stages of the decision making process"[3]. Serious concerns have, however, been expressed about the extent and quality of project evaluation in Australia. Although there is a long history of use of Cost-Benefit Analysis

[1] Von Hagen (2006), page 464.

[2] Address to the BITRE 2009 Infrastructure Colloquium, 18 June 2009.

[3] 2008-09 Budget Paper No. 1, Statement 4, page 14-15.

(CBA) (see Dobes 2008 for a survey), recent years have seen increased emphasis placed on other, less rigorous, approaches to project evaluation (see Dobes and Bennet 2009 and Ergas 2009). And some important infrastructure decisions appear to have been taken by Australian governments without any systematic assessment of their costs and benefits.

So how robust are our project evaluation processes? In examining this question, we proceed as follows. We start by setting out the nature and role of CBA, and especially its bearing on efficient resource allocation and on the control of principal-agent problems in government. That discussion highlights just how important CBA is to serious project appraisal, and to helping to control the risks inherent in a situation where very large projects, offering highly concentrated benefits but with very diffuse costs, are being vigorously advocated by powerful private interests.

On that basis, we examine the situation in telecommunications. In essence, neither the Howard government (1996-2007) nor its successor placed any weight on systematic analysis of the costs and benefits of major telecommunications decisions. The most spectacular recent instance is of course, the decision to build a “National Broadband Network” (NBN) with significant taxpayer funding. As the government has stated that no CBA has been, or will be, undertaken of this decision, we carry out such an assessment, using an engineering cost model to estimate the project’s incremental costs. We also estimate a range for consumer Willingness to Pay and its evolution over time. We then define some counterfactual scenarios, including one that involves postponing deployment of the NBN. Our results suggest that the incremental benefits of the NBN, when compared to the counterfactual scenarios, do not justify the incremental costs.

Given that evaluation of project decision-making in telecommunications, we turn to transport. We outline some major trends in transport CBA in Australia, including those resulting from the creation of the Building Australia Fund and the establishment of Infrastructure Australia as a policy advisory body. To assess the quality of the evaluation processes, we undertake a detailed analysis of the East-West rail project in Victoria. Although that project involves several components, some of which are not now proceeding (or have been deferred), it remains extremely large and has now received very substantial funding from the Commonwealth. However, this is a project which, even in its sponsor’s CBA, had benefits that were not far above costs. Our examination of that CBA raises a number of concerns, including double counting of benefits and substantial difficulties with the approach the CBA adopts to the calculation of the project’s ‘wider economic impacts’ (essentially, pecuniary externalities associated with the project).

Overall, our review suggests the following conclusions:

- Insufficient attention is paid in the evaluation process to options that would avoid investment, or more broadly, that would focus on securing greater efficiency from the existing capital stock. Simply put, infrastructure investment appears to be viewed as a benefit, rather than a cost;
- The distortions arising from this undesirable narrowing of the range of options considered are then compounded by evaluations that are too vulnerable to ‘fudge factors’. In a Gresham’s Law of evaluation, bad evaluations (often by consultants) can drive out good, given that they trade at equal values.

In our view, these outcomes are driven by governments that see little real value in major project evaluation. They may see merit in evaluation of essentially routine decisions (such as the decision to place a new roundabout or improve a road surface) or in cost-effectiveness analysis of the options available for meeting pre-determined goals (such as improving bus transit in a congested area) but not in the full analysis of objectives and options (including the option of not spending taxpayers' money). This, we argue, reflects the impact of a perception (initially due to strong economic growth, and then to a belief that the global financial crisis justifies greatly increased outlays) that public funds have a negligible opportunity cost. This perception has been accentuated by the growing blurring of accountability in the Australian federation, which reduces the budget disciplines on the States, and the blurring also of responsibility for financing infrastructure as between the public and private sectors (which, whatever its other merits, increases the return to rent-seeking deals between governments and private infrastructure developers). Together, these trends risk making CBA merely a box to be ticked, rather than an exercise that has real value, not least to government itself.

We are not optimistic that changes to CBA processes alone can counteract these powerful trends. Nonetheless, we think three changes would have merit:

- A requirement for all CBAs to be disclosed – which would also highlight which projects had not been subjected to economic project evaluation;
- Far greater, and systematic auditing of CBAs, both at the stage of the financing decision and post-project completion. In contrast, there is little or no such audit currently, and in many instances, CBAs are not even updated, maintained or properly archived after the initial 'go/no go' decision is taken;
- The establishment of a centre of excellence or reference for CBA within the Commonwealth government, preferably in an independent entity, such as the Productivity Commission.

The Little/Mirrlees rule (discussed below) suggests that the value of proper project appraisal is at least 10 percent of the value of projects. With Australia spending ever more on infrastructure, these are gains well worth seeking. Whether they can be achieved is obviously an open question.

THE NATURE AND ROLE OF COST-BENEFIT ANALYSIS

We start our survey of Australian project evaluation by setting out some background to the role of Cost-Benefit Analysis (CBA) in the public finance process.

In essence, CBA is a technique for evaluating collective decisions that hinges on the comparisons of the costs of a proposal to its benefits, where costs and benefits are valued in monetary terms. Cost-benefit analysis asks whether the sum of the amounts the individuals who comprise the community at issue would be willing to pay for the project to proceed exceeds the costs of that project. Generally, a project enhances wealth – in the sense of the aggregate monetary valuation of the community's resources – if it meets a properly specified cost-benefit test.

CBA can be viewed in four, complementary, perspectives.

First, CBA is related to (though not identical with) the basic equi-marginal condition for overall efficiency in resource allocation. Thus, given a cardinally measurable objective function and perfect knowledge of the effect on welfare of any decision, it is a condition of an optimal set of decisions that the marginal dollar of public expenditure has a benefit equal to that of the marginal dollar of private expenditure (thus assuring that the overall level of public expenditure is optimal) and that the benefit of a marginal dollar of public expenditure is equalised across programs, projects and project elements. Because CBA aggregates willingness to pay across agents with different marginal valuations of income, it is not a perfect measure of underlying utility (and hence cannot be treated as an ideal social welfare function); nonetheless, taking that important caveat as given, one would at least question whether a set of public decisions was optimal if it did not maximise the aggregate benefits obtainable for given aggregate costs or minimise the aggregate costs required to obtain a given aggregate benefit, in each case, measured using CBA.

Second, set against the backdrop of a given portfolio of projects, CBA can be used to evaluate whether one or more public projects should be added to or removed from that portfolio. In other words, CBA is a tool that can be used to asses whether wealth (the difference between the aggregate valuation of outcomes and the cost of obtaining those outcomes) would be increased by the decision to (say) proceed with a particular project, compared to the relevant alternatives (which may involve doing nothing, deferring or otherwise varying the project, or proceeding with an alternative project). Whether enhancing wealth in this sense is either necessary or sufficient for a project to be worthwhile is a complex issue. Without going into the details of that discussion, it seems reasonable to suggest that projects that fail properly specified cost-benefit tests should be looked at very carefully, and found to have other, significant, redeeming features, before they are allowed to proceed. By the same token, if a project has benefits that (evaluated in willingness to pay terms) clearly exceed its costs (i.e. the net benefits of forgone alternatives), it seems reasonable to presume that absent compelling reasons to the contrary, society would gain were it to proceed.

Third, CBA is an instrument that the principals in public sector governance can use to improve the decisions taken by their agents, and to enhance their supervision of those agents.[4] Thus, for a CBA to be properly conducted, the evaluator has to go through the key elements of proper policy analysis, namely, specification of the objectives being sought, identification of the alternative options for achieving those objectives, an analysis of the likely consequences of each such option, and consideration of the risks (including of error in evaluation) that attach both to each option and to the assessment as a whole. Moreover, whether a properly specified CBA has been undertaken should be readily verifiable. As a result, the requirement to carefully assess, and report, the costs and benefits of decisions can improve the quality of decision-making and reduce the information asymmetry between principals and agents. In doing so, it can:

- Help reduce the risk of “capture”, in which the agent’s decisions, rather than reflecting the interests of the principal, come to be determined either by the agenda of self-interested third parties or by the agent’s own interests and aspirations. Capture risks are especially great in areas such as infrastructure where the benefits of greater spending are highly concentrated while the costs of that spending are very widely spread;

- Help correct “policy bias”, which is a situation in which those working in an agency have policy commitments that differ from (and may undermine) those of the public, as can occur when traditions dictate a particular response to particular types of problems, even though the circumstances which may have made that response appropriate in previous times no longer hold;

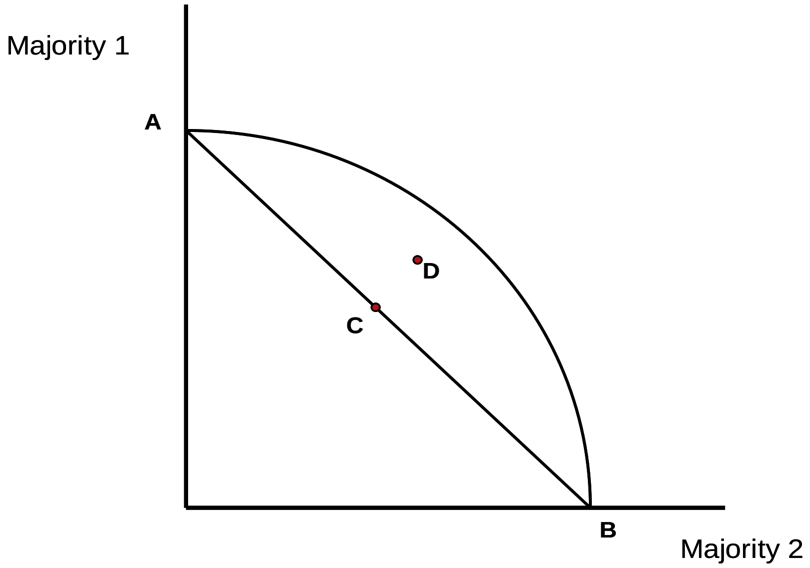
[4] See for example Adler and Posner (2006), Posner (2001), Spence and Cross (2000).

- Help overcome "shirking", in which agents do not exercise as much diligence in taking decisions as would be warranted;
- Help disclose and correct the cognitive biases that affect decision-making, including the tendency to confuse the unfamiliar with the improbable, and more generally to under-estimate the risks of a course of action when its benefits seem large, and under-estimate the benefits of a course of action when its risks seem large[5];
- Increase consistency in decision-making, both by standardising the information base on which decisions are taken and by highlighting anomalies, such as differences between project appraisals in the valuation of common elements; and
- Improve performance auditing and accountability, by providing a standardised *ex ante* statement of key expected values for costs and benefits, thus allowing readier *ex post* identification of variances from those expected values and encouraging analysis of the causes of those variances, which (importantly) can facilitate learning and continued improvement in the decision-making process.

Ultimately, all of these effects mean that cost-benefit analysis is never merely an analytical tool: rather, as Aaron Wildavsky emphasised many years ago (Wildavsky 1966), it is inevitably an instrument in shaping bureaucratic structure and process, both within each public sector body and between that body, the other elements of the public sector with which it interacts, and the wider political system.

Fourth and last, CBA can be anchoring device that reduces undesirable policy instability. Thus, consider a situation in which government alternates between two majorities, 1 and 2, whose pivotal voter preferences are for project portfolios A and B respectively, as indicated in Figure 1.

Figure 1 **Policy instability**



[5] As Thomas Schelling observes in his introduction to Roberta Wohlstetter's classic study of Pearl Harbour, "There is a tendency in our planning to confuse the unfamiliar with the improbable. The contingency we have not considered seriously looks strange; what looks strange is therefore improbable; what is improbable need not be taken seriously." Schelling in Wohlstetter (1962) at p. vii.

Although A and B are on the welfare frontier (which is convex because asymmetric information makes all social transfers costly, i.e. imposes a deadweight loss or excess burden of taxation), the expected value of the sequence of policy choices is the interior point C. Systematic application of CBA could then lead to a point such as D, which falls short of the frontier (because CBA is not a perfect measure of underlying utility and in any event, will involve errors in application) but which is still superior to C (Laffont 2000). In essence, in this setting, CBA acts to give greater legitimacy and wider credibility to policy choices, and hence makes them less vulnerable to displacement. The resulting gains are obviously all the greater if, in the alternative world, policy instability leads to programs being initiated, causing significant costs to be incurred, only to be terminated before their benefits are obtained.

For all of these reasons, CBA has been widely recognised as a central component of proper project appraisal. We therefore now turn to consider its role in recent infrastructure decision-making, beginning with telecommunications and then proceeding to transport.

TELECOMMUNICATIONS

We start by explaining the relevant context and then examine recent decisions in the light of cost-benefit analysis.

Context and background

The background to recent telecommunications decisions is set out in Ergas (2008). Two trends dominated the period leading up to the 2007 change in government.

First, an impasse developed in relations between Telstra and the Commonwealth government over the issue of upgrading the Australian telecommunications network to higher broadband speeds. Simply put, Telstra was unwilling to undertake that upgrading without substantial regulatory reforms that would have protected the required investments, while the government was unwilling or unable to convince the regulator (whose discretionary powers would have been significantly curtailed, as they had been in the energy industries) to accept the proposed reforms.

Second, the Commonwealth engaged a wide range of spending programs (with appropriations totalling close to $4 billion, in 2008 prices) aimed at promoting service upgrading, usually in regional areas, and implemented an ever broader and more draconian range of quality of service regulations.

None of these spending initiatives or quality of service regulations was ever subjected to proper cost-benefit analysis (or if such analysis was undertaken, it was never disclosed). However, an analysis by one of the authors found that in 1999, the total benefits associated with addressing claimed service quality problems (including in terms of consumer gains and network-related cost savings) were between $644 million and $713 million in present value terms over the length of the project life. These benefits were outweighed by the costs which (again in present value terms) were estimated at $1,387 million over the project life (Hardin and Ergas 1999). Despite this, the Howard government proceeded with the quality of service requirements and made them even more stringent in subsequent years.

The lack of attention to systematic evaluation of the costs and benefits of policy initiatives has continued under the Rudd government. Upon being elected, the government launched a request for proposals for a network that could deliver a capability of at least 12 Mbit/s to 98 per cent of the Australian population. That process closed at the end of January 2009 without any of the proposals received being considered satisfactory. Following the failure of that process, the government announced on April 7 2009 that it had decided to build a National Broadband Network (NBN) which – at a cost that could reach $43 billion – would provide fibre optic connections (at speeds of 100 Mbit/s) to all premises in towns of 1000 people or more, which equates to coverage of some 90 percent of the population. 'Next generation' wireless and satellite would be used to deliver 12 Mbit/s to the remaining 10 percent, with simultaneous deployment of the new network (which is to operate on a 'wholesale only' basis) in urban, regional and rural areas. Additionally, the government announced that it would initially own at least 51 percent of the new network, although it could "sell down" its equity interest within 5 years of the network being fully constructed.

As regards evaluation of the costs and benefits of the proposals, Communications Minister, Senator Stephen Conroy, when asked by the Opposition whether a cost-benefit study had been carried out of the proposed expenditure, said (according to a report in Communications Day of May 13th, 2009), that there was "no need" for such a study, as "Labor's commitment to build a high speed broadband network has been clear... A range of studies have been carried out all over the world that have investigated the economic impact of broadband." Senator Conroy also said, still in responding to Opposition queries, that "We don't need any more studies, any more cost benefit analyses, to know that this is an infrastructure investment that this country is crying out for. How many reports do they [the Opposition] need before they just accept that they have been responsible for leading [to] Australia falling behind the rest of the world?" The Finance Minister, Lindsay Tanner, then confirmed that no cost-benefit study had been carried out and that none was envisaged, because "We just formed the view that in effect we had to make the clear decision that said this is the outcome we are going to achieve come hell or high water because it is of fundamental importance to the future of the Australian economy'' (Bartholomeusz 2009).

Since then, one study, by Professor Joshua Gans, has been submitted as evidence to a Senate inquiry into the NBN (Gans 2009). Although its author notes that the calculations are essentially back-of-the envelope, the submission suggests that the social benefits of the NBN will exceed the costs. However, these calculations are seriously flawed. They understate costs, as they exclude obvious cost items such as operating and maintenance expense, depreciation and backhaul. They overstate likely revenues, as they confuse wholesale and retail prices and outlays. They also confuse benefits and transfers, treating reductions in profits as a social gain (when they are merely a transfer). These deficiencies are summarised in Appendix A. Even more seriously, however, Professor Gans' submission uses the wrong test for assessing whether a project is worthwhile: it compares total costs and benefits, when the correct test is whether the incremental gains from the project (relative to network capabilities in the base case) exceed the associated incremental costs. Even if the total benefits (as measured by aggregate willingness to pay) exceeded total costs (which is far from clear), this would say nothing about whether society gained by undertaking the project, as the project's incremental benefits might be less than its incremental costs.[6]

Before turning to examine the project's costs and benefits, however, it is useful to undertake a wider consideration of the relevant decision. In particular, it is uncontroversial that sensible policy evaluation requires a specification of the problem to be addressed and of the policy options which

6 Under reasonable conditions, the correctly measured willingness to pay for a quality improvement that raises the demand curve is given by the *increase* in conventional consumer surplus resulting from that improvement: see Bradford and Hildebrand 1977.

might be available for addressing it. As a result, it is reasonable to ask what the precise problem the NBN is intended to resolve is, and what other means might have been used to do so.

The government's primary concerns appear to be with the availability of broadband access and its price. However, the data the government has cited as to availability actually refers to take-up of broadband services, and hence might be more indicative of the demand for broadband than of its supply. This is all the more probable given that broadband availability appears to greatly exceed demand, with some 80 percent of PSTN lines being connected to ADSL2+ enabled exchanges and close to 50 percent of copper lines being short enough deliver very high speeds. Moreover, competing hybrid fibre coax networks (which currently deliver up to 30 Mbit/s but which can, at relatively low cost be upgraded to much higher speeds) either pass or run very close to some 60 percent of premises.[7] Despite all of this, high speed fixed services account for a relatively small share of total broadband services.[8] It is therefore not implausible that penetration levels simply reflect consumers' low valuations of the incremental benefits of higher speed fixed network access.

A similar picture emerges as regards business access to high speed broadband. Competing, ubiquitous fibre networks cover all of the capital city Central Business Districts (CBDs). Larger business premises outside the CBDs are almost always on direct fibre optic connections, even in non-metropolitan areas, as are premises such as hospitals and government offices. Smaller businesses have access to business parks, which are almost invariably on fibre access networks, and those smaller businesses that operate in activities where high speed communications are an important element tend to locate in those business parks (where they can also benefit from other economies of agglomeration). Symmetric high speed services over copper (such as BDSL) are available in virtually all urban locations and in many regional centres. There is, in short, no evidence of any absence of business access to high speed broadband networks.[9]

Nor is there evidence that suppliers of social services lack access to high speed services – indeed, the opposite is the case. Thus, according to the Commonwealth Government's own *National Baseline of School Broadband Connectivity* 2008, "The majority of schools in metropolitan locations reported using fibre (51.6 per cent) and most schools in provincial locations also reported using fibre (46.5 per cent)." However, despite having high speed access, most schools "use download speeds of up to 4 megabits per second, which is the lowest download speed range used in the FCS baseline survey. This disparity may be due to affordability of the service or the specific contractual arrangements negotiated, throttling and issues relating to the availability of suitable online curriculum resources and tools." In other words, availability does not appear to be the constraint the NBN deployment assumes.

7 Low incremental costs for HFC upgrade are discussed in Soria and Hernández-Gil 2009, as well as in Telstra 2008A, 2008B and 2008C. It is worth noting that according to *Communications Day* of 31 July 2009, Telstra will upgrade its HFC network in New Zealand to 100 Mbit/s for NZ$10 million. The cost of deploying the proposed FTTP network in those coverage areas is likely to be at least 10 to 20 times greater.

8 Thus, according to Telstra's most recent annual results, released on August 13 2009, Telstra's wireless broadband subscriptions doubled over the year to reach over 1 million (this does not include customers with 3G handsets; rather, it solely covers the number of data card subscribers). In contrast, Telstra's high speed services (20Mbit/s plus) had 241,000 high-speed subscribers in June 2009, up from 160,000 the previous year. This represents about 10 per cent of Telstra's broadband customers. See http://www.telstra.com.au/abouttelstra/investor/docs/tls685-fyr2009esultsannouncement.pdf.

9 Moreover, as we note below, residential mobility and new household formation rates in Australia are relatively high. As a result, consumers who value high speed access highly will tend to move to locations at which access is available and incur low incremental costs from doing so. Moreover, we are unaware of any evidence of a residential housing price premium associated with access to high speed broadband. These elements suggest that latent demand, and welfare losses from lack of access, are likely to be low.

As to prices, Australian broadband prices are in upper half of OECD comparisons. However, prices in a number of countries are distorted by subsidies, and those subsidies would need to be added back, along with a mark-up to reflect the marginal social cost of funds, for a welfare comparison to be made. Additionally and importantly, there is significant competition in Australian broadband supply and key input prices are regulated. Service supply to CBDs and business parks is intensely competitive, as is the wiring of new residential estates. As for established premises in metropolitan areas, broadband is widely provided by Telstra's competitors using Telstra's Unconditioned Local Loop Service (ULLS, a regulated service that provides third party access to the copper pair). As is shown in Appendix B. Australian regulated ULLS charges are relatively low in urban areas, while take-up of ULLS has increased very rapidly. Thus, in the 18 months to March 2009, the number of ULLS lines in all areas more than doubled to well over 600,000. This increase has been accompanied by a growing presence of ULLS access seekers in Telstra exchanges, with the number of Telstra exchanges with three or more competing ULLS access seekers rising from 155 to 300, while the number of exchanges with less than three access seekers shrank. It seems unlikely that retail prices that substantially exceeded costs (i.e. high mark-ups over input charges, which are low and regulated) could persist in the face of such large-scale competitive entry; rather, the more logical inference is that retail prices for high speed broadband broadly reflect costs, which are relatively high in Australia due to population geography[10], high costs for content and high expectations of service reliability and costly technical support.

As for non-metropolitan areas, the case that supply is failing to keep up with demand is also weak. Thus, these areas have already benefited from large scale subsidies both to supply and to demand, but the gap in penetration levels persists (though it has tended to narrow). Tasmania, which the government has selected as the first location for deployment of the NBN, is a case in point. State and Commonwealth initiatives have seen well over $100 million spent in Tasmania on broadband subsidies since 1999 with limited tangible outcomes to date.[11] More generally, existing high speed access facilities in non-metropolitan areas (such as fibre deployments in Ballarat, Cooma and the Green Triangle, as well as fibre optic deployment in new 'sea changer' estates) appear to have low utilisation and in some cases, are poorly maintained and hence are being run down. Overall, these outcomes, like those above, suggest that the primary obstacles to take-up may lie in low customer demand, which implies low customer valuation of any new network.

This is not to say that there are no issues with respect to investment in, and the upgrading of, Australia's telecommunications network – the opposite is true. As argued in Ergas (2008A, 2008B), the current telecommunications-specific access regime vests enormous and unwarranted discretion in the regulator; in this industry as in others, such discretion creates a risk of time-inconsistency, i.e. of regulatory decisions which *ex post* expropriate the returns on socially worthwhile investments.[12] To that extent, an option for the government would have been that of

10 The average spacing between residential premises in metropolitan areas in Australia is nearly twice that in the United States and over three times that in Europe.

11 This includes the funding secured by Senator Harradine in 1996 in exchange for his support for the initial tranche of the Telstra privatisation. Since then, there has been little transparency in the Commonwealth funding allocations, so the actual outlays may be significantly greater. There has also been considerable State government spending on broadband, including the core funding for the TasCOLT FTTP trials. As for take-up levels, while the gap between Tasmania and the rest of Australia has narrowed in recent years, it remains substantial (with Tasmanian broadband penetration about half that in the ACT, which has the highest levels in Australia), reflecting lower income and education levels and a higher average age in the population.

12 Simply put, time inconsistency refers to situations where a policy that is optimal (from the point of view of the policy maker) ex ante turns out not to be the optimal policy ex post. If the policymaker cannot commit to a policy, it may then find itself wanting to change its policy ex post (say, after a regulated firm has made an irreversible investment decision), regardless of what it promised ex ante. Such an approach to policy is said to be time-inconsistent – see

reforming the regulatory arrangements (along lines already adopted in the energy industries) so as to provide greater investor confidence, and then seeing whether socially desirable investment in network upgrading materialised.[13] As for areas where service is commercially unviable, these could have been dealt with at relatively low cost through a voucher scheme, which would have the merit of being technologically and competitively neutral (Ergas and Ralph 2008). There is, however, no evidence, at least in what material has been disclosed to date, that the costs and benefits of those options were assessed relative to the option of simply building a new network.

The economics of the new network

What then can be said about the costs and benefits of the new network? To examine the underlying economics, we have used a cost model developed by Concept Economics.[14] The model describes the rollout of a fibre to the home (FTTH) network with a footprint covering 90 per cent of the Australian population by modelling the construction cost of new infrastructure.

The model's geographic coverage is differentiated at a high level between metropolitan and non-metropolitan areas. A bottom-up modelling approach is used, building the required infrastructure up from assumptions on the:

- Number and approximate geographic distribution of current exchange areas;
- Total number of services;
- Average line densities;
- Average frontage of a metropolitan or non-metropolitan housing block; and
- Average number of lines per housing block.

From these assumptions, the model derives the average size of the metropolitan and non-metropolitan exchange areas and the length of main and distribution cables.

Current exchange areas are further aggregated to account for the substantially longer reach of fibre technology compared to copper. Based on the maximum fibre length defined in ITU-T standard (G.984.1), the aggregated exchange area is determined and the main cable is extended from estimated current exchange locations to the aggregated exchange.

The core transmission network is not explicitly modelled, but investment costs are inferred from annual lease cost data and from assumptions on required contention ratios, or Committed Information Rates.

As regards capital costs, we have assumed a Weighted Average Cost of Capital (WACC) in which the cost of equity is determined according to the Capital Asset Pricing Model. This reflects three considerations. First, this investment substitutes for private sector investment in competing

Kyland and Prescott 1977. Specific applications of the concept to regulated industries can be found in Evans,. Levine and Trillas 2008, Guthrie 2006 and Levine, Stern and Trillas 2005. A test of whether ACCC decisions in telecommunications are time-inconsistent (with the conclusion that they are) is in Ergas 2009.

13 Obviously, some care is required in the design of such an option. In particular, if there remains a material threat of the government expropriating the returns on that investment, for example by subsequently building a network of its own, then socially desirable investment may be deterred. A systematic discussion of the conceptual issues involved can be found in Jullien, Pouyet and Sand-Zatman 2009.

14 The model was developed by Dr Dieter Schadt, and we are grateful for his assistance in this respect. Obviously, he bears no responsibility for our use of the model's results.

infrastructure. Use of any other cost of capital than that for the private sector alternative will distort resource allocation as between the public and the private sector – see for example, Steiner 1974. Second, the government has confirmed on a number of occasions that it intends the project to earn a commercial rate of return, suggesting that it values capital devoted to this project at that rate of return. Third and last, investing in a new broadband network has a high level of systematic risk. As a result, the Arrow-Lind conditions for use of the risk free rate as the discount factor (which depend on the assumption that the benefits of the investment are independent of variations in overall incomes) do not hold in this instance, and the cost of the project to taxpayers must reflect the project's systematic risk.[15] For modelling the base case, we have therefore assumed an asset beta of 0.825, which is consistent with the upper bound of Telstra's beta estimate of the CAN for a range of services. We believe this value is conservative, as it presupposes that returns from the new network are no more sensitive to economic conditions than Telstra estimates for its legacy copper network.

The model is designed to allow testing of the sensitivity of the results to a range of variables. Some of these variables are:

- Rollout schedules for metropolitan and non-metropolitan areas;
- Percentage of new trenching required and lease rates on existing trenching;
- Extent of aerial deployment;
- The level of backhaul construction required;
- Overall network architecture, i.e. GPON or a P2P; and
- The splitter ratio for the GPON architecture (with a default ratio set to 1:32).

Setting these variables to their base case levels (which involves a GPON architecture), we estimate a final retail cost per customer (on a nationally averaged basis) of just over $170 per month. This amount is the cost of the access network plus the cost of backhaul to the service provider's network, and an allocation for usage and other retail costs. It is, in other words, broadly comparable to the charge for a broadband service, minus the cost of any content.

While both the input assumptions and the outcomes are broadly consistent with studies undertaken in other countries – see for example Analysys Mason 2008 – the cost estimates are sensitive to a range of assumptions, including with respect to consumer take-up rates and cutover arrangements, the extent of aerial deployment, the project cost of capital, achievable operational efficiency improvements and the quality of service provided. Variations in those parameters lead to a possible range for unit per-customer costs of between $125 per month and $225 per month. There is also very significant variation in costs as between metropolitan and non-metropolitan areas. Thus, for the most likely estimate of $170 per month, unit costs in metropolitan areas are of $133 per month, while those in non-metropolitan areas are just under $380.

Given these sensitivities, we have run a variant which seeks to minimise unit costs, including by assuming that eventually, all premises will subscribe to the service. This variant, which also sets

[15] In a classic article, Arrow and Lind showed that if a government project is 'small' (in relation to the total wealth of taxpayers) and 'the returns from a given public investment are independent of other components of national income', then the social cost of risk for project flows that accrue to taxpayers tends to zero as the number of taxpayers tends to infinity. The required assumption, in other words, is that the returns from the project are not related to (in the sense of being dependent on) income from other investments in the economy. See Arrow and Lind 1970.

initial service quality to relatively low but perhaps not inappropriate levels (in terms of the Committed Information Rate used to dimension backhaul) and somewhat reduces the WACC, only slightly reduces unit retail costs in metropolitan areas but could reduce unit retail costs in non-metropolitan areas to around $280 per month. Nonetheless, even these costs are high compared to current charges. They are about double the level of current non-content payments for telephony and broadband service (i.e. the sum of the monthly rental and of the non-content component of DSL charges) in metropolitan areas and three or more times those in non-metropolitan areas.[16]

These costs need to be compared to alternatives. The most straightforward counterfactual involves continuation and some upgrading of the current copper-based network alongside progressive upgrading of the HFC, with copper delivering speeds of some 20 to 40 Mbit/s and the HFC delivering speeds of 50 to 100 Mbit/s. Incremental and selective upgrading to fibre optic would occur over time, with fibre optic likely reaching 30 per cent of premises by the end of the next decade, either directly, i.e. on an FTTP basis, or extending to the curb. The costs of this scenario could be in the order of one-third those of the NBN in the metropolitan and regional areas, up to around 80 per cent of the population. As for remaining areas, these would primarily be served by wireless, at costs that would be around one-half those of the NBN, with speeds of 10 to 30 Mbit/s. Regulatory reform that increased investment certainty would make the progressive upgrading that took place in this counterfactual both quicker and more extensive.

Incremental cost based retail network charges for broadband service per connectable premise under the counterfactual would therefore be in the order of $50-70 per month in metropolitan areas, rising to around $80-100 per month in regional areas, with a difference relative to the NBN scenario of around $75 a month in metropolitan areas and of $120 per month in regional areas (noting that the regional areas have less population coverage than is envisaged for the NBN, so that the like-for-like comparison involves assuming a regional cost-based rate in the NBN of around $210). Broadly speaking, the additional outlays (of $75 a month in metropolitan areas and of $120 per month in regional areas) allow speeds to rise to 100 Mbit/s in one step. However, this benefit is somewhat qualified by the fact that deployment of the new network may take 7 to 10 years (if not longer), but the prospect of that deployment may prevent the somewhat more limited, but sooner in time, upgrades that would otherwise have occurred from occurring.

The question then is whether the valuation of the incremental speed associated with the NBN outweighs the incremental costs. In considering this, it is important to remember that most currently envisaged applications function reasonably efficiently at speeds well below those contemplated either in the NBN world or in the counterfactual. Thus, over time, advances in compression and coding tend to reduce bit rate requirements, to some extent offsetting the tendency for applications to become ever more 'content rich'.[17] As a result, even high definition broadcasting and high definition video-on-demand have peak transmission requirements of less than 20 Mbit/s. While there are some symmetric services (such as very high quality videoconferencing) that could benefit from higher speeds, the difference in delay and overall service quality between (say) 30 Mbit/s and 60 Mbit/s would only rarely be discernible. This is all the more so as once the access network operates at reasonably high speeds, the relevant constraints on service quality are likely to come from performance in the core network (i.e. the

[16] They are even higher when compared to the access payments made by the average residential premise, remembering that about 30 percent of households do not subscribe to any form of broadband service. Relative to those current average monthly payments, they are more than twice the current average monthly payments in metropolitan areas and about four times those in non-metropolitan areas.

[17] With MPEG4, for example, High Definition video can now be transmitted at 8Mbit/s, which brings it within the range of 12 Mbit/s DSL.

links between the first point of traffic aggregation and the global Internet), with further increases in access network speeds having little effect. Holding all else constant, it is therefore reasonable to expect the valuation of further reductions in download time to decline as average download times themselves decline (i.e. as speeds increase). The median consumer's Willingness to Pay (WTP), taken as a function of service bit rate, would, in other words, increase more slowly for successive increases in speed.

This can be illustrated using the standard Becker time-allocation model (Becker 1965). Thus, adapting that model, consider a consumer who spends time either working or downloading. The consumer derives incremental benefits from an increase in download speeds, as this frees up additional time for working, boosts the individual's labour supply and widens the individual's consumption possibilities.[18] Naturally, the incremental benefits are higher for those earning higher wages (i.e. who have a higher opportunity cost of time), but all else being equal, the incremental benefits decline with the square of the speed.[19] For any given set of applications, the valuation of speed will therefore be significantly concave, though the location of the valuation curve will shift over time, as 'bandwidth hungry' applications develop and as a greater number of consumers attain a utility level from access to broadband that induces them to obtain the service (i.e. that exceeds the service's start-up costs). Appendix C details the model.

Incremental Willingness to Pay and Net Benefits for the New Network

Given these considerations, we have undertaken an assessment of the costs and benefits for the project. As with any such assessment, a substantial number of assumptions need to be made. In this section, we explain the approach we have adopted.

A cost benefit analysis should assess the incremental benefits and costs of the project, and then compute the incremental benefits net of incremental costs. To this end, we consider a median consumer over the next twenty years. This representative consumer has a willingness to pay (WTP) curve for higher speeds, which (for the reasons set out above) is increasing but concave as speeds increase. In addition, we assume that this willingness to pay curve is growing over time with increases in income, the development of new applications, and possibly 'bandwagon effects' in demand.

Computing incremental benefits of a project requires specification of a baseline scenario with which to compare the project scenario. We consider three such scenarios, which entail the following alternative comparisons:

Scenario A

- **Baseline:** The median consumer initially has speeds of 10 Mbit/s, which gradually increases to 60 Mbit/s by year 6, and remains on 60Mbit/s.
- **Project:** The median consumer initially has speeds of 10Mbit/s, which gradually increase (but at a slightly slower rate than the baseline) to 60 Mbit/s by year 9, and then has speeds of 100 Mbit/s from year 10 onwards.

Scenario B

[18] Nothing is lost in the formulation by replacing the alternative 'work' with a composite good, valued at the opportunity cost of time.

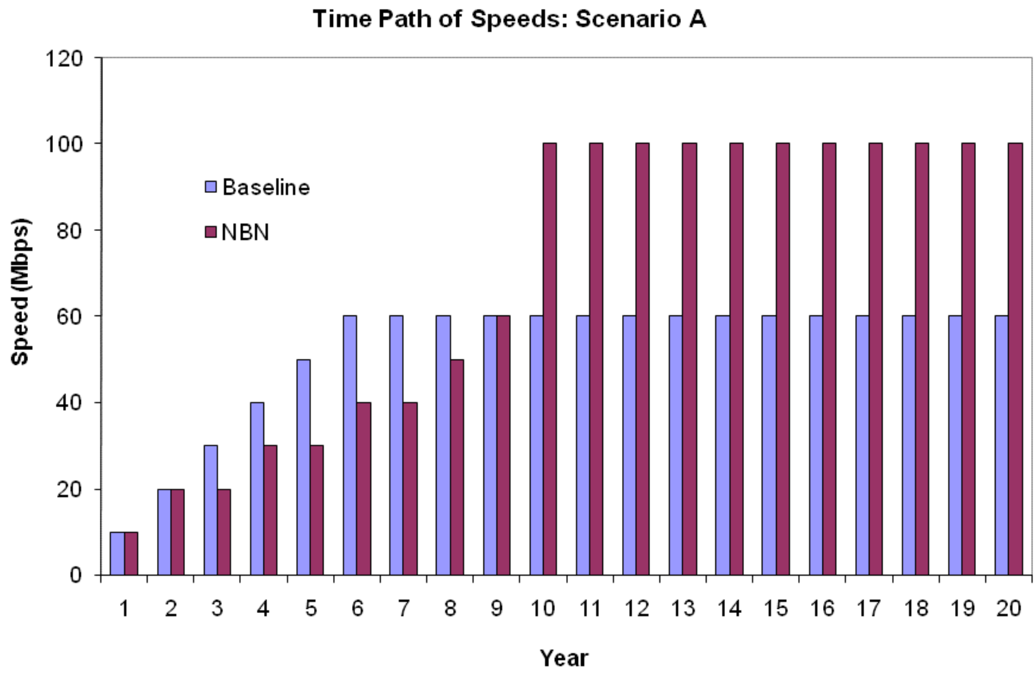
[19] Goolsbee and Klenow 2006 use Becker's framework to compute the consumer benefits of access to the Internet, but they do not examine the welfare effects of greater download speeds.

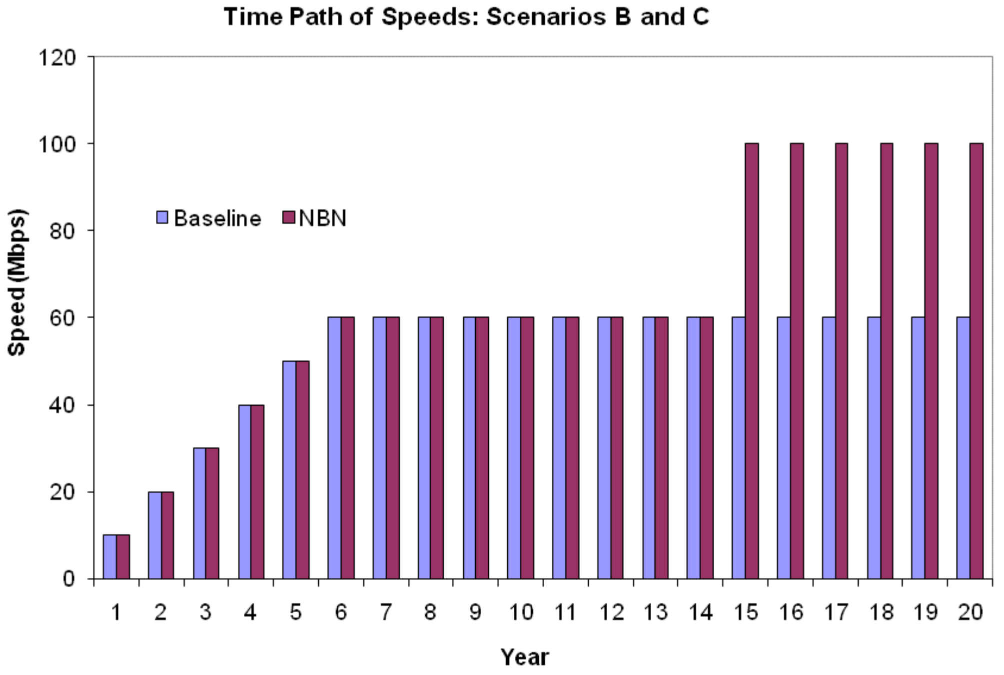
- **Baseline:** Same as for scenario A.
- **Project:** The project is delayed by 5 years, during which time the median consumer is on the same path as the baseline. The median consumer then goes on to 100 Mbit/s at a later time than with the project Scenario A – from year 15 onwards.

Scenario C

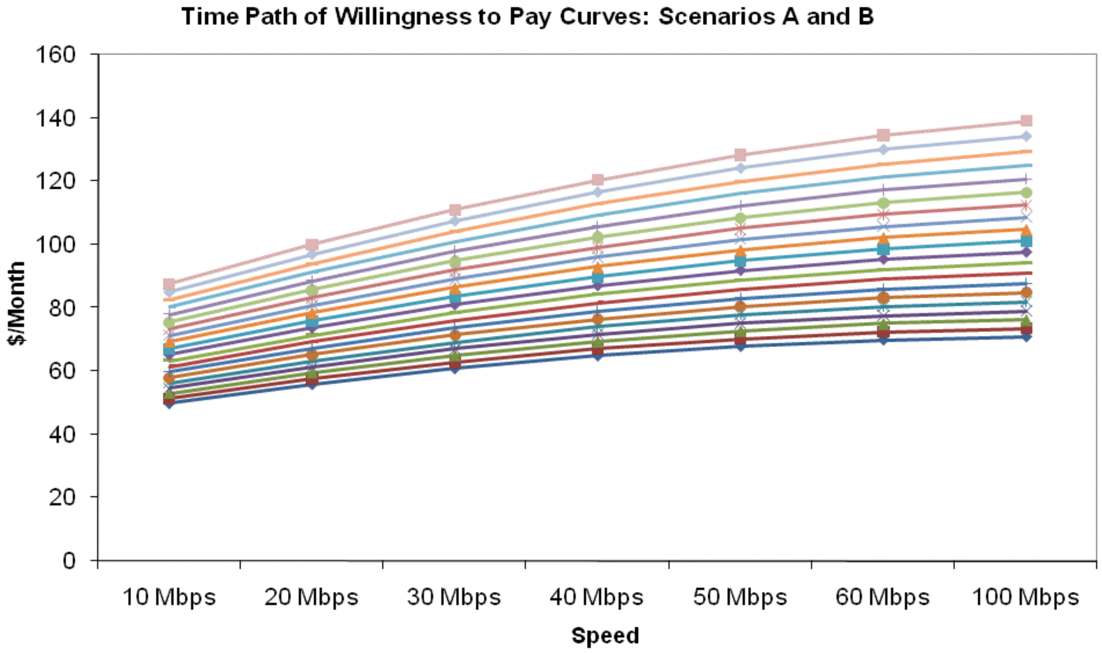
- **Baseline:** Same as for scenario B.
- **Project:** Same as project for scenario B, but the project is targeted at consumers with a relatively high willingness to pay – those consumers in the top quintile. This is, in other words, a targeted version of the project, with the aim of serving only high WTP areas.

These speed adoption paths are plotted below.



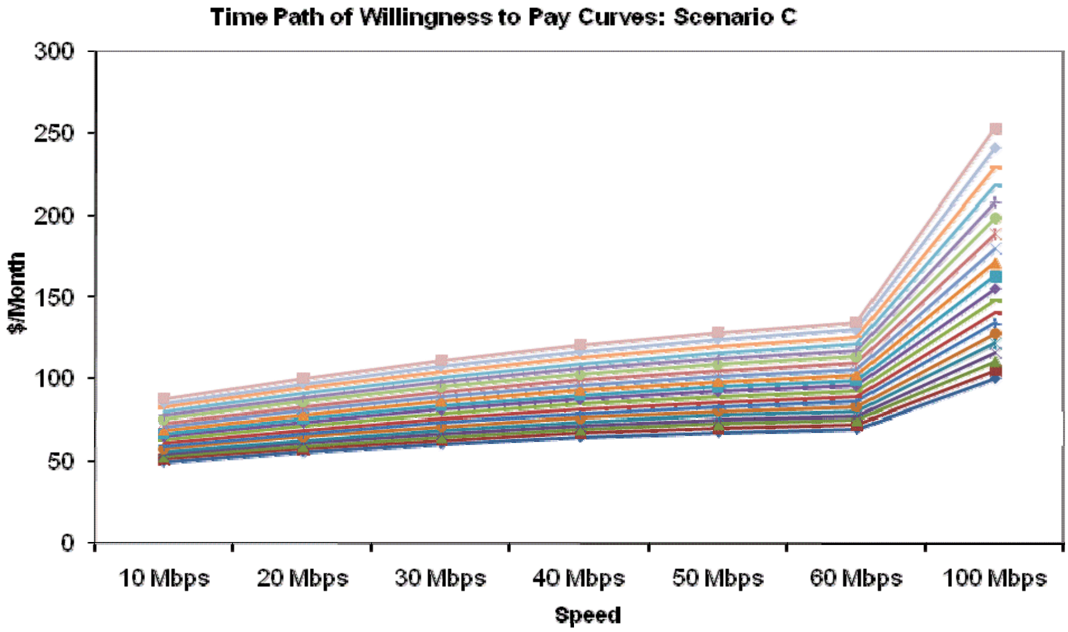


For the median consumer's willingness to pay, we assume $50 WTP for 10 Mbit/s, increasing to $71 for 100 Mbit/s. As these assumptions pertain to the median consumer, they are reasonably close to current market outcomes. We also assume an annual growth rate of 3 per cent in WTP at the lowest speed, but assume that the growth rate increases as we move up the WTP curve, with annual growth of 3.6 per cent for WTP for 100 Mbit/s. The initial WTP curve for scenarios A and B and their growth rates over time are shown in the figure below.



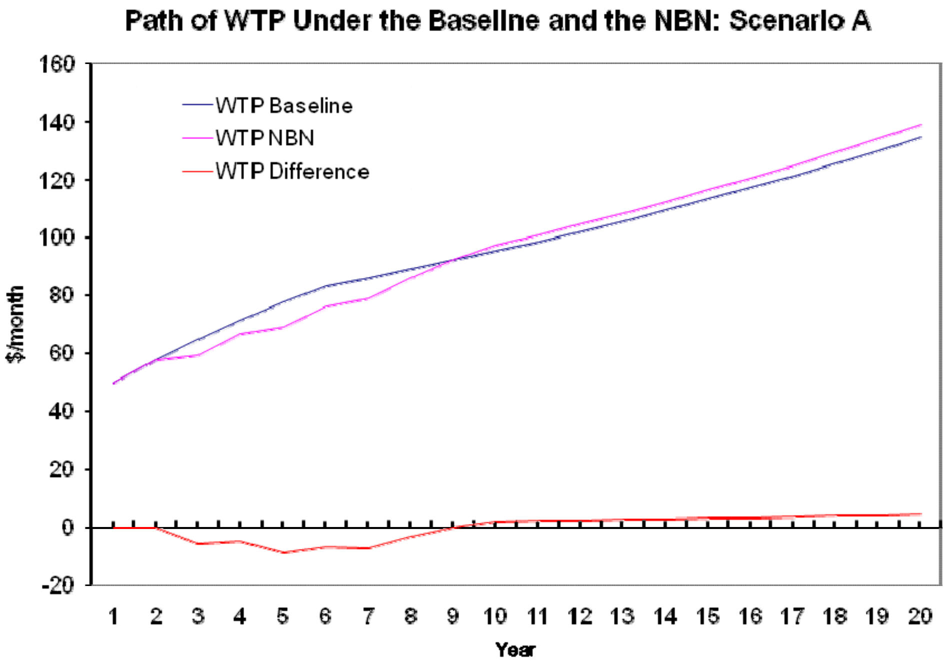
For scenario C, we assume the same WTP curves, except that the relevant consumer that is targeted when the project is built has a much higher WTP. To this end, suppose that WTPs are log-normally distributed, with the median of the natural logarithm of the distribution of WTPs set so that the resulting distribution has the same median as under the baseline scenario (i.e. the median

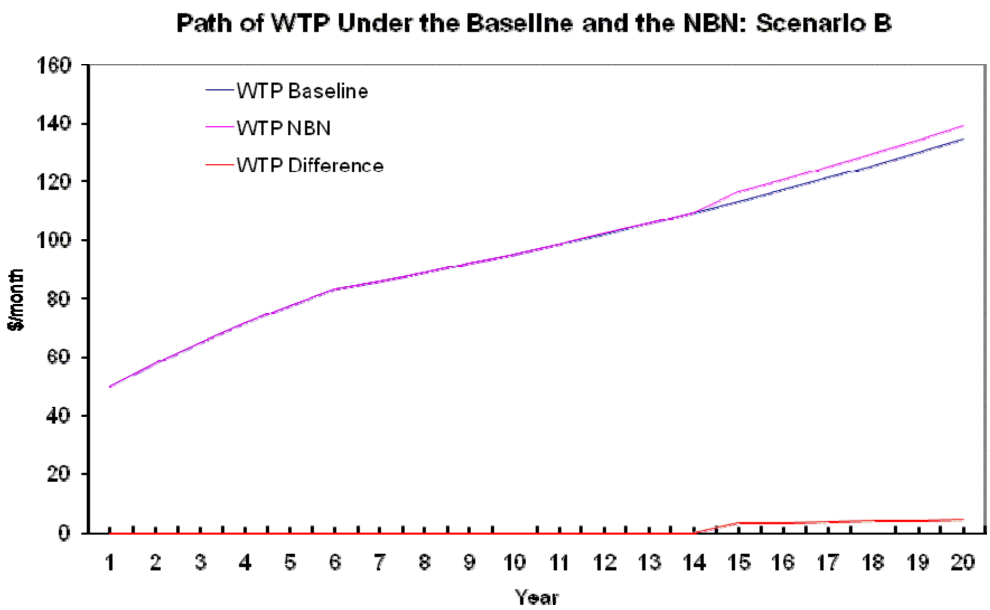
WTP is $50), and with the standard deviation of the natural logarithm of WTPs equal to one quarter of the natural logarithm of the mean. Then, by construction, the top 25 per cent of consumers will have initial valuations exceeding $100, and we take this consumer as the representative consumer that is targeted by the project under scenario C. We also assume that the growth rate of this consumer's WTP is 5 per cent per year.

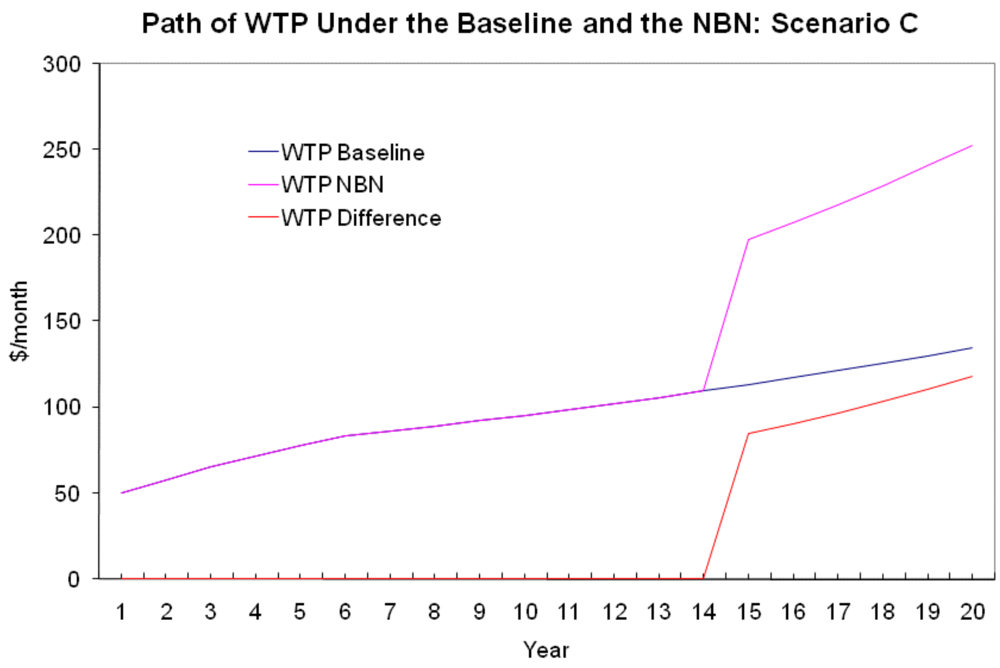


The next step is to combine the speed adoption path and the WTP curves to calculate a WTP curve for the baseline and the project under each scenario, and also compute the difference in the path of WTPs under each scenario. This gives us the incremental WTP curve – it is the path of benefits that the representative consumer would receive if the project went ahead, instead of the baseline.

These are plotted in the charts below.







We then compute the present value of the stream of benefits under each scenario, using a range of discount rates. The numbers in the tables are the present value of the consumer's WTP, expressed in dollars per month. Thus, the number in the first row of the first column ($1,273) is the present value of the future stream of benefits that the consumer expects to receive.

Table 1 **Incremental Benefits Under Various Scenarios**

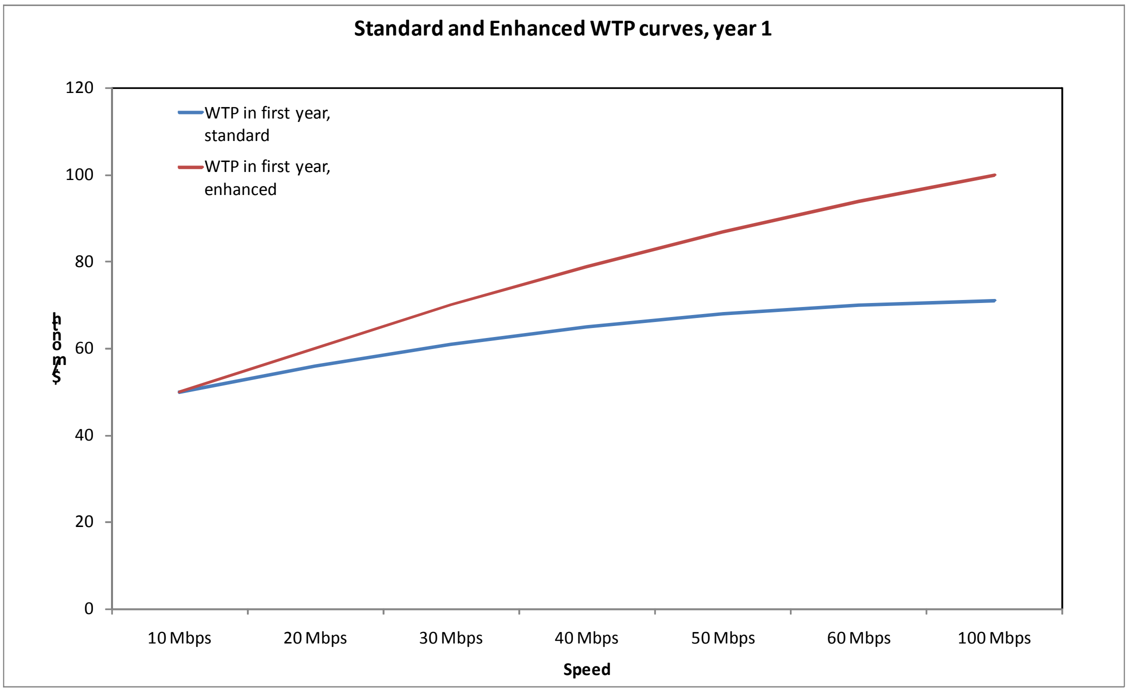
		NPV of per month Benefits ($)			Monthly Equivalent ($)		
	Discount Rate	***Baseline***	***NBN***	***Increment***	***Baseline***	***NBN***	***Increment***
	4%	1,237	1,228	-9	91	90	-1
Scenario A	8%	846	834	-13	86	85	-1
	12%	612	599	-13	82	80	-2
	4%	1,237	1,249	11	91	92	1
Scenario B	8%	846	852	6	86	87	1
	12%	612	615	3	82	82	0
	4%	1,237	1,540	303	91	113	22
Scenario C	8%	846	1,002	156	86	102	16
	12%	612	695	83	82	93	11

The tables also compute the "monthly constant equivalent", which is the constant amount that a consumer with the relevant discount rate would be willing to pay in each and every month over the next 20 years to receive the given stream of benefits. So, for example, under scenario A, a consumer with a 4 per cent discount rate would be willing to pay $0.52 every month (rounded up to $1 in the table) for the next 20 years to not have the NBN, and instead receive the benefits under the baseline.

To arrive at a final assessment of costs and benefits, we subtract the incremental costs computed earlier from these incremental benefits. Note that under scenario A the incremental benefits are negative, and so accounting for the incremental monthly costs that were computed earlier (of around $75 a month in metropolitan areas and of $120 per month in regional areas), the NBN has incremental net benefits that are negative. For all the other scenarios, the incremental benefits of the NBN are far below the incremental costs; indeed, it is difficult to conceive of credible scenarios for the NBN that would make its incremental costs fall below the incremental benefits, i.e. result in the project yielding net benefits to Australia. Indeed, in all of the scenarios, the incremental upgrading path is always the most socially beneficial.

Sensitivity Analysis of WTP paths

To what extent do these results depend on the willingness to pay curves? To examine this question we have conducted a sensitivity analysis on the WTP assessment, by examining "enhanced" WTP curves in each of the three scenarios. Under these new enhanced scenarios, the consumer's willingness to pay curve still begins at the same point for low speeds, but increases more rapidly as speeds increase. In other words, the consumer's *marginal* willingness to pay for increases in speeds is higher in the enhanced settings. The year one WTP curves in the original (standard) analysis and the enhanced analysis are shown in the chart below. In the enhanced Scenario C, the targeted, high WTP consumers are assumed to have a WTP of $120 for 100 Mbit/s speeds in the first year (compared to a WTP of $100 in the first year of the standard analysis). In all enhanced scenarios, the growth rates of WTP are assumed to be the same as the standard analysis.



The results of the enhanced WTP analysis are very similar to the standard analysis. The ranking of the three scenarios remains unchanged, with the delayed project (Scenario B) and the targeted project (Scenario C) becoming slightly more attractive from an incremental benefit point of view. The incremental benefits under Scenario A actually fall and become more negative under the enhanced WTP setting. In other words, increasing the willingness to pay for higher speed reduces the attractiveness of the NBN option, essentially because it also increases the density of demand in the mid-speed tier (and hence increases the relative value of the options that involve incremental development of the access network).

Put slightly differently, the enhanced WTP curves have higher marginal WTP at lower speeds relative to the original analysis. Under the NBN the consumer misses out on those relatively high marginal gains in the early years, even though the consumer eventually receives high absolute benefits. This fact, combined with the logic of discounting, means that scenarios B and C become more attractive, while scenario A becomes less attractive.

Table 2 Incremental Benefits Under Various Scenarios, Enhanced WTP

		NPV of per month Benefits			Monthly Equivalent		
	Discount Rate	*Baseline*	*NBN*	*Increment*	*Baseline*	*NBN*	*Increment*
	4%	1,608	1,609	1	118	118	0
Scenario A	8%	1,087	1,070	-17	111	109	-2
	12%	776	753	-23	104	101	-3
	4%	1,608	1,648	41	118	121	3
Scenario B	8%	1,087	1,108	21	111	113	2
	12%	776	787	11	104	105	1
	4%	1,608	1,918	310	118	141	23
Scenario C	8%	1,087	1,247	160	111	127	16
	12%	776	861	85	104	115	11

Overall, the results are relatively robust because WTP is concave in speed, network coverage and in the rate at which upgrades are deployed, while costs are convex at a discontinuity (the upgrade to FTTP).[20] Moreover, the results reported above tend to understate the consequences of this fundamental feature of the situation, as we consider a median user, while there are substantial numbers of users – especially in non-metropolitan areas – who have low willingness but very high costs to serve.[21] In the counterfactual, the loss incurred on these users is limited by the more limited coverage of the upgrading; in the NBN, these costs are incurred in full and relatively soon.

Comparison of project costs and benefits

To examine the net benefits and costs of the NBN, we examine a scenario that is intentionally conservative as far as service quality is concerned, as it involves speeds under the base case rising to only 20 Mbps, which is less than the HFC networks can currently provide. Specifically, we examine:

Scenario D:

- **Baseline:** The median consumer initially has speeds of 10 Mbps, which increase to 20Mbps in year 4 and remain there.
- **Project:** The median consumer initially has speeds of 10Mbps, which gradually increase to 100 Mbps by year 6 of the NBN project, where they remain.

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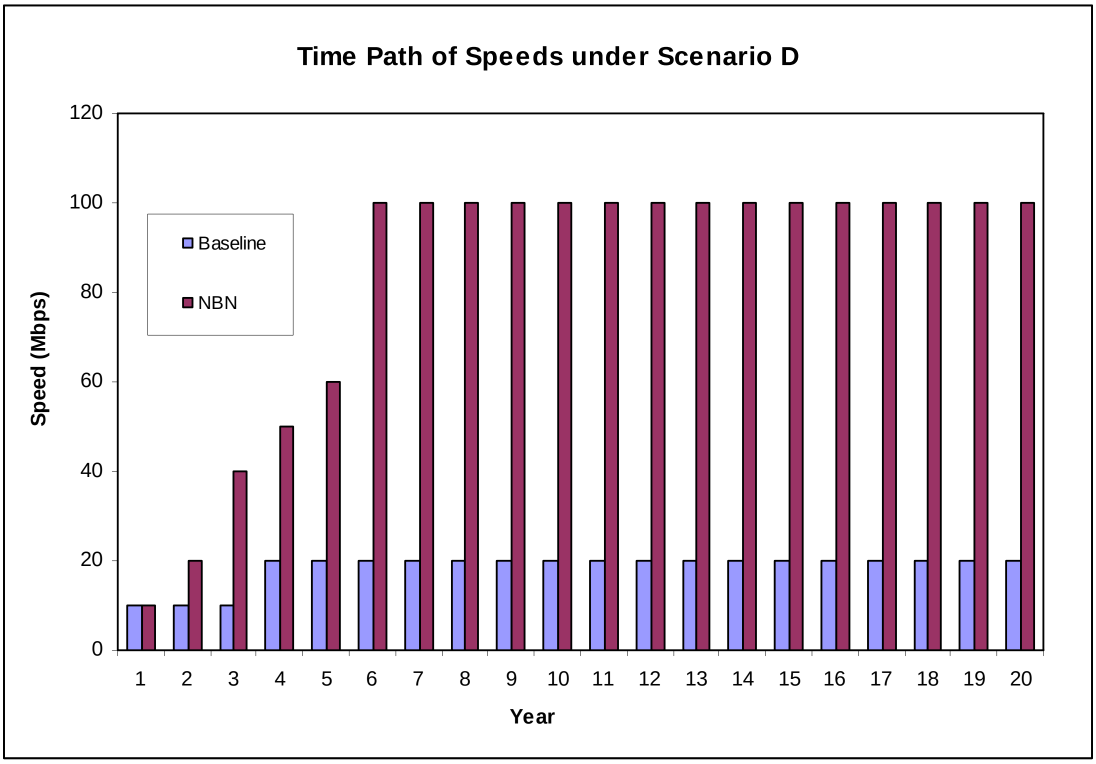
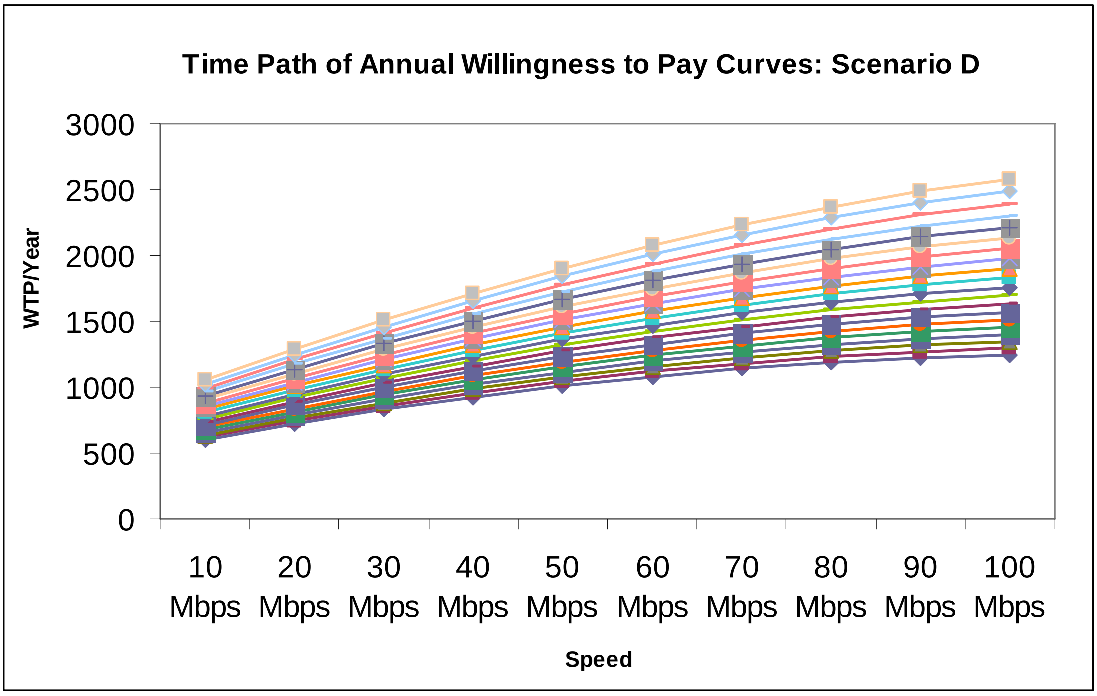
[20] Costs are, in other words, concave in speed up to 30-60 mbps and then leap at the discontinuity. Costs are always likely to be convex in the geographical breadth of deployment and in the speed of deployment, while the WTP gains in each of these dimensions are likely to be concave.

[21] This likely reflects the fact that WTP is correlated with human capital endowment, and human capital, and especially that associated with 'information' activities, tends to be concentrated in metropolitan areas. See Glaeser and Ponzetto 2008 and O'Flaherty 2005.

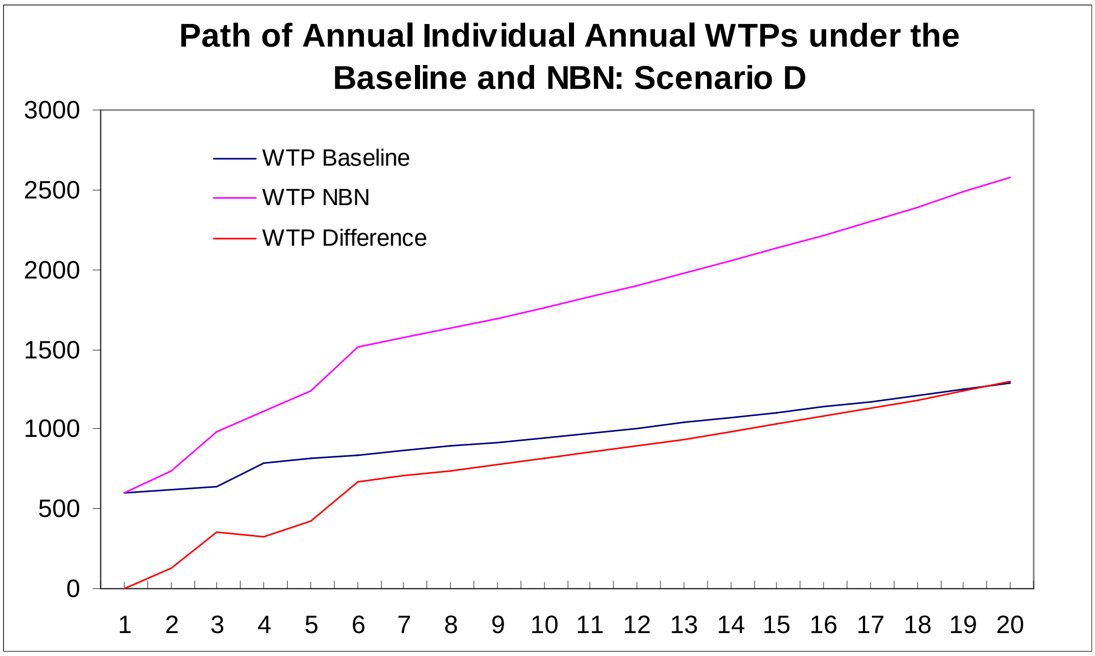
These speed adoption paths are plotted below.



For consumer willingness to pay, we assume a monthly WTP of $50 for 10 Mbps, increasing to $104 for 100 Mbps. To estimate aggregate willingness to pay, we assume that all consumers are alike. We also assume an annual growth rate of 3 per cent in WTP at the lowest speed, but assume that the growth rate increases as we move up the WTP curve. Thus, we assume an annual growth of 3 per cent for WTP for 10 Mbps, with the growth rate rising to 3.9 per cent for 100 Mbps. The initial annual WTP curve for scenario D and its growth rate over time is shown in the figure below.



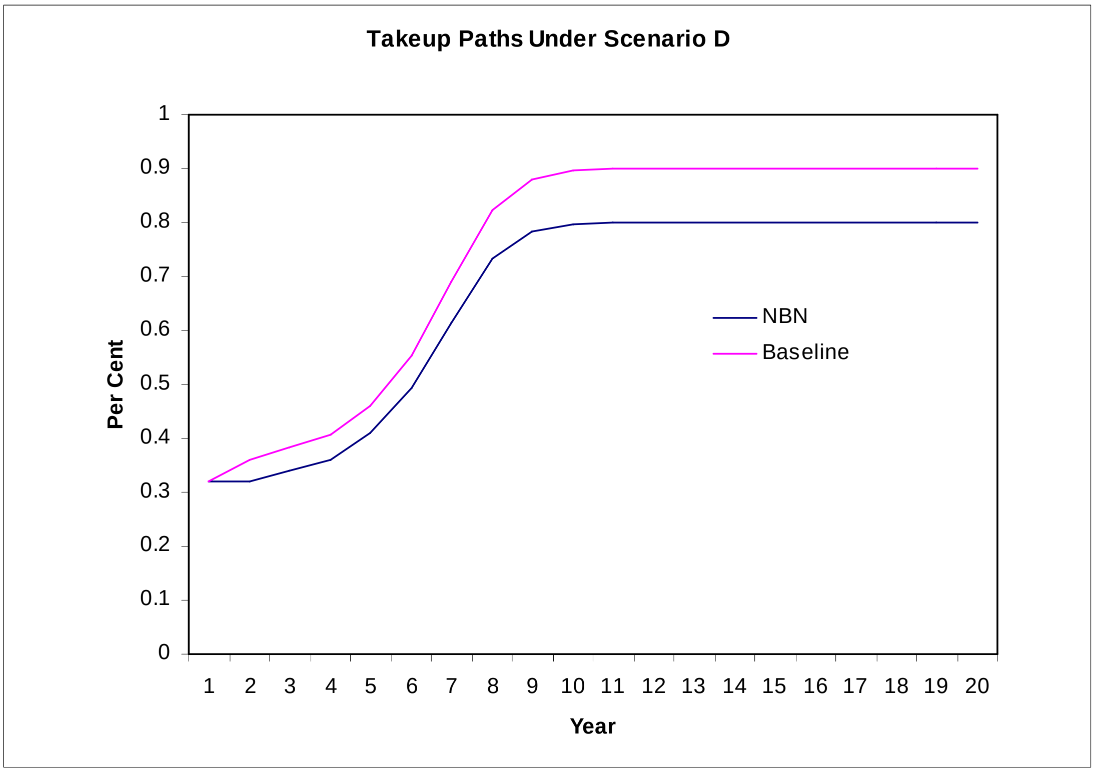
Our next step is to combine the speed adoption path and the WTP curves to calculate a WTP curve over time for the baseline and the project, and also compute the difference in the path of WTPs under each scenario. This gives us the incremental WTP curve – it is the path of benefits that the representative consumer would receive if the project went ahead, instead of the baseline. These are plotted in the chart below.



Under the scenario D baseline, we assume that retail prices are $30 per month in metropolitan areas, and $50 per month in non-metro areas, which gives a national monthly cost recovery retail price of $32.90 under the assumption of an 85%-15% split between urban and non-urban areas.

For the NBN, under Scenario D and the assumption of a CIR of 1 Mbps, the engineering cost model provides estimates of break even retail prices of $128 per month in metro areas, and $313 in non-metro areas, for a national average cost recovery price of $155, again assuming an 85%-15% split between metro and non-metro areas.

To compute aggregate costs and benefits, an assumption must be made about the path of demand. Under scenario D, the NBN engineering cost model assumes an S-shaped takeup pattern over time, with 50 per cent of the population taking up the service by year 6 and a saturation rate of 80 per cent. For the baseline case we assume a slightly more rapid takeup rate, with the same starting percentage as under the NBN but with a final saturation rate of 90 per cent. These two demand profiles are shown in the figure below.



Finally, we can put all of this together and compute aggregate costs and benefits under the baseline and the NBN, and compute the present value of net incremental benefits of the NBN. The estimates are set out in the table below. The numbers in the table are the estimated present value of the net incremental benefit of the NBN, relative to the baseline. The estimates suggest that undertaking the project will result in a social loss in present value terms of between $13.9 billion and $20.4 billion, depending on the discount rate chosen.

Table 3 Present Value of the Net Incremental Benefits of the NBN Under Scenario D

Discount Rate	Present Value of Incremental Benefits of the NBN (2009 $bn)
6%	-$20.4
7%	-$19.2
8%	-$18.1
9%	-$17.2
10%	-$16.2
11%	-$15.4
12%	-$14.6
13%	-$13.9

Since we have assumed that the willingness to pay for the NBN far exceeds that for the baseline, it is clear that the key drivers of the NBN's social losses are the large capital and operating costs of the project.

In fact, the central result of our modelling can be expressed in terms of the familiar condition for replacement investment. More specifically, it is economic to replace the existing network with a new network if the net present value of the ***total*** costs of the new network is less than the net present value of the ***incremental*** costs of the existing network, in each case adjusted for relative service quality (which we do through the willingness to pay calculation). It turns out that the NBN would only satisfy this condition if the present value of the additional cost of deploying and operating the NBN, compared to even the 20 Mbps scenario, were no more than $14 billion (evaluated at a discount rate of 13 per cent) to $24.7 billion (evaluated at a discount rate of 6 per cent).

Put slightly differently, assuming a mid-point discount rate of 10 per cent, it is irrational to spend more than $17 billion on the NBN, even if the alternative is a world in which the representative consumer cannot obtain service in excess of 20 Mbps and even if demand for high speed service is rising relatively quickly. This amount of $17 billion is well below current estimates of the costs the NBN will involve, especially if it is to serve non-metropolitan areas. Alternatively and more realistically, if the base case (i.e. the alternative to the NBN) is one in which the representative consumer is assumed to ultimately have access to 40 Mbps (rather than 20 Mbps as above), then it is inefficient to proceed with the NBN if the present value of its incremental costs of deployment and operation, evaluated at a 10 per cent discount rate, exceed $10.6 billion, which is below the lowest bound of the estimates of these costs.[22]

Discussion of the results

It may be thought that these estimates understate the gains from the project because they do not take account of wider economic and social benefits. While it is of course likely that use of higher speed access lines will allow productivity gains, we would expect those gains to be reflected in consumers' and businesses' willingness to pay for that use. As a result, treating the productive efficiency gains as an added benefit amounts to double counting. As for wider social benefits, it is

[22] Using 40 Mbps is especially realistic if sorting is allowed to occur – i.e. if account is taken of the fact that suppliers will target those customers who place a high value on speed, and that those customers will have incentives to choose locations (for instance, at which to site offices) that offer such access.

unclear what they consist of, and whether they are indeed greater under the project than under the counterfactual. Moreover, to the extent such social benefits exist, there must be the question of whether the project is the most efficient means of ensuring their delivery.[23] Without more precise specification of those benefits, it is not possible to assess whether they have any substance, although some that have been cited in the press seem dubious.[24]

Rather, it is our view that the estimates understate the likely project-related social costs. Thus, it seems probable that, evaluated at a rate of return that reflects the risks the project imposes on taxpayers, the project will incur losses.[25] While those losses themselves are a transfer, the distortions associated with financing them through taxation are not, and need to be added to the social costs of the project. In contrast, under the counterfactual world, taxpayer outlays would be limited to any vouchers used to subsidise demand by consumers in high cost areas. Moreover, the prospect of taxpayer financing of the project's losses can lead to moral hazard, as well as to direct political interference in project decisions, diminishing the productive efficiency with which the project is pursued. Our estimates, however, do not gross up financing costs for the difference in the value of private and public income (i.e. for the marginal social cost of funds) and assume the project is deployed and operated at least cost.

Additionally, the NBN project, whatever its merits, will create risks to the integrity of the regulatory system. First, the Commonwealth government will be both the primary investor in a major competitor and the industry policy-maker and regulator, creating sovereign risk for private investors and introducing potential distortions to policy and regulatory decisions. Second, the NBN may involve some form of joint venture between entities that would otherwise have the scope to compete on a head to head basis, with the associated dangers of collusion. Third, there will be strong pressures for geographically uniform pricing, which can add distortions not only to resource allocation but also to competition (for example, if restrictions or taxes on bypass are used to protect the flow of cross-subsidies). These costs are not taken into account in our estimates.

At the same time, our estimates of the project benefits do not take account of offsetting equilibrating processes, and therefore tend to overstate them. In particular, it is clear that in the counterfactual, those consumers that place the greatest value on high speed access will generally have such access, for two reasons: first, suppliers will have incentives to provide it, including through geographically targeted upgrades; and second, over a ten to fifteen year period of time, geographical mobility is relatively high, and consumers will sort themselves geographically in a way that *inter alia*, reflects the valuations they place on different forms of broadband access. As a result, the population that gains access to very high speed broadband in the NBN world relative to the counterfactual is likely to be that segment that places the lowest valuation on broadband access. To that extent, our estimates, which do not allow for this sorting process, exaggerate the

23 If these benefits can be obtained at lower cost under some alternative option, then the cost increase from forgoing the use of that lower cost option (i.e. from using the NBN to deliver those benefits, rather than the cheaper alternative) is a net cost to the project and should be treated as such in the analysis.

24 Claimed wider benefits such as the promotion of tele-medicine seem very difficult to credit. With respect to tele-medicine, it is not clear what residential medical applications require access to residential fibre optics, short of a future being projected in which individuals will have CAT scanners in their homes. As for GPs and medical centres, there is no evidence that network access costs and speeds have any effect on their use of tele-medicine: Paolucci, Ergas, Hannan and Arts 2009 survey the literature on the effectiveness of tele-medicine and do not find such evidence. Finally, hospitals are generally already connected to high speed access networks and would be so under the factual and counterfactual alike.

25 Of course, the project might be profitable were it given a monopoly or regulatory protection from competition (say, through an exemption from the merger laws that allowed it to acquire assets that would otherwise act as an effective competitive constraint). However, were that the case, then the efficiency costs of such a monopoly would need to be brought to account in the CBA.

gains from NBN deployment. This is all the more the case as our counterfactual scenario – scenario D – assumes relatively low speeds would be available should the NBN not proceed.

This overstatement of project gains is accentuated by our approach to estimating net benefits, which compares to the willingness to pay for the incremental speed the project provides, the incremental cost of providing that speed. However, whether benefits are realised depends to a significant extent on the entity's future pricing policies. For example, if prices are set at average costs, then some potential utility gains will not be realised (as those consumers who value the project output at more than incremental cost, but less than project average cost, will not consume its services).[26] This is equivalent to the issue that arises when toll roads are built: the CBA for the road link may be undertaken on the basis of potential social gains; however, the tolls may lead to some users whose valuations exceed marginal costs (and hence are counted towards the CBA's estimate of benefits) not actually using the road, causing realised benefits to fall below assumed levels. Because we do not discount our estimated benefits for this effect of the entity's pricing policies, we probably overstate the likely benefits.[27] This element of overstatement may be particularly severe for the NBN, as it is intended to be a 'wholesale only' network. This could limit its ability to price discriminate (as it will not know or be able to directly access the willingness to pay of final customers), increasing the social cost of any break-even constraint.[28]

Finally, we have not costed the most natural alternative – which is simply to delay the project and re-examine its economics every few years. This option to delay is likely to have high value, particularly if it is accompanied by regulatory reform that addresses the current disincentives to invest. Such an option would allow any public investment to be more narrowly targeted to areas of genuine and durable market failure and would reduce both the risk of asset stranding and of significant deadweight losses due to the tax financing of project losses.

In short, we believe our estimates overstate the likely gains and understate the likely costs from the NBN.

All that said, the notion of wider productivity benefits from broadband deployment is a popular one, with especially frequent reference being made[29] to an estimate by Access Economics that:

> *.. economy-wide multifactor productivity levels would be around 1.1 per cent higher in an Australian economy with HSBB [high speed broadband] available everywhere*

[26] As noted above, the Commonwealth Government's *National baseline of school broadband connectivity 2008*, shows that while "The majority of schools in metropolitan locations reported using fibre (51.6 per cent) and most schools in provincial locations also reported using fibre (46.5 per cent)", most schools "use download speeds of up to 4 megabits per second, which is the lowest download speed range used in the FCS baseline survey. This disparity may be due to affordability of the service or the specific contractual arrangements negotiated, throttling and issues relating to the availability of suitable online curriculum resources and tools."

[27] Obviously, were perfect lump sum taxes and transfers available, then no such social costs would eventuate. Project charges to users would, in such a world, be set to marginal costs, and any fixed costs would be covered through public transfers. Unfortunately, such perfect lump sum taxes and transfers are not available, and hence it may be efficient to impose break-even constraints (or at least some degree of fixed cost recovery) on public suppliers. The welfare costs of any such constraints then need to be taken into account.

[28] In other words, the entity's ability to engage in Ramsey-Boiteaux pricing may be quite limited. While menus of self-selecting charges (i.e. second degree price discrimination) can be used to approximate Ramsey-Boiteaux pricing, the approximation is far from perfect and there are in any event additional costs involved in using self-selecting prices for intermediate inputs – see Ordover and Panzar 1982.

[29] "Access Economics predicts that a national high-speed broadband network would mean economy-wide productivity growth 1.1 per cent higher after ten years compared to if the network was not built." Senator the Hon Stephen Conroy, Minister for Broadband, Communications and the Digital Economy, Speech to CeBIT Australia 2009 AusInnovate Conference, Tuesday, 12 May 2009. The Minister goes on to say that "It is worth noting that Access Economics views this as a conservative estimate." However, as discussed below, the comparison Access Economics make is to a world in which only dial-up service is available (noting that as of the time of writing, 70 percent of Australian households subscribe to some form of broadband).

> *relative to an Australian economy without any HSBB after ten years. That is, the average annual growth rates in productivity would be around 0.1 percentage points a year higher in a complete HSBB world* ***compared with a situation where only, say, dial-up was available****.*[30]

However, as the Access Economics report plainly states, these productivity gains are relative to an economy in which only dial-up service, or similarly very low speed access options, would otherwise be available. Moreover, it is also plain from the Access Economics report that the numbers cited are no more than assumptions, albeit ones Access Economics believes to be conservative for the comparison being made. Those assumptions cannot be carried over to the NBN for two reasons: first, the relevant comparison is to a counterfactual world in which high speed broadband is relatively widely, though not universally, available (rather than to one in which there is no high speed broadband); and second, the NBN will receive public funding on a larger scale than envisaged for the Government's first-round process.

To take account of these differences, we believe that the Access Economics' estimates of productivity gains should set to one-third to one-half their initial levels, given that 70 percent of households now have some form of broadband access. Additionally, account needs to be taken of the likely crowding out effects of the public expenditure. We use a simple macroeconomic model with crowding out ($\lambda > 0$ **)** to assess the likely impacts. The results, set out in Table 4, are expressed as the present value of the cumulative change in GDP over a twelve year period, discounted to the present at a discount rate of 7 percent (the rate used by Access Economics) and put in 2009 dollars. Broadly, the results suggest that cumulative GDP declines, despite an assumed increase in productivity.

Table 4: Present value of the cumulative twelve year change in GDP due to construction of the NBN, in 2009 $s, for a range of values of productivity increase and of extent of crowding out of other investment

Increase in Productivity Level	Degree of Crowding Out					
	0.5	0.6	0.7	0.8	0.9	1
0.3	-12	-17.1	-22.2	-27.3	-32.4	-37.5
0.4	-7.6	-12.7	-17.8	-22.9	-28	-33
0.5	-3.2	-8.3	-13.4	-18.5	-21	-23.6

Note: A discount rate of 7 percent is used, for comparability with the results given in Access Economics 2009.

This loss is not directly comparable to that derived from a comparison of incremental project costs and consumer valuations; however, some component of it – that part that reflects distortions due to the burden of taxation – could properly be added to the CBA loss (as that loss is calculated without regard to the difference between the private and public value of income). Unfortunately, this component is not separately identifiable, being simply an element in the assumed crowding out parameter.

Conclusions on telecommunications

In short, under both the Howard and Rudd governments, important telecommunications decisions have been made without formal, transparent assessment of costs and benefits. Our review – both of the quality of service regulations implemented by the previous government, and of the proposed

[30] Access Economics 2009, page 20, emphasis added.

NBN – suggest such an assessment would conclude that the policies at issue impose costs than exceed the relevant benefits.

TRANSPORT

We now turn to a consideration of project evaluation in transport, where there have also been very significant increases in outlays. We first discuss some important features of the institutional context; and then examine one of the largest projects which the Government has decided to fund, as a example of some of the limitations of our project evaluation procedures.

Institutional context and background

A summary of the major steps in the development of transport funding in Australia is set out in Appendix D. Over time, there has been a trend to an expansion in the role of the Commonwealth, with the division of responsibilities between levels of government becoming increasingly blurred. Focussing on recent developments, the most relevant measure is the establishment of the Building Australia Fund (BAF), which was set up on 1 January 2009 by the Nation-Building Funds Act 2008 to finance capital investment in transport infrastructure (such as roads, rail, urban transport and ports), communications infrastructure (such as broadband), energy infrastructure and water infrastructure. The BAF is essentially a hypothecated fund for financing investments in the areas noted above.[31]

The Government also set up Infrastructure Australia (IA), a policy advisory body, which was established by the Infrastructure Australia Act 2008 that came into effect on 9 April 2008. IA's composition includes representatives of the States and Territories, along with representatives of the Commonwealth. Among other functions, IA is charged with reviewing and recommending proposals for infrastructure projects. These assessments are to be guided by the "Building Australia Fund Evaluation Criteria", which, under the terms of the Nation-building Funds Act 2008, are determined by the Infrastructure Minister. These criteria, which were tabled on 18 December 2008, require IA to only recommend projects that *inter alia*:

- "demonstrate a positive impact on national productivity and economic growth";
- "address a need that is not provided for through existing infrastructure";
- "demonstrate through a cost-benefit analysis that the proposal represents good value for money .. (and have) an expectation of long term public benefits, taking into account economic, environmental and social aspects of the project."[32]

IA has issued an outline of its project evaluation methodology, which state that the first step in its evaluation of proposals is to "assess compatibility .. to Infrastructure Australia's strategic priorities". To then evaluate those proposals that are so compatible, IA says it will:

> *Use objective cost-benefit analysis as the primary driver of decision making;*
>
> *Consider a wide range of benefits and costs – not just economic, but also social and environmental;*

[31] However, the hypothecated funding is not attached to a hypothecated tax, so this is not a Wicksell-like earmarking scheme (where taxpayers would face the tax price of infrastructure). Rather, it is simply a 'piggy bank' allocation of funds to a particular set of purposes.

[32] BAF Evaluation Criteria, Tabled 18 December 2008, at Schedule 1.

> *Give monetised CBA (through the benefit cost ratio) a key role in decision making;*
>
> *Ensure non-monetised effects are also taken into account; and*
>
> *Consider both efficiency and equity impacts.*

IA goes on to say that:

> *Cost benefit analysis (CBA) is the primary appraisal tool by which Infrastructure Australia assesses the net benefit of an initiative. It is an objective tool that combines 'monetised' benefits and costs – those expressed in dollar value terms. In the Infrastructure Australia methodology, as many benefit and cost are monetised as widely as possible. Estimates of wider economic benefits and costs (WEBs) are to be included where relevant .. WEB are improvements in economic welfare that are acknowledged but which have not been typically captured in traditional CBA.*[33]

It is clear that this evaluation framework places considerable emphasis on CBA. As IA itself notes, this is "consistent with national and State and Territory guidelines on economic appraisal".[34] As can be seen from Appendix E, (which lists the relevant instruments and their coverage), these guidelines broadly require the use of CBA to evaluate all major transport projects. However, two further trends also emerge from the IA material and from a consideration of developments in the various Australian jurisdictions.

The first is the tendency to constrain the range of options considered to those which demonstrate "strategic fit". Thus, the 2006 Australian Transport Council *National Guidelines for Transport System Management in Australia*, which are now the standard reference for all transport agencies in Australia, introduced a 'strategic merit test'. In practice, that test – which asks whether an option is consistent with government strategy – can act to filter out projects and options that do not pass a prior test of political suitability. The result is that in considering how best to address a given transport need, the range of options compared in the CBA may be restricted in ways that (by eliminating relevant alternatives) can disguise the true opportunity costs of the option ultimately selected.

The second tendency, which is also marked in all Australian jurisdictions, is the ever greater reliance being placed on multi-criteria evaluation (Dobes and Bennett 2009). There is, in other words, a proliferation of evaluative criteria and approaches that, although claimed to complement CBA, may in practice displace it. A striking instance is the so-called 'triple bottom line' methodology, which purports to give due weight to environmental and social considerations as well as to economic ones. However, because CBA *already* takes account of social (and not merely private) costs and benefits, the effect of reliance on this methodology is to allow the evaluator to double or treble count benefits, and to increase the cumulative scores given to favoured projects: for example, by including as separate criteria, which are used to rank and score alternative projects, impacts on the environment, on bio-diversity and on greenhouse gas abatement, counting each of these as separate and additive sources of benefits. The weights given in these approaches to the various evaluation elements are almost invariably arbitrary, bearing no relation to the community's willingness to pay for the relevant benefits (or to accept for any relevant costs) – see Ergas 2009.

The overall result is that while the form of CBA is retained, both the value of the CBA is compromised (by the narrowing of the range of considered alternatives) and the significance of

[33] Australian Government, Infrastructure Australia, 24 September 2008, pages 4 and 5, page 12.

[34] Ibid, page 12.

the results of the CBA reduced (as the CBA is only one element among many in the evaluation criteria, and decision-makers pick and choose among the alternative results). The consequent risk is that of the CBA becoming a box to be ticked but not to be taken too seriously, either in its execution or in the weight placed on its results. This in turn reduces the barriers to rent-seeking and to poor governance, as 'fudge factors' distort the policy assessment and muddy the documentary trail leading to the ultimate decision.

A case study

So as to examine these issues in a practical context, we have analysed the CBA undertaken for the East-West rail (EWR) project in Victoria.[35] This project, which broadly aims at improving the rail links between Melbourne, Geelong and the regions to Melbourne's west, was recommended by IA for immediate funding; indeed, taking the project as a whole, it is the largest such project. The Commonwealth Government has since announced that it is making $3.2 billion available for the project to proceed.[36] The very extent of that funding therefore makes it a suitable case for closer examination; additionally, it is one of the few recommended projects for which a CBA is publicly available.[37] Before turning to examine this project in greater detail, it is worth emphasising that our discussion of the CBA is not intended to suggest that this CBA is particularly poor; rather, it highlights issues that occur, albeit to differing extents, in Australian CBA more widely.

As with many current CBAs, the first issue the EWR assessment raises is that of whether the appropriate range of alternatives has been considered. In particular, the project is designed to alleviate capacity constraints affecting regional rail in Victoria; however, it is by no means established that significant new capacity is the only, much less the most effective, option in that respect. Thus, Mees 2008a, 2008b argues that current capacity constraints on the links at issue are primarily due to poor management and inadequate governance; and that both past experience in Melbourne and international benchmarks suggest those constraints could be effectively addressed by reforming work practices, improving scheduling and making minor investments in signalling and related equipment. Mees also shows that previous capacity increments, themselves aimed at alleviating projected capacity constraints, were based on unduly optimistic projections of demand, leaving a costly legacy of underutilised capacity. Mees concludes that policy-makers should have examined less expensive, albeit politically less attractive, alternatives that involve altering the way the Melbourne rail system is run. Similar concerns about the range of options considered are also raised, somewhat less directly, in an independent review of the project undertaken for the Victorian government (Dotson 2008).

However, these alternative options are not considered in the CBA of the project undertaken for (and apparently accepted by) the Victorian government (Meyrick and Associates 2008), which broadly assumes that existing constraints would persist absent the capacity augmentation.

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35 The project involves several related components, including an initial upgrade to a regional rail link and then the construction of a tunnel. These elements, as they relate to the rail link, were combined in the published CBA and hence are treated here on a combined basis. We understand that the relationship between these components, and their sequencing, has undergone continued development since the CBA was completed. The project's elements are referred to as the Regional Rail Express and East-West Rail Tunnel in the May 2009 statement "Nation Building for the Future". It is the combined project, as assessed in the CBA but without its non-rail component, that is discussed here.

36 Combining the East–West Rail Tunnel and the Regional Rail Express, total estimated cost is $7.3 billion; the Pacific Highway Corridor project, which is the next largest project recommended by IA, has an estimated cost of $6.7 billion. The Commonwealth Budget has allocated $3.2 billion to the former and $618 million to the latter.

37 Taking the IA list of "priority projects ready to proceed", CBA's are publicly available for the F3-Branxton Freeway project (NSW), the Seaford Rail Extension project (SA) and the Majura Parkway (Stage 2) project (ACT). There is also a public version of an early stage feasibility study for the Gold Coast Rapid Transit (QLD).

Further concerns arise on closer assessment of the CBA. These relate, first, to the treatment of the standard building blocks of transport sector CBA (which we refer to as the conventional savings); and second, to the role of what are now referred to as 'Wider Economic Benefits' (we explain the meaning of the term below). As can be seen from Table 5, the finding that the project has net benefits relies significantly on each of these.

Table 5: Main results of the EWR CBA

	Combined Road and Public Transport Solution	Public Transport Only Solution
Present Value of Costs	$15.0 billion	$7.9 billion
Present Value of Benefits	$11.1 billion	$7.9 billion
Wider Economic Benefits (WEB)	$3.3 billion	$1.3 billion
Present Value of all Benefits (incorporating WEB	$14.4 billion	$9.2 billion
Benefit Cost Ratio incorporating WEB	1.0	1.2

Source: Meyrick and Associates 2008

Conventional savings

Transport CBA follows a relatively standardised form, typically focussed either on examining net social savings from a project or on assessing changes in net social surplus from a project, with the outcomes, if properly implemented, not being affected by the choice of approach. These standard building blocks are used in the CBA for the EWR.

However, in the EWR CBA, incremental fare revenues are simply added to the other sources of benefit – see Meyrick and Associates 2008, Table 16. This is equivalent to double counting the gain from the vehicle operating and travel time savings (as these are 'paid for' through the fares) and is incorrect.[38] While these incremental revenues are a small share of total estimated project gross benefits, they are a large share of project net benefits (which are themselves very small).

Wider Economic Benefits

Consistent with IA's project evaluation methodology, the EWR CBA examines a range of 'Wider Economic Benefits' that are claimed to arise from the project proceeding. Reliance on these 'Wider Economic Benefits' to increase gross estimates of benefits is increasingly common in Australian infrastructure evaluation, following work initially done in the UK – see UK Department for Transport 2006 and Joint Transport Research Centre (JTRC) 2008.

[38] This can be readily seen by considering a highly simplified example. Thus, assume there are 100 identical users who in the counterfactual drive from Geelong to Melbourne but under the proposed project, will take the train. The capital cost of the train is $900 and it costs $5 in operating expense per user. Driving costs each user $3 in operating costs and $10 in time costs; taking the train, they pay a $5 fare and incur a time cost of $3. The approach adopted in the EWR CBA is broadly to write: *Travel time saving* (in the above case, $700; for the study, see PV of time savings, column 1 of Table 16) + *Operating cost saving* ($300, avoided from not taking the car trip; for the study, see PV of Vehicle operating cost savings, column 2 of Table 16) + *Incremental fares* ($500; for the study, see PV of increased public transport revenue, column 5 of Table 16) = $1500, divided by *Cost of the new line*: $900 in capital + $500 in expenses = $1400, for benefit/cost ratio of 1.07. However, this greatly overstates the benefit. Thus, the net gain to travellers, which is the difference between the $1300 cost they incur for road travel minus the $800 cost they incur from train travel, is $500. The rail operator incurs an operating cost of $500 and has operating revenues of $500, leaving an expected rental of zero. The current social surplus is therefore only $500, which is insufficient to cover the capital cost of the train. (The use of the benefit/cost ratio (BCR) as a criterion is also incorrect, as it will not, in general, lead to an efficient allocation of a given level of outlays, which requires use of a criterion that maximises the sum of net benefits – see for example, Quinet and Sauvant 2007.)

CBA has, of course, long taken account of technological externalities (such as project-related changes in noise); 'Wider Economic Benefits' are essentially pecuniary externalities, that is, effects on other parties caused by changes in the prices at which they can transact. In competitive markets, such pecuniary effects are merely transfers of benefits from one party to another – see for example, Meyer and Straszheim 1971, pp. 199-202. This is not the case, however, when markets are imperfectly competitive and in particular, when markets are neither perfectly competitive nor completely monopolised (in which case, benefits are internalised by the monopolist – see Mohring and Williamson 1969).

A familiar example is a transport project that by opening trade between two regions, reduces the extent of monopoly power. In the simple case in which the demand curve in each region is linear, producers are identical and marginal costs are constant, the total benefit from the project is 1.5 times that measured in the conventional CBA. While that has long been known to cost-benefit analysts, the general view has been that in mature economies with well developed transport networks, these effects are likely to be very small, and possibly offset by 'Williamson trade-offs'.[39] However, attention to these pecuniary externalities has been revitalised as a result of the renewal of geographical economics, with the emergence of the Krugman-Fujita-Venables general equilibrium model of spatial monopolistic competition, the parallel renewal of urban economics, both theoretical and empirical, and (though less centrally) developments in the analysis of oligopsony in labour markets. Each of these areas of work has suggested that transport changes could have effects in reshaping locational decisions, product markets and labour markets that are not fully captured in conventional approaches to CBA and are sufficiently material to warrant attention.

Reflecting this, and drawing on work in the UK, it has become increasingly common for Australian transport analysts to ascribe benefits to claimed effects of the project in allowing fuller exploitation of agglomeration economies, reducing market power in product and/or factor markets and increasing labour force participation. Thus, the EWR CBA ascribes material benefits to increased agglomeration economies and to greater labour supply. Indeed, absent these benefits, the project would not have benefits in excess of its costs.

However, it is not clear that these benefits have been correctly and reliably assessed.[40]

Turning first to **agglomeration economies**, the CBA treats these as a black box, ascribing a benefit to reductions in the 'effective economic distance' between areas (with the benefits being calculated using estimates of these effects for the UK). At an analytical level, it is difficult to reconcile these estimates either with the results of urban economics or with those of general equilibrium geographical economics. Thus, in the work-horse model of geographical economics, a reduction in transport costs creates net gains from external economies but these are the sum of greater gains in the 'larger centre' (and to immobile factors in that centre) and of smaller gains and losses in the 'smaller' centre (typically, with losses to immobile factors in that smaller centre): see, for example, Brakman, Garretsen and Marrewijk 2001, pp. 308-313. As a result, the calculation of

[39] This refers to situations where improvements that increase economies of scale, or convert variable costs into lower but fixed and sunk costs, yield potential increases in social surplus but at the expense of greater monopoly power (and hence possibly lower consumer surplus – depending on the reference point adopted).

[40] A review of the analysis of Wider Economic Benefits in the East-West projects was undertaken by PriceWaterhouseCoopers for the Victorian government -- PriceWaterhouseCoopers 2008a. However, this assessment omits the points covered here.

the net change requires a consideration of both the gains and the losses.[41] Moreover, the extent of the net welfare change is generally highly sensitive to the precise structure of the transport change and of the production and demand environment: see, for example, Baldwin et al. 2003. Application of what amount to no more than standard multipliers for the UK is of little help in this context, particularly for the purpose of assessing projects involving many billions of dollars of public outlays. This is all the more the case as there appear to be identification problems in the estimates used and as marginal and average, gross and net, effects are not separately identified.

Consideration of modern urban economics only underscores these concerns. Thus, both theory and empirical analysis suggests that a substantial share of agglomeration economies arise from spill-over effects in human capital – see Glaeser 2000, Acemoglu and Angrist 2001, O'Flaherty 2005, and Glaeser and Gottlieb 2008. Moving skilled people from one area to another is only advantageous if the impacts of those skills differ across areas – resources should, in other words, be pushed to areas that are more productive and where the elasticity of productivity with respect to agglomeration is higher. When this is done, the resulting gain in the new equilibrium (that is, the equilibrium once the transport project is complete and the allocation of people over space is such that the spill-over at the margin is equalised across places) is not the gross gain in the destination area (assuming there is such a gain), but rather the net gain taking account of the loss of agglomeration economies in the origin area. Again, rather than demonstrating that such rearrangements of skills are likely to occur, the EWR CBA appears to assume as much, as well as assuming that the effects can be assessed by applying summary impact multipliers derived from the UK.

Additionally, in the standard model of urban residential location, the welfare benefits of changes in transport costs depend on the extent to which transport infrastructure and other goods subject to congestion (such as schools and hospitals) are appropriately priced – see Arnott 1979. Thus, reductions in transport costs (such as those being modelled in the EWR CBA) will alter settlement patterns, typically inducing greater decentralisation (as people exercise their preference for larger lots at points further along the initial bid/rent curve): see, for example, Baum-Snow 2007 and Duranton and Turner 2008b. While this leads to a welfare gain (as those moving clearly value the new location at more than the previous location), whether welfare rises overall depends on whether externalities are imposed on existing users of the congestible facilities.[42] Given this, it is incorrect to assume there will be benefits from agglomeration without taking account of any possible offsetting costs as location patterns change.

Finally, even if there were possible gains from increased agglomeration, it would only be correct to impute to the project that element of those gains that the project delivers at least cost. If the gains at issue could be delivered by cheaper means – for example, by reducing restrictions on urban development and redevelopment – and the project is an alternative to those means, then the offset to project costs should be no greater than the cost of the foregone alternative.

None of this is to say that agglomeration economies and other changes associated with transport-induced shifts in the pattern of economic activity are negligible. As a growing body of literature shows – see among others Baum-Snow 2007, Chandra and Thompson 2000, Donaldson 2009,

[41] Thus, in a study of ports, Cohen and Monaco 2008 find that an increase in port capital stock in one US State leads to lower manufacturing variable costs in that State but increases the variable costs of manufacturers in neighbouring States. The net effect depends on the balance between these.

[42] Of course, in the long run spatial equilibrium, utilities must be equalised across locations. However, because equalisation occurs in utilities (assuming one cannot live in two places at once), rather than marginal utilities, the equilibrium is not first best.

Duranton and Turner 2008a, Elhorst and Oosterhaven 2008, Fernald 1999, Heyma and Oosterhaven 2005, Michaels 2008 – that is not the case. However, the literature also results in a broad range of estimates of the extent of effects, the degree to which they prevail across different transport modes[43] and whether they persist at high levels of transport infrastructure development.[44] It is therefore our view that unless detailed location-specific studies are undertaken, there is great merit in the conclusion reached by Glaeser and Gottlieb 2008 in their consideration of urban policy:

> *Since we lack confidence about which places should be subsidized, a simple model suggests that social welfare is maximized by choosing transport spending to maximize its direct benefits, not according to its ability to enhance one place or another.*

We would therefore put little or no weight on the agglomeration benefits claimed in the EWR CBA.

Turning now to **labour force participation effects**, the EWR CBA treats reduced commuting costs as an increase in the take-home wage and applies to that wage increase a labour supply elasticity estimated for the UK (with a value of 0.1)[45]. A correction factor (0.69) is then applied to adjust for the likely difference in labour productivity between the additional workers and the existing workforce. Given that the added labour hours are valued at the take-home wage, it would obviously be inappropriate to include them as a social benefit; however, it is correct to treat the tax wedge as a social gain[46], as it is effectively an externality that accrues to taxpayers.

However, the approach adopted in the CBA is incorrect. This is because a reduction in transport costs cannot be equated to an increase in net wages. This can be seen from **Figure 2, Figure 3, Figure 4 and Figure** 5**.**

which show the shift in the budget line and in the consumption/leisure equilibrium consequent on a reduction in travel time. In essence, while an increase in net wages changes the slope of the consumption/leisure budget line, a reduction in travel time shifts the budget line out. The effects on labour force participation depend on the impact on hours for those who already work, which depends on the income expansion path, and the extent of the shift into the paid labour force for those who would not work in the counterfactual. There is no reason to expect a conventional elasticity of labour supply to capture these effects (all the more so one estimated for the response of hours to wages in the UK).

Figure 2 **The Consumption/Leisure Trade-off Prior to the Reduction in Travel Time**

[43] For example, the agglomeration effects of public transport seem to be less than those for road travel – a factor not taken into account in the EWR CBA.

[44] For example, Fernald 1999 finds that US interstate highway investment had high returns in terms of increasing productivity during the period before 1973, in the order of 10 per cent per year, and an almost zero return after. He attributes this result to the fact that the interstate highway network was essentially complete after 1973, and that marginal improvements to the network were no longer as productive, and also to the fact that the interstate highway network became progressively more crowded, and to that extent more expensive to use, after 1972.

[45] The elasticity is reported in the EWR CBA as -0.1 (see Meyrick and Associates 2008, page 27 and page 44); we assume it is intended to be 0.1, or the claimed effects would not follow.

[46] Assuming the increased hours are not matched by a required increase in public outlays.

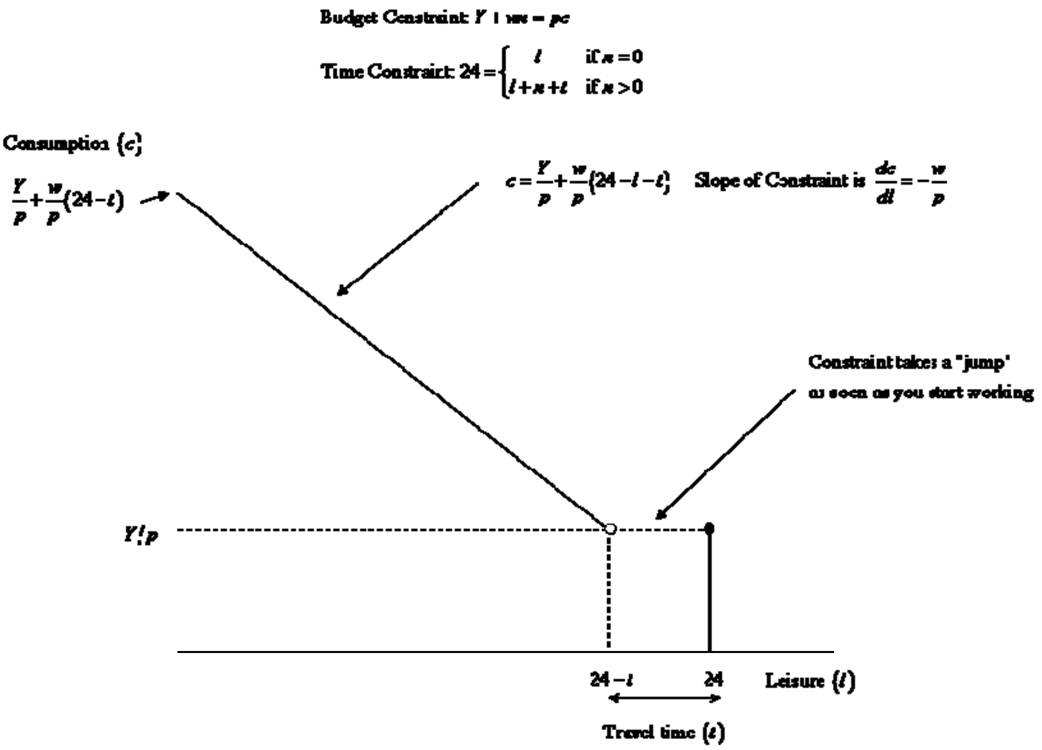


Figure 3 The Effect of a Reduction in Travel Time

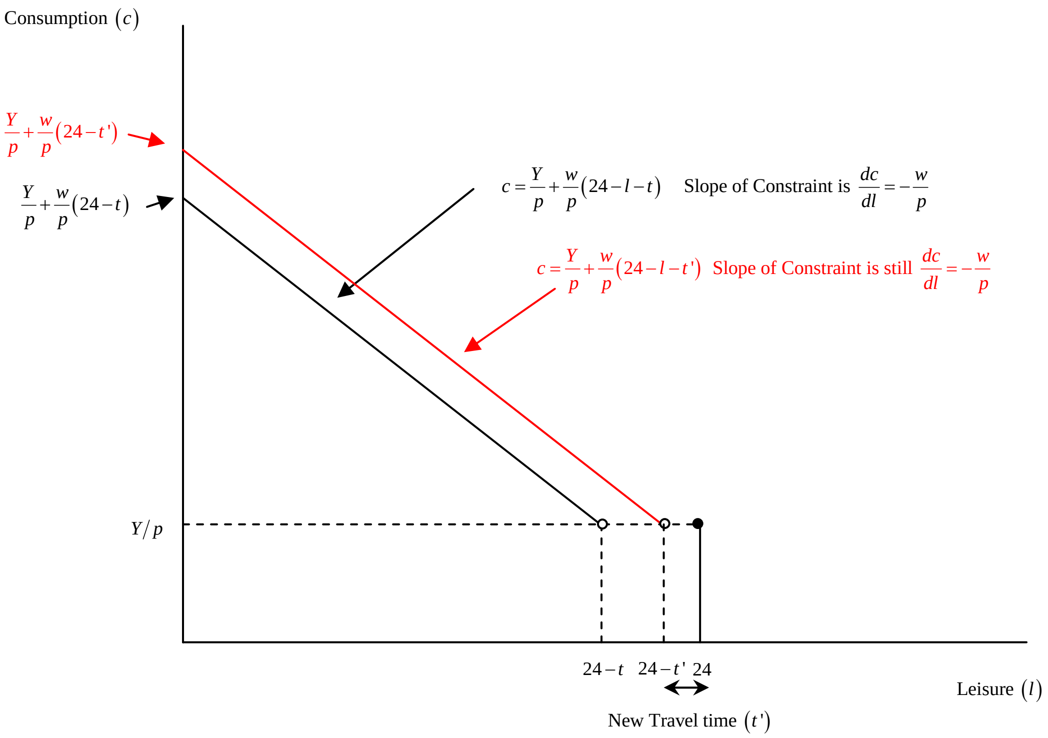


Figure 4 Reduction in Travel time, Increased Hours Effect

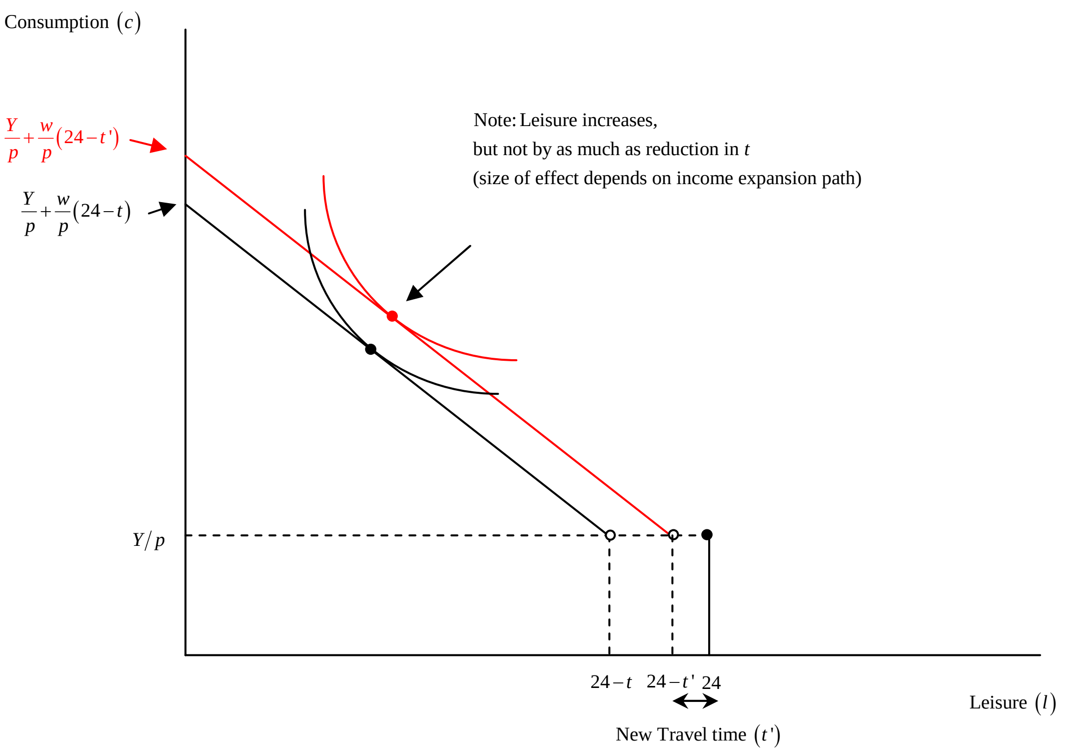
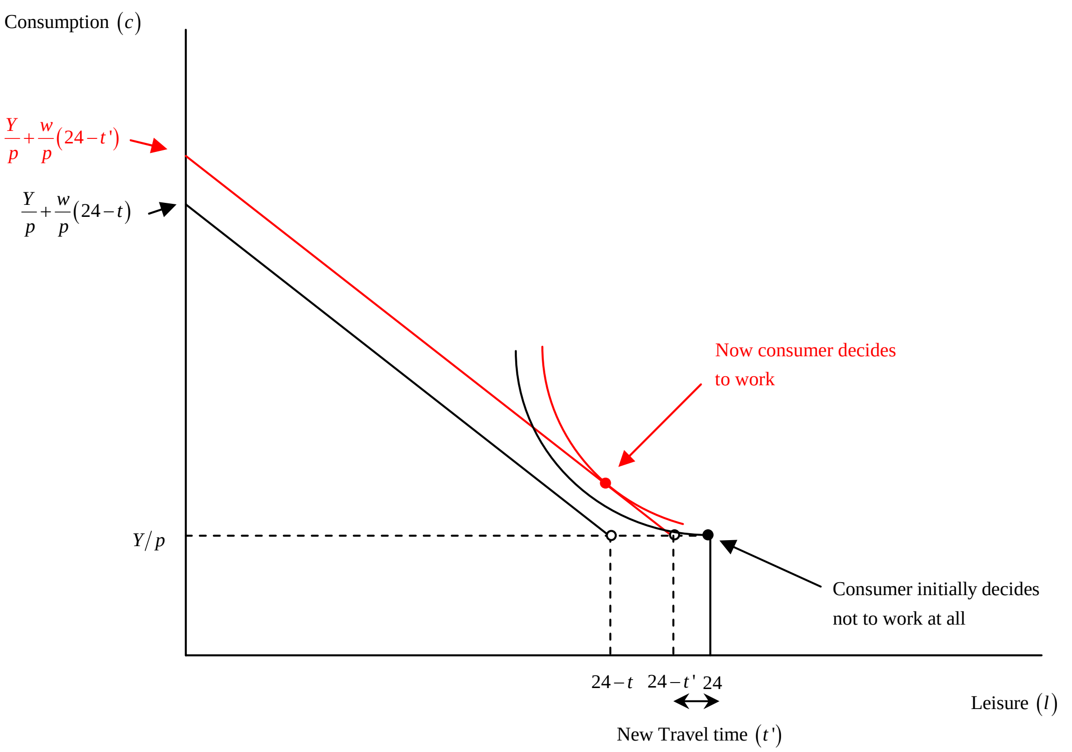


Figure 5 **Reduction in Travel Time, Labour Participation Effect**



Matters are further complicated by the fact that reductions in transport costs affect settlement patterns.[47] While the likelihood of such consequential changes is well-evidenced (see the discussion above), the interactions with long-term labour supply decisions are not. In particular, it may be that the main effect of reduced commuting times is to alter the distribution of working hours as between days worked per year and hours worked per day (with lower commuting times being associated with greater incidence of part-time work or more generally, short working days but possibly more days of work per year) – see, for example, Huberman and Minns 2007. Again, absent detailed modelling, of the kind done by Elhorst and Oosterhaven 2003, the most reliable estimate of the long run effects on labour supply is likely to be zero.

Conclusions on EWR CBA

The EWR is a very major project, involving billions of dollars of taxpayers' money. It has been endorsed by the Victorian and Commonwealth governments. However, there are a number of difficulties with the CBA, at least in its published form. When the errors are corrected, and account is taken of the marginal social cost of public funds (which the CBA ignores), project costs greatly exceed project benefits.

Many of the difficulties associated with the EWR CBA, and especially those with respect to the treatment of 'wider economic benefits', also arise with increasing frequency in other Australian transport CBA's. They suggest a need for significantly greater rigour in the way these benefits are determined, if they are not to become a 'fudge factor' that undermines the quality and relevance of the cost-benefit studies.

IMPROVING THE EVALUATION PROCESS

The case studies set out above suggest that at least some important infrastructure decisions are being taken on the basis of little evidence and in at least some instances, inadequate analysis. This is an obvious concern given the scope poor infrastructure decisions have to reduce capital productivity and hence lower living standards in the longer term. Mounting evidence of inefficiencies in the way our infrastructure is run – with the search for 'ribbon cutting' opportunities displacing adequate investment in maintenance, causing a rapidly growing maintenance deficit that is well-documented in Victoria and New South Wales (NSW Audit Office 2006, Victorian Auditor General's Report 2008) – only adds to the concerns. What then can be done to strengthen the evaluation process?

Ultimately, the quality of evaluation depends on the value governments place upon it. Governments that view project evaluation as merely a nuisance that stands in the way of the decisions they want to take, and that believe they can get away with no evaluation or poor quality evaluation, will, over time, invariably succeed in devaluing the evaluation process. This has, we believe, occurred in Australia in recent years.

In part, this simply reflects a loosening of government budget constraints due first, to sustained economic growth and then, to a belief that the global financial crisis meant that high levels of government spending were not only feasible, but desirable. As the threat of recession loomed, confused reasoning lead to a belief that infrastructure investment could legitimately be claimed to be a tool of macroeconomic policy – even though, in an economy with monetary and aggregate

[47] The observed long-term constancy of time spent commuting to work (see Vanderbilt 2008 pp.131 and follows) is consistent with the inference that reductions in travel time are largely offset by shifts in settlement patterns. So too is Down's 'fundamental law of traffic congestion' – see Downs 1992 and Duranton and Turner 2008b.

fiscal policy instruments, infrastructure investment should play no role in stabilisation policy and cyclical conditions should not affect the timing or extent of infrastructure outlays, other than through their effects on projected demand and on the shadow prices of inputs (effects which, properly analysed, can suggest that infrastructure projects should be deferred, rather than accelerated, during downturns): see, for example, Bureau 1985.[48]

There are, however, also longer term forces at work. These forces reduce the effectiveness of accountability and increase the attractiveness of infrastructure decisions as elements in rent-seeking bargains.

The first is the ever greater blurring of responsibility for infrastructure between the Commonwealth and the States, and the progressive loosening, by the Commonwealth, of budget constraints at a State level. This reduces the electoral accountability of, and electoral pressure on, State governments, while reducing the opportunity cost State governments incur for poor investment decisions. To some extent, the Commonwealth has sought to offset the resulting moral hazard by imposing performance obligations on the States – such as the evaluation requirements built into Auslink. However, much as with foreign aid, these requirements typically bear only a very indirect link to the outcome being sought (which in this case, is quality decision-making) and readily become (at best) 'tick the box' constraints, that are often easily gamed (as the quality of compliance is rarely monitored, and when monitored, even more rarely acted upon). Threats of conditionality have little credibility, especially when doing so would impose a significant political cost on the Commonwealth itself. Again, much as with foreign aid (see Azam, Devarajan and O'Connell 1999, Brautigam 2000, Knack 2001, Alesina and Weder 2002, Bardhan 2005, Easterly 2006, Moss, Pettersson and Walle 2006, Janus 2009), the result is a degradation in institutional quality and in ultimate outcomes.

These issues associated with fiscal federalism have become even more complex with the creation of the BAF and of Infrastructure Australia. Although there can be merit to coordinated approaches to infrastructure selection, there can be little doubt that the new mechanisms create significant incentive problems. To the extent to which the projects they fund are worthwhile, that funding may simply displace funding of those projects by the States themselves, but with higher transactions costs and possibly poorer monitoring and other performance incentives in the process.[49] There may, in other words, be incentives for adverse selection, and then for moral hazard in project execution to boot.[50]

The second factor that has contributed to a decline in the quality of project evaluation is the growing involvement of the private sector in the design, construction, financing and operation of major infrastructure projects, both through the contracting out of almost all aspects of project implementation and perhaps especially, through Private-Public Partnerships (PPPs). While these

[48] Bureau develops a non-Walrasian model with an external constraint, a monetary policy instrument and fiscal policy. While no policy instrument should be thrown away, his main result is that macroeconomic considerations should enter into the evaluation of infrastructure investment only to the extent that the consequences of that investment are orthogonal to those of the macroeconomic instruments. As for the impacts of cyclical factors on the CBA, where public assets will compete with private assets (as in the case of the NBN), then the costs of those public assets will rise during recessions, even in the presence of Keynesian unemployment – see for example, Johansson 1991, pp. 122-123. Additionally, to the extent demand expectations are reduced, this should lead to lower infrastructure investment.

[49] Obviously, if the Commonwealth funding were simply matching grants associated with the pure spillover effects of the State infrastructure decisions – i.e. a Pigouvian subsidy – the issue of displacement would not arise. Conversely, if the projects are so poor that they would never have been undertaken by the States then there will indeed be a 'flypaper' effect and aggregate infrastructure outlays will rise (on which see generally Brennan and Pincus 1990: as per Brennan and Pincus, this is a case where the grant pushes spending to the corner solution).

[50] The question of how to design multi-level funding institutions, and associated CBA processes, so as to deal with these effects has received some attention in the EU, although with few readily implemented results to date: see Florio 2007.

may have merits in terms of productive efficiency, the use of high-powered incentives[51] has complex, and often undesirable, impacts on the quality of public administration – see for example, Estache and Martimort 1999. In particular, because the incentives are high-powered (i.e. the private party secures substantial gains from reducing costs under the contract), these arrangements increase the returns to rent-seeking and to tainted deals between governments and private sector suppliers. Particularly with PPPs, the effects are then threefold: they concentrate the gains from the project (as some share of these is now captured by the private participant), and by so doing, increase the payoffs from collusion between the public decision-maker and the project's private beneficiaries; they allow crucial aspects of the project to be cloaked in commercial commerciality, thus reducing the transactions costs of collusion; and they relax (or, more properly, are widely but incorrectly claimed to relax) the public sector budget constraint. Each of these effects induces a deterioration in the efficiency of decisions and overall outcomes.

Ultimately, PPPs are only as good as the governments that make them; and given governments intent on poor decisions, PPPs can not only make those decisions more (privately) profitable but allow them to be locked in through long term, judicially enforceable, contractual commitments.[52]

A third factor, that is yet to fully play itself out, is the recourse to hypothecated funding sources for long-term infrastructure finance, most notably the BAF. While economic theory yields ambiguous results as to the effects of hypothecation on fiscal efficiency[53], it does identify a number of important ways in which earmarking it can reduce the quality of public expenditures.

First, earmarking implies inflexibility in the allocation of revenues among competing uses. If the earmarking is substantive, in the sense of being effectively constraining, social rates of return are unlikely to be equalised at the margin across uses. Tax rates, expenditure levels or more likely both, will be distorted as a consequence.

Second, reserving revenues to a program gives it a monopoly over those revenues, encouraging and potentially perpetuating technical inefficiency in its supply.

Third, earmarking can facilitate rent-seeking by allowing the interest groups that benefit from the hypothecated revenue stream to focus their activities more effectively. Rather than competing against other interest groups for a larger share of general revenues, the relevant groups can limit their efforts to seeking an increase in (or protecting from erosion) the hypothecated fund. At the same time, the political commitment they secure is potentially made more credible by the earmarking, increasing both the 'price' that the interest groups are willing to pay in exchange and the resources they are willing to dissipate in obtaining it. Rent-seeking coalitions therefore become easier to create and sustain, and the aggregate costs to the community from rent-seeking rise, as Kimenyi, Lee and Tollinson 1990 found in their study of the US Highway Trust Fund.

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[51] The 'power' of an incentive structure is determined by the extent to which the agent to whom that incentive structure applies can secure for itself the gains from cost reductions (or other improvements in performance). Incentives are said to be 'high powered' when the agent secures a large share of the gains (as in a fixed price contract); conversely, they are 'low powered' when the agent's share of any gains is small (as in a cost-reimbursement contract).

[52] This is similar to the 'Landes-Posner effect', whereby an independent judiciary increases the extent of rent-seeking by making it easier for legislators to lock in tainted deals – see Landes and Posner 1975.

[53] For example, earmarking may be a way of increasing the credibility of promises, reducing the inherent incompleteness of the implied contracts between government and the public. As well as any direct benefits arising from greater credibility of commitments, this may allow proponents of programs to signal the quality of the programs, of the proponents or both. Thus, in the model of Brett and Keen 2000, a commitment to dedicate revenues to a particular use, which is of value to the public but would not be of value to a 'poor quality' politician, can support a separating equilibrium in which politicians signal their quality to the electorate.

Fourth, these adverse consequences are made all the greater by the risk created by earmarking of fiscal illusion, that is, of the hypothecated revenues not being as visible as other forms of public revenue and expenditure.

All of these factors create risks that the new earmarked funds, though they may increase spending on infrastructure, could reduce the quality of that spending.

Set against these long term forces, project evaluation is a relatively weak reed, and the effects of changes to evaluation processes alone may well be relatively small. Nonetheless, we would suggest three areas for reform.

The first is **greater transparency**. There is no reason why CBAs should not be publicly disclosed as a matter of course. Instead, most CBAs are never released, and those that are, are often difficult to locate. Governments should also regularly publish, in readily accessed form, the CBA rankings of those projects they have decided to proceed with and those they have considered and rejected (as is done in Finland, for example). Were disclosure of CBAs routine, the fact that a CBA had not been conducted on a particular project would become more obvious, as would the relative quality of the CBAs that had been carried out.

The second is greatly enhanced **auditing**. Auditing plays an important role in improving the efficiency of principal-agent relations, both by allowing principals to better assess the outcomes of the efforts made by agents and by deterring collusion between agents and third parties – see Mookherjee and Png 1989. The introduction of an independent auditor, whose interests are separate from those of the party being audited, increases the likelihood of poor conduct being detected, including when that conduct takes the form of bias (for instance, associated with 'excess optimism' or with the strategic understatement of costs[54]).

The auditing we believe desirable would take two forms. To begin with, there is substantial merit in having independent review of all CBA's for 'mega projects' (say, projects with projected outlays in excess of $500 million). This could be done by an office answerable to Parliament, rather than forming part of the Executive. Such an office could be similar to the Congressional Budget Office in the United States. Were establishing such an institution considered too radical, at the very least adequate specialist resources should be provided to a Parliamentary standing committee to engage the kind of forensic analysis required. This is not to cast doubt on the ANAO, but rather to suggest that its competence, and standard form of operation, are not especially well-suited to this task.

As well as this form of review, there is a pressing need for much more to be done in terms of post-completion review of projects. Although a few useful post-completion reviews of CBAs have been undertaken (Bureau of Transport Economics 2001, Bureau of Transport and Regional Economics 2007a and 2007b, NSW Audit Office 2006, NSW Auditor General's Report 2005, NSW Treasury 2008, Victorian Auditor General's Report 2009), these are *ad hoc* in character, which limits their effectiveness both as instruments of accountability and as a means of learning from experience. The Auslink program mandated post-completion reviews; unfortunately, this requirement has not been rigorously enforced. We believe it should be.

Mandating systematic and transparent post-completion review could have far-reaching consequences. To begin with, it would force Commonwealth and State entities to more properly

[54] The pervasiveness of these forms of bias in transport assessments is amply documented in Flyvbjerg, Bruzelius and Rothengatter 2003.

document and archive material related to the CBAs and the CBAs themselves. In contrast, as matters currently stand, CBAs are typically undertaken before the final form of projects is determined, and then never updated. Additionally, little investment is made in documenting CBAs and in ensuring the integrity of the documentation chain. A genuine system of post-completion reviews would require all of those deficiencies to be addressed. At the same time, such reviews could be used both to benchmark jurisdictions and to more effectively learn from mistakes.

In short, we would strongly endorse – and argue more should be done to implement – the conclusion Little and Mirlees reached in reviewing, after two decades, the impact of their great CBA manual:

> *If good project appraisal warrants expenditure, as we argue, so does good appraisal of appraisal.*[55]

Third and last, there is a great deal that could be done both to increase the **quality of CBAs** and to promote a greater sense of professionalism in the group of people engaged in project evaluation. There are still many complex technical issues to tackle in Australian project evaluation – including the selection of the criterion function (where, unfortunately, the use of Benefit-Cost Ratios is still widespread, despite its well-known deficiencies), the treatment of the marginal social cost of funds (which is usually ignored), the determination of the discount rate (often set in a manner that is somewhat arbitrary), the assessment of changes in service quality and reliability (which is particularly important in public transport, as well as in communications), the appropriateness or otherwise of corrections for 'optimism bias' (which in the authors' opinion, are likely to be ineffective at best and distorting at worst), the role of 'Wider Economic Benefits', and so on. While many of these issues are well-traversed in the literature (if not in the practice) of project evaluation, there are other important issues that are relatively under-explored – such as the implementation of CBA in the context of hypothecated funds (where congruence requirements should come into play[56]) or the design of incentive-compatible evaluation schemes for structures such as Infrastructure Australia.

There is consequently considerable potential for cooperative research across jurisdictions, and for using that research, and its dissemination, as an instrument of on-going training for both practitioners and users of CBA. Moreover, that process could help give greater standing to the 'profession' of project evaluation and help define a community of those involved in project evaluation across different areas of infrastructure policy. There is an important role here for the Bureau of Transport and Regional Economics and also for the Productivity Commission. Thus, the PC could, much as it did in regulation review, issue 'Information Notes' recommending particular approaches to the technical issues analysts face. While we do not believe there is one 'right' approach to all of these issues, and hence would not favour mandatory standardisation across the States, that should not impede the exchange of views and the fostering of comparability of analyses across jurisdictions (so that the effect of different approaches can be identified). Much has been done in this respect by the Australian Transport Council's 2006 *National Guidelines*, but the list of issues identified above highlights the task that remains.

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[55] Little and Mirlees 1994 at page 206.

[56] When decisions are delegated to agencies, and agencies are instructed to make optimal use of their budgets, the expected growth path of agency budgets on the one hand and of investment opportunities on the other becomes an important factor in determining the optimal pattern of outlays. When an agency regards both its current budget and its current set of investment opportunities as representative of future opportunities – either because these regenerate periodically or because they are linked – it is referred to as having **congruent expectations**. Agencies should, in defining the choice set for evaluation, choose a set of projects and time horizon that can reasonably be regarded as congruent. Where agencies are budget funded, it is not unreasonable to assume the current budget defines such a set; however, this assumption cannot simply be carried over to an agency whose budget is hypothecated.

CONCLUSIONS

Infrastructure investment is a cost, not a benefit: a means, not an end. This proposition, which is obvious to economists, is as utterly alien to contemporary Australian politicians as the notion of comparative advantage was to their predecessors.

That matters should be so is by no means a new phenomenon. Thus, in Hancock's magnificent *Australia* (1930), now sadly out of print, the great historian famously said that it was a failing of democracies, and especially of Australian democracy, to constantly confuse ends and means, and to show too much reluctance "to refuse favours, to count the costs, to discipline the policies they have launched". "[The] policies therefore yield diminishing returns, until at last, they may become a positive danger to the national purpose that called them into existence". Nowhere was this more marked, Hancock noted, than with public involvement in infrastructure ventures such as rail, where Australian government was "particularly slow to confess it has got into a bad business, for its mere entry .. has created vested interests which immediately express themselves in politics.. So.. it throws good money after bad, and hopes that something will turn up. In this way, losses accumulate in a lump, and the crisis, when it comes, is likely to be prolonged and severe."

The costs and risks of this approach to infrastructure have also been known for many years. There are surely many echoes in current telecommunications decisions of the tendency Butlin, Barnard and Pincus identified in their analysis of the development of the Post-Master General's Department, for Australian public enterprise to provide "services that were too large, too quickly supplied and too cheap" (Butlin, Barnard and Pincus 1982, page 294). That so little should have changed is not encouraging.

Set against that background, how great a contribution can improved project appraisal make to securing better outcomes? Little and Mirlees, in considering 'The costs and benefits of analysis', develop a simple model of the value of information in which good project appraisal yields benefits that, in expected value terms, are in the order of 10 per cent of project value[57] (Little and Mirlees 1994, pp. 225-227). For an economy investing over $10 billion a year on its transport and communications infrastructure, 10 per cent of project value would seem like a saving well worth seeking. That said, the Little/Mirlees model assumes unbiased estimates and a decision-maker who, as a benevolent social planner, maximises social welfare; it is hardly contentious those assumptions do not hold – if they did, central planning would be a far better system than it has ever proved to be.

To recognise this, however, is not to imply that no value should be placed on good appraisal: on the contrary, it is one of the protections taxpayers deserve to have. Testimonials of commitment to 'evidence-based policy' notwithstanding, shaping an environment in which project appraisal can effectively discharge this task remains as great a challenge as it has ever been.

[57] The Little-Mirlees formulation yields a value of appraisal that is at least 10 percent of standard deviation of the errors removed by the appraisal, multiplied by the ratio of that standard deviation to the standard deviation of the errors not removed. This ratio should be about 1, though with competent appraisal it could be much more than that. As a result, a conservative estimate of the value of appraisal is 10 percent of project value.

APPENDIX A GANS NBN RETURN CALCULATIONS

Each of the steps in Gans analysis is set out below and problems are identified.

Step	Method	Output	Problem(s)
1. Estimate Annual Costs	$43 billion capital expenditure to be recovered over the life of the network	$4.3 billion to be recovered each year from end-users	For costs to be recovered, charges to users must include not only annual capital charges but also taxes, deprecation, O&M, marketing and retailing as well as costs for those network components (such as backhaul, switching etc) not provided by the NBN. Gans ignores all these other cost items.
2. Estimate Gross Commercial Return	Assume 3.6 million users (half of all fixed users) taking voice and broadband services over the NBN. Voice ARPU assumed to be current voice ARPU less usage costs ($765 minus $238 in usage costs = $527 pa) and broadband ARPU assumed to be the same as current ($500 pa).	$3.7 billion recovered from end-users annually (3.6 million users at $1027 ARPU)	This calculation assumes that all voice and broadband revenue accrues to the NBN operator and can be used to recover the costs of the NBN. However, prices will also need to cover retailing and network costs incurred by the NBN's wholesale customers (e.g. for backhaul). Currently, only a small share of broadband revenues goes towards covering costs of the copper access network (at most $20 per month out of around $60 per month average revenue) which the NBN will replace. If all the current revenues go to the NBN Co (which only provides the access loop) retail charges must increase for full cost recovery to occur.
3. Estimate Net Commercial Return	Subtract annual costs from gross commercial return	Gans states there is a $320 million shortfall	This calculation seems wrong. Subtracting costs from revenues above, we get a $600 million shortfall.
4. Estimate Consumer Welfare Gains	Assume usage costs for all end-users fall by $400 pa and calculate the increase in consumer surplus that results from this.	$2.88 billion in consumer surplus gains ($400 multiplied by 7.2 million end-users)	It is not clear why usage prices would fall by $400 under the NBN. Since Gans acknowledges that access costs 'may rise', this implies calling prices (both fixed-to-fixed and fixed-to-mobile) falling to 0 (Gans notes that access charges account for $350 out of the $765 paid by end-users for fixed voice). The calculation ignores the fact that providing calls and other forms of usage involves costs (for switching, transmission, network control, termination on other networks (eg mobile networks) etc) above and beyond those incurred in the fixed line reticulation network (which is all that is included in the estimated NBN cost). Gans seems to assume these costs do not need to be recovered. How that can be is not explained. The calculation is also inconsistent with the ARPU assumed in step 2 above, which assumes that only fixed-to-fixed usage costs will be eliminated and that current prices will only fall by $238 per user. It assumes all fixed-line users (not just NBN users) will benefit from the same price reductions, but it is not apparent why this would be the case.
5. Estimate Net Social Return	Add consumer welfare gains (step 4) to net commercial return (step 3).	$2.3 billion net benefit	The 'social return' is in fact not a social return at all, but rather a transfer from producers to consumers. Gans seems to assume that fixed operators currently profit from high usage charges and that under the NBN this profit will be transferred to consumers. Even if this were the case (and it is not clear why it would be), this would not amount to an increase in net economic welfare. Rather, it would simply be a transfer of wealth from producers to consumers.

Source: Gans J, 'The right policy for telecommunications and broadband', Submission to the Senate Select Committee on the National Broadband Network, June 2009

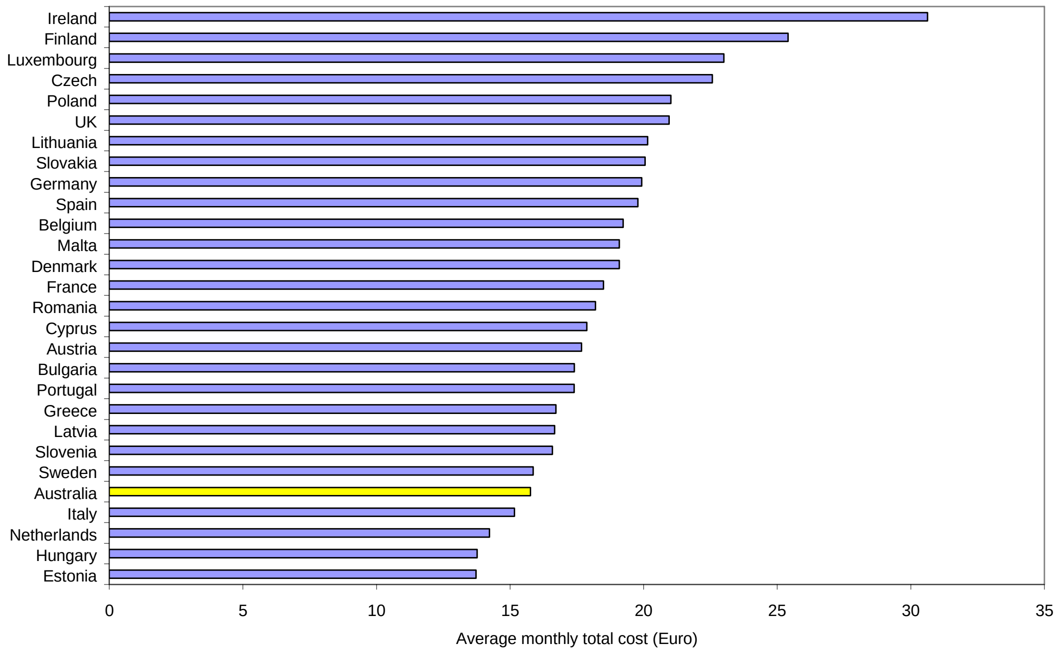
APPENDIX B ULLS PRICING AND TAKE-UP IN AUSTRALIA

ULLS PRICING

The regulated price of the Unconditioned Local Loop Service (ULLS) in Australia is relatively low by international standards. In the latest published ULLS pricing arbitration, the Australian Competition and Consumer Commission (ACCC) determined a Band 2 monthly charge of $14.30 and a connection charge of $52.80 for 2007-08.[58] Comparing these charges to those prevailing in the EU-27 in September 2008[59], we find them to be relatively low – only Italy, the Netherlands, Hungary and Estonia had lower ULLS charges (Chart 1).

For comparison, we take the monthly charge and add a share of connection costs assuming the connection lasts for three years (ie the connection charge divided by 36). Charges for the European countries are converted to Australian dollars using the average exchange rate for 2008 (A$1 = 57.743 Euro cents).[60]

Chart 1 **Monthly ULLS prices in Australia and Europe (AUD)**



Data source: ACCC; European Commission; Oanda

Since the Powertel determination the ACCC has published Pricing Principles and Indicative Prices for 2008-09.[61] The indicative price for 2008-09 is slightly higher than the 2007-08 price determined in the Powertel determination, at $16 per month. Although this price will not necessarily apply to

[58] ACCC, *Access Dispute between Powertel Ltd and Telstra Corporation Ltd: Final Determination under Section 152CP of the Trade Practices Act 1974*, March 2008

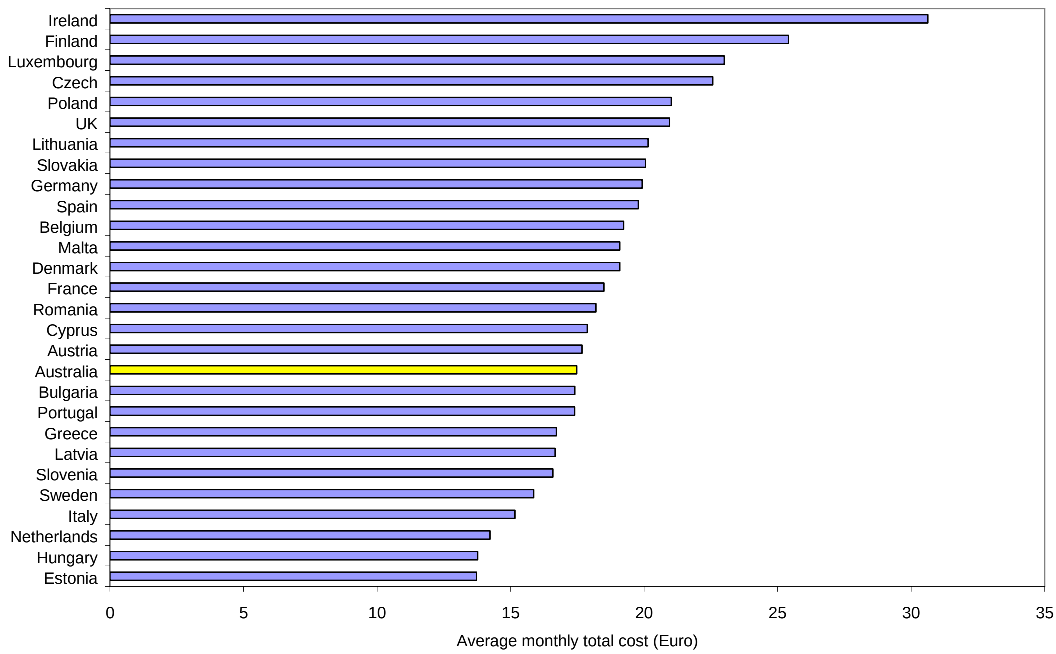
[59] European Commission, 'Progress Report on the Single European Electronic Communications Market 2008 (14th Report)', Brussels, March 2009, Annex 2, pp121-122

[60] Exchange rates sourced from Oanda

[61] ACCC, *Unconditioned Local Loop Service Pricing Principles and Indicative Prices*, June 2008

any access seekers unless an access dispute is notified, we also compare this price to the European benchmarks in Chart 2 below. Again, this price is at the lower end of the international sample.

Chart 2 **Monthly ULLS prices in Australia and Europe (AUD)**



Data source: ACCC; European Commission; Oanda

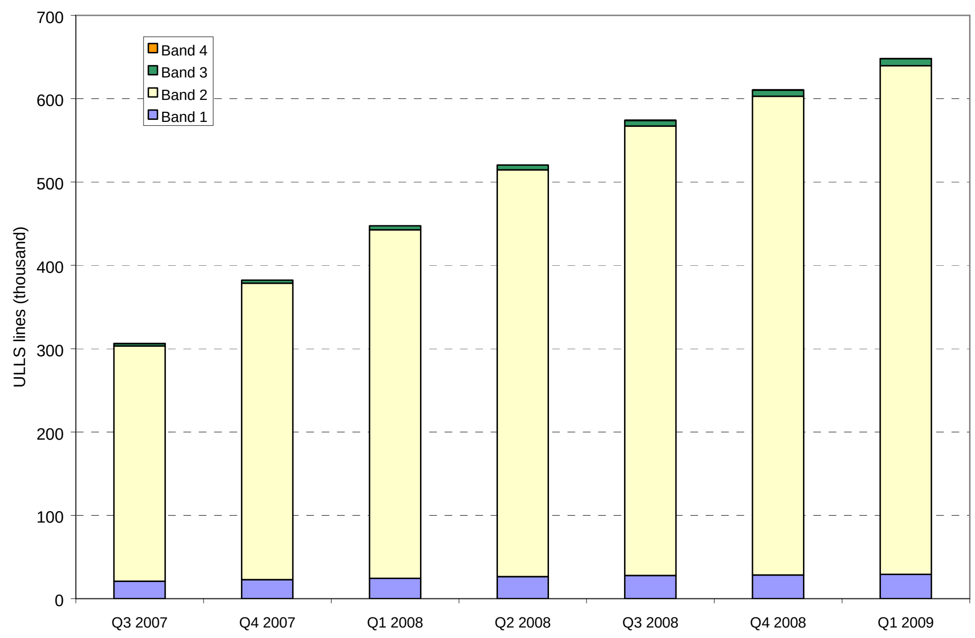
ULLS TAKE-UP

Partly as a result of low and declining ULLS prices, adoption has been growing rapidly in recent years. ULLS lines now account for 11% of all PSTN lines in CBD areas (Band 1) and 9% in metropolitan areas (Band 2).[62] In the 18 months to March 2009, the number of ULLS lines in all areas more than doubled to well over 600,000. This growth was dominated by Band 2, with very little growth seen in Bands 3 and 4 (Chart 3).

This has been accompanied by a growing presence of ULLS access seekers in Telstra exchanges. Over the same 18-month period, the number of Telstra exchanges with three or more ULLS access seekers grew from 155 to 300, while the number of exchanges with less than three access seekers shrank (Chart 4)

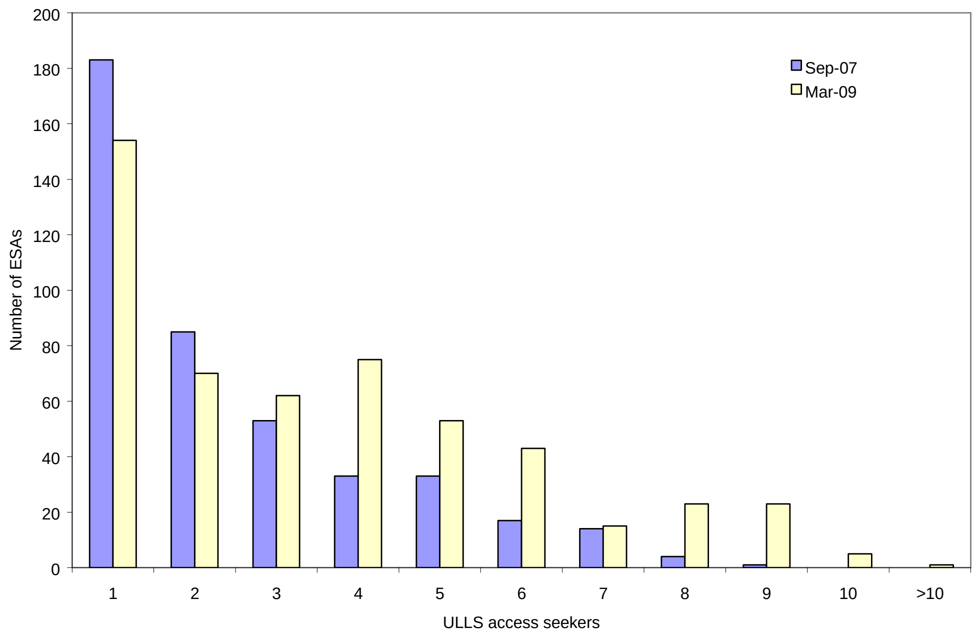
[62] ACCC, 'Snapshot of Telstra's customer access network – March 2009'

Chart 3 ULLS take-up by geographic area, September 2007 to March 2009



Data source: ACCC, 'Snapshot of Telstra's customer access network'

Chart 4 ULLS access seekers in Telstra exchanges, September 2007 to March 2009



Data source: ACCC, 'Snapshot of Telstra's customer access network

APPENDIX C A SIMPLE MODEL OF CONSUMER VALUATION OF SPEED

Greater speeds allow individuals to download the same amount of information in a shorter period of time, or more information in the same amount of time, or some combination of these two possibilities: i.e. more information in less time. The marginal willingness to pay for higher speeds is the marginal change in the consumer's indirect utility as speed changes marginally. Willingness to pay for a discrete increase in speeds will be the accumulated marginal changes in utility over the discrete increase in speeds.

To model this willingness to pay, consider a simple model of the allocation of time, due to Becker (1965). The model can be extended in various directions but the basic version illustrates the main features. Suppose that the consumer values sending and receiving information over the internet; call this commodity D for the volume of "downloads". The price of a unit of information is p_i.[63] The consumer also values other consumption goods. Let c be the quantity of other goods consumed, which have a price of p.

Suppose that it takes time to download and upload information on the internet. Let S_i be the internet speed, measured in volume of information per unit of time (eg Mbps) Then the amount of time devoted to downloading information from the internet is D / S_i.

This simple framework of course has its limitations. Information that is downloaded may itself take time to be consumed. For example, in an electronic book is downloaded, it must be read, and faster download speeds will not alter the time taken to read the book. Thus for many information goods the amount of time actually saved with faster download speeds may not be that great if the consumer has to take time to consume the information anyway. On the other hand, some goods are consumed instantaneously (for example, internet games), and in this case an increase in speeds may be more relevant to the consumer.

Similarly, other consumption goods take time to consume – for example, reading the newspaper, drinking a cup of tea, and so on. The internet may be a substitute for some of these goods (for example, reading a newspaper), but may be a complement to others (for example, drinking a cup of tea). If internet speeds increase, then the consumer will switch out of the former and towards the latter.

In any case, suppose that the consumer has lump-sum income Y and earns labour income at a nominal wage rate of w from working. Let n be the number of hours worked. The time and budget constrains for the consumer are therefore:

$$T = \begin{cases} \dfrac{D}{S_i} & \text{if } c = 0 \\ n + \dfrac{D}{S_i} & \text{if } c > 0 \end{cases}$$

and

[63] We consider other pricing schemes below. In particular, one would be interested pricing schemes that set flat monthly access fees, and zero per unit download charges up to a certain download limit.

$$Y + w\left(T - \frac{D}{S_i}\right) = pc + p_i D$$

The consumer maximises utility from consumption goods and the quantity of downloads, subject to the constraints above. At an interior solution we have:

$$u = u\left(D, c\right) = u\left(D, c\left(D\right)\right) = u\left(D, \frac{w\left(T - \frac{D}{S_i}\right) + Y - p_i D}{p}\right)$$

At an interior solution the first order conditions equate the marginal rate of substitution between consumption goods and downloads with the relative price:

$$\frac{u_D}{u_c} = \frac{\frac{w}{S_i} + p_i}{p}$$

A unit increase in downloads increases utility by u_D, divided by the cost in terms of both time and money. The time cost comes from the loss of the wage the consumer could otherwise have earned, multiplied by the time foregone in employment which depends on the time taken to download one more unit of information. The direct money cost is simply the money price of downloads. At the same time, the consumer gives up some units of consumption, which reduce utility by u_c/p. At the optimum, these two gains must be equal.

Now consider a consumer at the optimum who chooses an optimal bundle. Let the consumer's maximised utility be:

$$v = u\left\{D^*\left(S_i\right), c^*\left(S_i, D^*\left(S_i\right)\right)\right\}$$

Then a change in s at the margin increases indirect utility by:

$$\frac{dv}{dS_i} = u_D D_{S_i} + u_c\left(c_{S_i} + c_D D_{S_i}\right) = D_{S_i}\left(u_D + u_c c_D\right) + u_c c_{S_i}$$

Now the term c_D is the change in consumption of all other goods as downloads change, holding all other variables fixed. But this is just the slope of the budget constraint, i.e. it is equal to:

$$c_D = -\frac{\left(\frac{w}{S_i} + p\right)}{p}$$

This means that the first term in parentheses in the preceding equation is zero (this is just the envelope theorem), and thus:

$$\frac{dv}{dS_i} = u_c c_{S_i} = u_c \frac{w}{p} \frac{D}{\left(S_i\right)^2}$$

The marginal utility of income at the consumer's optimum is:

$$\lambda = \frac{u_c}{p}$$

Dividing both sides by this marginal utility of income, we get:

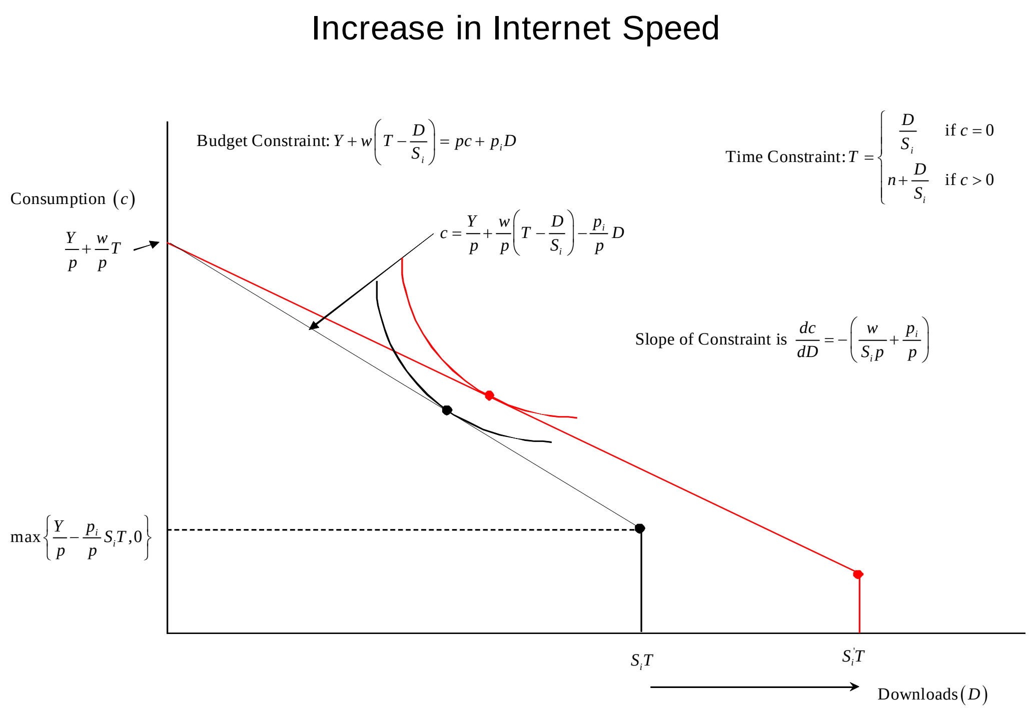
$$\frac{\frac{dv}{dS_i}}{\lambda} = \frac{wD}{(S_i)^2}$$

The welfare effect of a marginal increase in speed is the current amount of information downloaded, multiplied by the wage, divided by the square of the speed.

Note that an increase in S_i certainly increases welfare – it reduces the time taken to download one unit of information, so that downloads become less expensive in terms of their time opportunity cost. Thus the marginal benefits of (and marginal willingness to pay for) an increase in download speeds are likely to be higher for those consumers who have a high wage or who already consume high download volumes. On the other hand, other things being equal, marginal benefits fall away with higher speeds, and fall away with the square of the speed in this simple model.

The diagram below illustrates the effect on the consumer's choices and utility of an increase in internet speeds in this framework. Note that downloads increase, but time spent on the internet (and therefore labour supply) may either rise or fall, depending on the elasticity of demand with respect to changes in speed.

Figure 6 Increase in Internet Speed



INTRODUCTION

The use of the Solow-Swan model to derive rough estimates of the dynamic effects of changes in fiscal policy has a long history in the literature. Sato (1967) examines the effect of income taxes, consumption taxes, profits taxes, wage taxes and wealth (capital) taxes in the Solow-Swan model. Feldstein (1970), Grieson (1975) and Boadway (1979) examine tax incidence in the Solow-Swan model assuming separate rates of taxation on labour and capital income. Atkinson and Stiglitz (1980), Boadway and Wildasin (1984) and Jha (1998) present textbook treatments. Recently, Gale and Orszag (2004) and Shapiro (2004) have used the Solow-Swan growth model to estimate the growth effects of higher budget deficits (reduced rates of public savings) in the United States.

Consider a discrete-time version of the Solow-Swan model, allowing for a constant rate of exogenous technological progress over time. The production function is:

$$Y_t = AK_t^{\alpha}\left(\Gamma_t L_t\right)^{1-\alpha} = AK_t^{\alpha}\left(1+\gamma\right)^{t(1-\alpha)} L_t^{1-\alpha}$$

[see, for example, Prescott (1998)], where A is scaling parameter, Γ_t is an exogenous productivity factor that grows at a constant rate, K_t is the economy's net capital stock at the beginning of period t and L_t is aggregate hours worked during period t. We assume a constant aggregate savings rate, constant population growth, and that population growth translates into the same rate of growth in aggregate hours worked.

Let s be the private saving rate out of disposable income, let *n* be the growth rate of aggregate hours worked, and let γ be the growth rate of Γ_t. In the absence of government spending the capital stock evolves according to:

$$K_{t+1} = sY_t - \delta K_t$$

where δ is the rate of depreciation of the capital stock. For convenience we can express all the units in terms of effective hours of work:

$$\tilde{y} = A\tilde{k}^{\alpha}$$

where all variables are now expressed in terms of AL or "effective work hours". The law of motion for the capital stock per effective work hour is now:

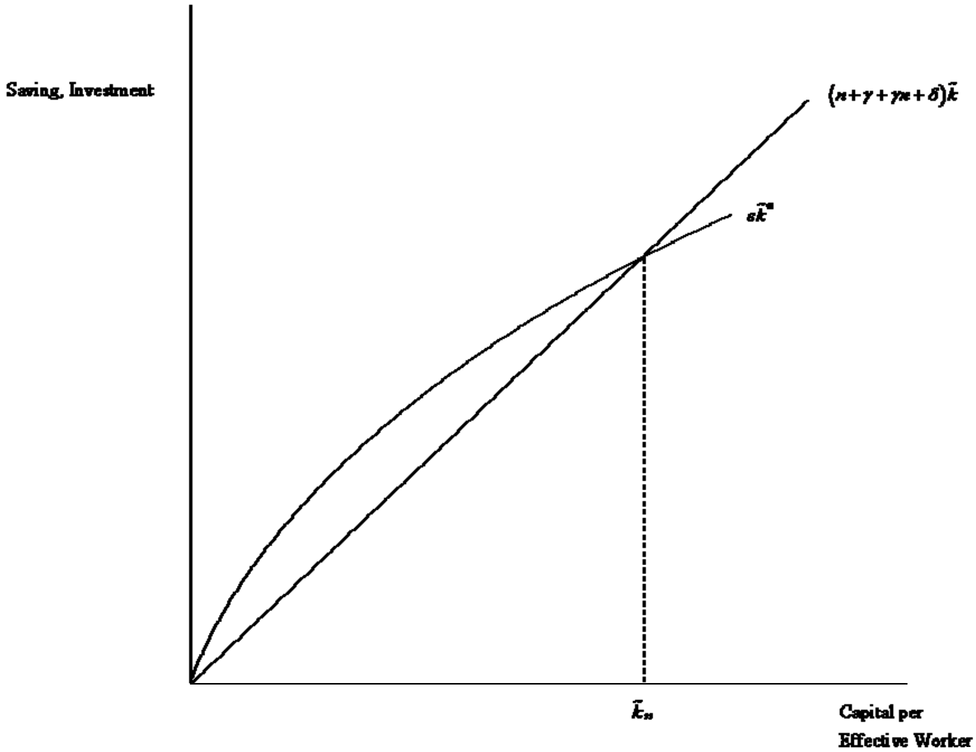
$$\tilde{k}_{t+1} = \frac{1}{\left(1+n\right)\left(1+\gamma\right)}\left[s\tilde{y}_t + \left(1-\delta\right)\tilde{k}_t\right]$$

In the steady state of this model, the growth rates of capital and output per effective work hour are zero. In other words, the steady growth rate of output and capital is simply equal to the growth rate of the population plus the growth rate of exogenous technological change. The steady state capital per effective work hour solves:

$$\tilde{k}_{ss} = \frac{1}{\left(1+n\right)\left(1+\gamma\right)}\left[sA\tilde{k}_{ss}^{\alpha} + \left(1-\delta\right)\tilde{k}_{ss}\right]$$

And so: $\tilde{k}_{ss} = \left(\frac{sA}{n+\gamma+\gamma n+\delta} \right)^{\frac{1}{1-\alpha}}$

This capital stock is an increasing function of the saving rate, a decreasing function of the growth rate of the effective labour force $(1+n)(1+\gamma)$ and a decreasing function of the depreciation rate of the capital stock. The steady state capital stock per effective work hour is illustrated in the diagram below.



In the steady state, the level of output per effective worker is constant. Thus, GDP grows at the rate $\frac{Y_{t+1}-Y_t}{Y_t} = \frac{(1+n)(1+\gamma)Y_t - Y_t}{Y_t} = n+\gamma+\gamma n$. The last term is small and so the steady state growth rate can simply be approximated by $n+\gamma$. In a continuous-time version of the Solow-Swan model this last term would not appear.

THE SOLOW MODEL WITH GOVERNMENT SPENDING: COMPARING STEADY STATES

The NBN represents a temporary increase in government spending above that which had previously been envisaged. To examine the economic effects of such a temporary increase, we first examine the qualitative effects of taxation and government spending in the Solow model.

Let τ be the average income tax rate, let g be the fraction of income spent on government services. Then, assuming that the government has no outstanding debt, the overall saving rate as a fraction of national income is:

$$\tau - g + s(1-\tau)$$

The first term is public saving; the second term is private saving. Suppose that the economy begins in a steady state in which the government spends G dollars each period, which equates to gy dollars per effective worker in each period. Since the steady state growth rate of output is exogenous and equal to $n+\gamma+\gamma n$, this means that government spending G grows at this same rate and that the size of government as a percentage of GDP is constant. To isolate the economic costs of government spending, we first assume that this spending does not enter into individuals' utility functions or production functions and that the spending is financed by a uniform tax on wage and capital income and returned to consumers as a lump sum transfer.

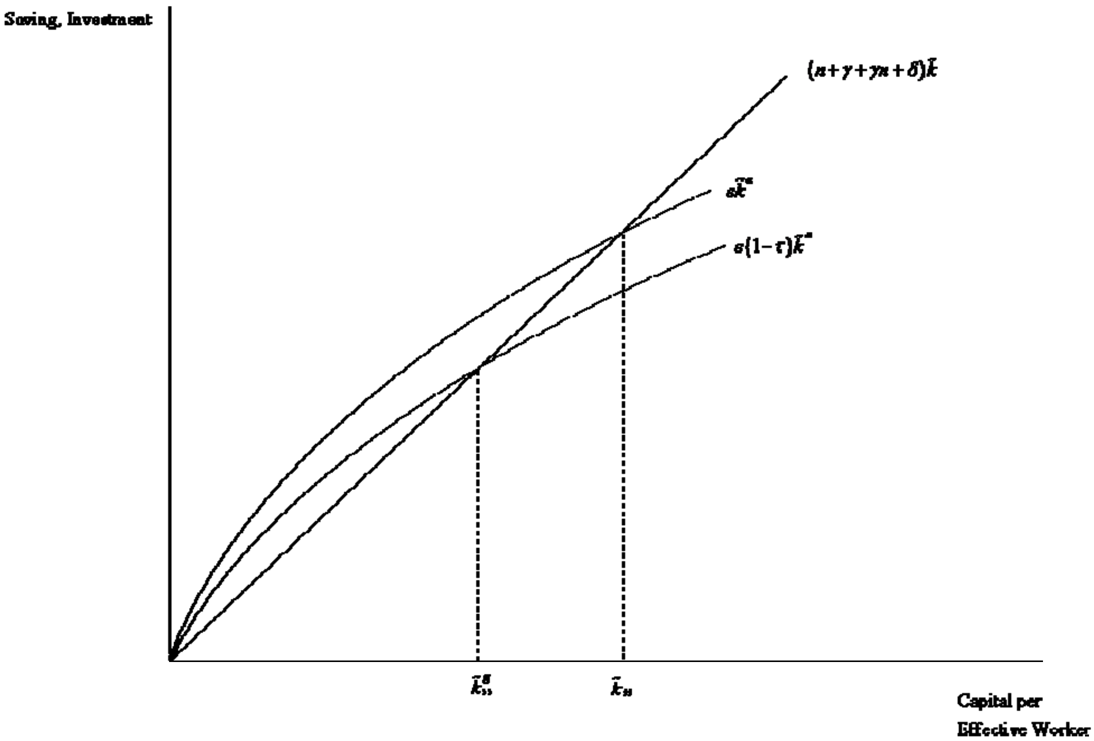
Let us first assume that the government's budget is balanced, so that $\tau = g$. With these assumptions, saving per effective worker is:

$$s\left(1-\tau\right)y_t = s\left(1-g\right)y_t$$

And so the steady state capital stock per effective worker is:

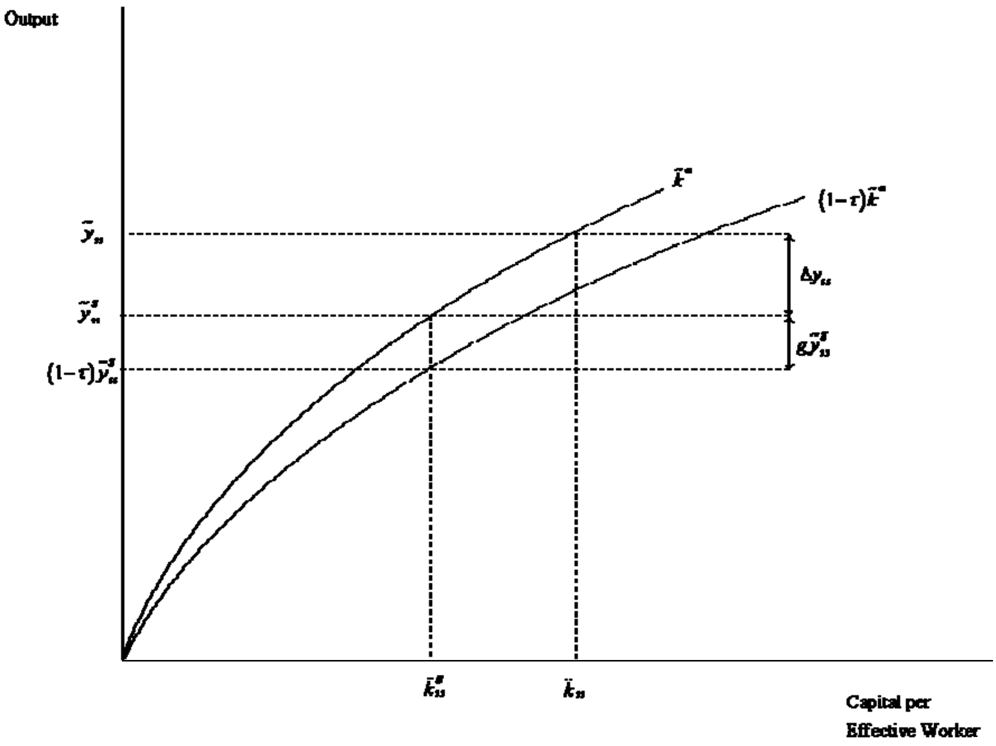
$$\tilde{k}_{ss}^{g} = \left(\frac{sA(1-\tau)}{n+\gamma+\gamma n+\delta}\right)^{\frac{1}{1-\alpha}} = \left(\frac{sA(1-g)}{n+\gamma+\gamma n+\delta}\right)^{\frac{1}{1-\alpha}}$$

Taxation reduces disposable income, which with a constant saving rate out of disposable income reduces overall saving per effective worker even when the government balances its budget. Lower saving reduces the steady state level of the capital stock per effective worker. This gives us the standard result in the literature: the cost of government spending financed by income taxation in the neoclassical growth model Solow model is that it reduces the steady state level of capital per worker, and therefore reduce the steady state level of GDP per worker.



What is the effect on steady state economic growth? Since growth is exogenous in this model there would be no steady state or long run effects of government spending on economic growth rates. Nevertheless we could go ahead and compute a measure of the cost of funds here by comparing the reduction in the steady state level of output and consumption with the revenue that the tax raises.

This cost of government spending in terms of foregone output is illustrated in the diagram below. The imposition of the tax to fund government spending reduces output per effective worker by $\tilde{y}_{ss} - \tilde{y}_{ss}^{g}$ because of the dynamic effect on saving, investment and the capital stock. This is the cost of funds in terms of output per effective worker. The revenue raised per effective worker is $g\tilde{y}_{ss}^{g}$. The excess burden of the tax is the difference between these two quantities. Note that $\tilde{y}_{ss} - \tilde{y}_{ss}^{g} > g\tilde{y}_{ss}^{g}$ so the tax has a positive excess burden in terms of foregone output. Note also too that the total excess burden (and the total cost of funds) will be a convex function of the tax rate here. As more revenue is required and taxes need to be raised, taxes will become more costly at the margin.



There will also be a Laffer curve for income taxation. In what follows we shall assume that the economy is operating on the increasing part of this Laffer curve, so that an increase in taxation increases tax revenue.

Table 6 **Long Run Effects of Tax-Financed Government Spending in the Solow-Swan Model: Comparison of Steady States**

Variable	Change
GDP	Falls
Capital Stock	Falls
Economic Growth Rate	No Change
Wage Rate	Falls
Interest Rate	Rises

PERMANENT INCREASES IN GOVERNMENT SPENDING

We can also examine the steady state costs of an *increase* in government spending from current levels. To this end, suppose that there is a permanent increase in government spending that is financed by an increase in taxation. Computing the steady state effects of higher government spending in each period is straightforward: higher g means higher taxes, and a lower capital stock per effective worker, and a lower level of steady state output per effective worker.

But what happens during the transition to the new steady state? In other words, what is the immediate effect of an increase in government spending financed by an increase in taxation? This will also help us to analyse temporary changes in g. Let Δg be the change in the fraction of spending. Then the capital stock per effective worker in the next period is:

$$\tilde{k}_{t+1} = \frac{1}{(1+n)(1+\gamma)}\left[s(1-g-\Delta g)\tilde{y}_{ss}^{g} + (1-\delta)\tilde{k}_{ss}^{g}\right]$$

$$= \frac{1}{(1+n)(1+\gamma)}\left[sA\left(\tilde{k}_{ss}^{g}\right)^{\alpha} - s(g+\Delta g)A\left(\tilde{k}_{ss}^{g}\right)^{\alpha} + (1-\delta)\tilde{k}_{ss}^{g}\right]$$

The immediate effect of the increase in government spending is to lower the capital stock per effective work hour. In the first period the change in the capital stock per effective work hour is simply:

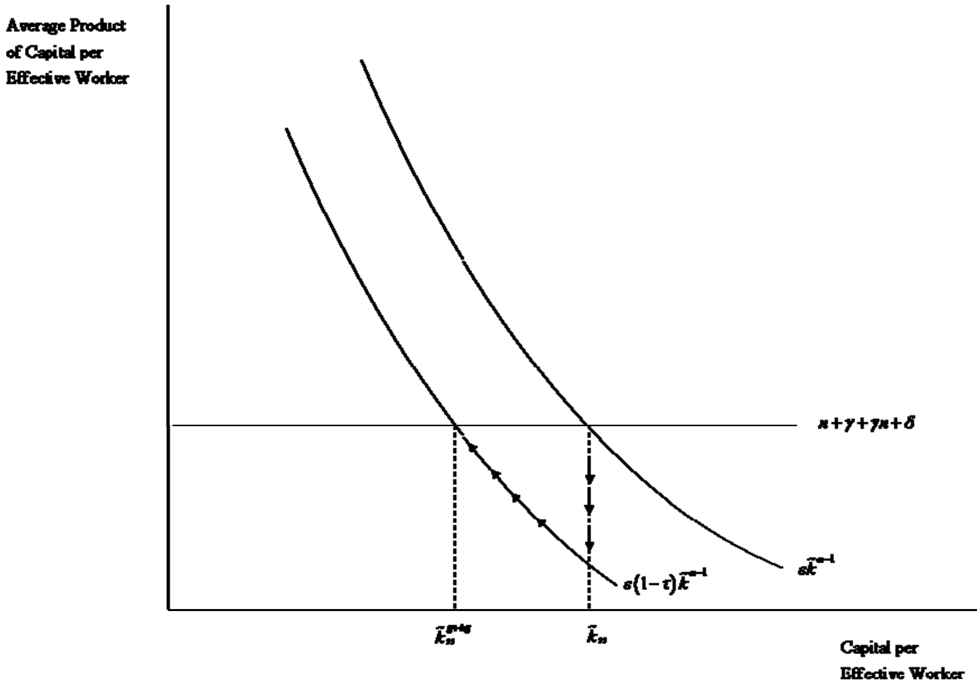
$$\Delta k = \tilde{k}_{ss}^{g} - \frac{1}{(1+n)(1+\gamma)}\left[sA\left(\tilde{k}_{ss}^{g}\right)^{\alpha} - s(g+\Delta g)A\left(\tilde{k}_{ss}^{g}\right)^{\alpha} + (1-\delta)\tilde{k}_{ss}^{g}\right]$$

$$= \frac{-s\Delta g A\left(\tilde{k}_{ss}^{g}\right)^{\alpha}}{(1+n)(1+\gamma)}$$

In the Solow-Swan model a permanent change in tax rates and government spending has no impact on steady state growth rates. But the above expression tells us such a change will impact growth rates during the transition from one steady state to another.[64] Since the new steady state output level is lower when taxes increase, and since the capital stock falls gradually to its new level during the transition to the new steady state, it must be the case that the economy's growth rate is less than the steady state growth rate between the new steady states. In other words,

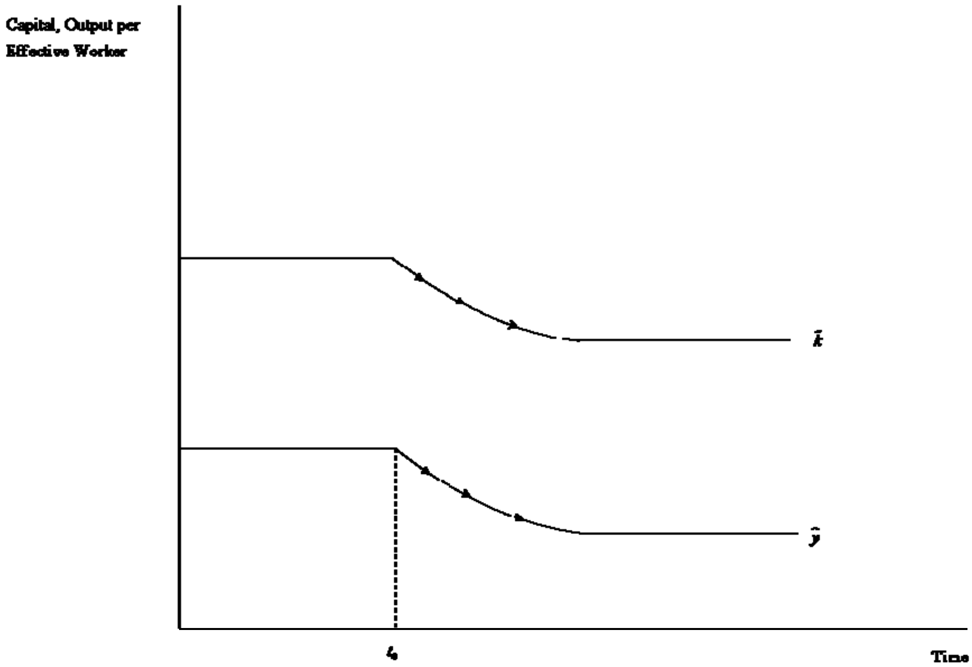
[64] This point has also been noted by Engen and Skinner (1996)

higher government spending financed by higher taxation not only lowers the level of output; it also lowers the rate of growth in all periods between the two steady states.



This result is shown in the diagram above for a situation in which the economy initially starts out with no government spending. The diagram plots the average product of capital per effective worker against the level of the capital stock per worker. The increase in spending means that the new steady state capital stock is lower than the old one. The economy therefore has “too much” capital stock, and must begin decumulating capital and reducing output. During this transition the growth rate of the capital stock must therefore be less than what it was in the old steady state, which means that along the transition path the growth rate of output must also be less than what it was in the old steady state. Thus, an increase in government spending reduces the rate of economic growth during the transition [see, for example, Engen and Skinner (1996)].

The implications for the path of the levels of GDP and the capital stock are illustrated in the diagram below. The government permanently increases government spending as a fraction of output at time t_0. This reduces the capital stock and output and puts the economy on a transition path toward the new (lower) steady state levels.

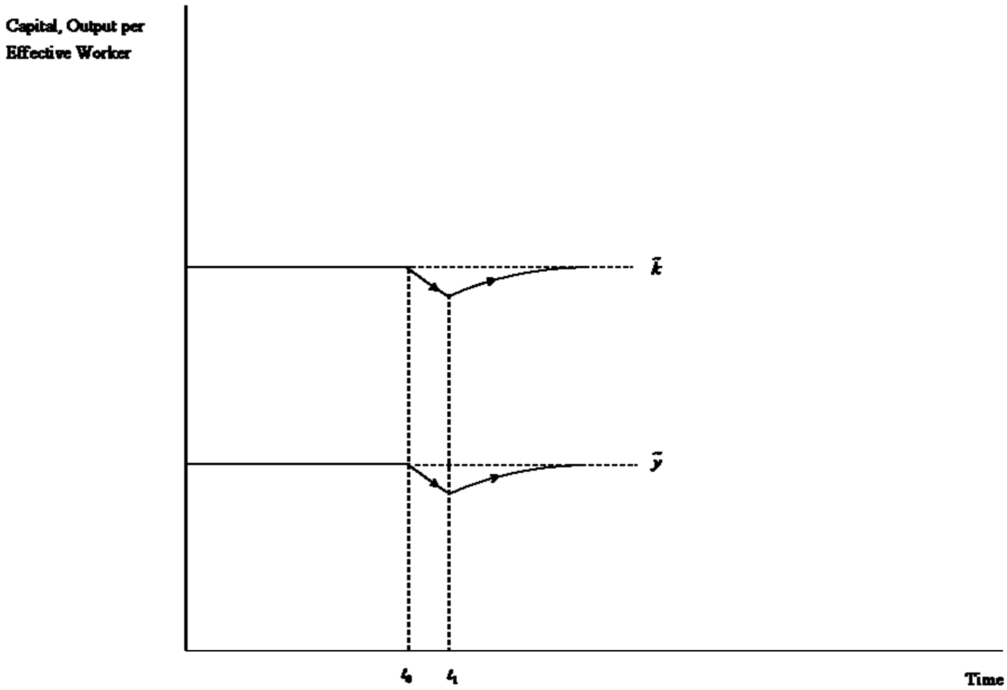


IMPLICATIONS FOR TEMPORARY CHANGES IN GOVERNMENT SPENDING

All of this has implications for temporary tax-financed changes in government spending. To analyse such a temporary change, we simply repeat the above analysis but reduce spending at some later point in time before the economy reaches its new steady state. The effects of reducing spending back to previous levels are simply the reverse of the effects outlined above. After the initial increase the economy is on a transition path to a new (lower) steady state. But once spending is reduced back to previous levels it begins a new transition path back to its old steady state.

Since the economy has been decumulating capital following the temporary increase in government spending, when spending suddenly returns to its old level it must now have less capital than in the old steady state. To get back to this old level it has to start accumulating capital again, which means that once government spending falls, economic growth must now exceed the steady state growth rate. The cost of this temporary increase in government spending is simply the sum of the reduction in output that occurs, relative to the level that would have occurred but for the temporary change in government spending.

This is illustrated in the diagram below. The government increases spending at time t_0, which puts the economy on a transition path towards a lower steady state. Then at time t_1 the government reduces spending back to its previous level, putting the economy back onto a different transition path back to the old steady state. (Note that the diagram is not to scale – it is drawn as if the decline in output and capital per effective worker is the same absolute size, but obviously this is not correct).



The analysis above assumed that the fraction of government spending borne by savings was equal to the constant saving rate, *s*. However, for temporary changes this may not be such a reasonable assumption, since permanent income does not change by much as a result of the temporary change. To model the possibility that a greater fraction of the government spending may be borne by saving, we introduce a new parameter, λ, which is the fraction of the increase in government spending that is borne by savings. If the spending change is temporary, we would expect that λ would be close to one. In the analysis below we provide various estimates of costs using different values of λ. If $\lambda \neq s$ then the change in the capital stock is:

$$\Delta k = \tilde{k}_{ss}^{g} - \frac{1}{(1+n)(1+\gamma)}\left[sA\left(\tilde{k}_{ss}^{g}\right)^{\alpha} - \left(sg + \lambda\Delta g\right)A\left(\tilde{k}_{ss}^{g}\right)^{\alpha} + (1-\delta)\tilde{k}_{ss}^{g} \right]$$

$$= \frac{-\lambda\Delta g A\left(\tilde{k}_{ss}^{g}\right)^{\alpha}}{(1+n)(1+\gamma)}$$

ASSUMPTIONS, CALIBRATION, SCENARIOS AND QUANTITATIVE ESTIMATES

To analyse dynamic effects in the Solow-Swan growth model, one has to make assumptions about whether the economy is initially in a steady state (a situation in which all variables are growing at the same growth rate) or not. The model economy can then be shocked and we can analyse the effect on different variables of interest and see how long it takes to get back to the steady state. Alternatively one can just take the economy as one finds it, impose the shock, and investigate deviations from the baseline.

In exercises of this kind some compromises must be made. To analyse dynamic effects of this policy change we assume that the economy is initially in its steady state.

The following parameter assumptions are used but can easily be changed. The capital share is $\alpha = 0.36$. The growth rate of hours worked is set equal to the 1997-2007 average of 1.2 per cent per year. The growth rate of productivity is set equal to the long run average of the last 40 years, at 1.1 per cent per year. These latter assumptions give a steady state growth rate of 2.31 per cent per year, which is consistent (for example) with Treasury's 2007 Intergenerational Report assumptions regarding growth rates over the next 20 years. We assume a depreciation rate of 5 per cent, which is the roughly equal to the average rate of 5.3 per cent in the National Accounts over the last 5 years. The saving rate is initially set at 20 per cent and the level of federal government spending as a fraction of output is 24.5 per cent (this is the 2008/09 figure used in MYEFO). These parameters loosely replicate Australian aggregate data, giving a steady state capital/output ratio of 2 and a gross marginal product of capital of 18 per cent (the actual capital/output ratio in the data is 2.94 per cent).

The full amount of NBN spending is assumed to take place in the first year of the experiment. An alternative approach would be to spread the spending out over a number of years; this makes only a minor difference to the cost calculations.[65]

The results of the experiment with the baseline Solow-Swan model are reported in the main text for various values of the crowding out parameter λ. Dollar values are calculated by shocking the hypothetical model economy, computing the percentage output loss relative to the baseline of "no policy change", and then translating the results into dollar values.

The costs are estimated as the net present value of the cumulative effect on GDP out to 2020, assuming the policy is implemented at the beginning of 2009. Costs are discounted back to present values using a 7 per cent discount rate. Note that, as expect, higher values of λ produce greater costs. Intuitively, as the temporary change in government spending is increasingly borne by savings and investment, the greater are the future costs since the NBN spending and taxation needed to fund it "eats up" more investment and therefore more capital stock.

Another interpretation λ here is that it partly reflects the extent to which the NBN adds to the nation's productive capital stock. Let h be the fraction of the change in government spending that brings about a net increase in the nation's productive capital stock. Then the change in the productive capital stock brought about by the temporary change in government spending is simply:

$$\frac{(h-\lambda)\Delta g A\left(\tilde{k}_{ss}^{g}\right)^{\alpha}}{(1+n)(1+\gamma)}$$

For example, h=1 and $\lambda = 0$ reflects the extreme case where the cost of the shock is completely borne by consumption, and all spending on the project adds to the capital stock. This is a highly unlikely scenario for two reasons. First, there is a very real possibility that this new public capital expenditure could partially or completely crowd out new private sector expenditure. There is much evidence in the macroeconomics literature for this crowding out effect. For example, Aschauer (1989) finds that an increase in non-military public capital accumulation induces as much as a dollar-for-dollar reduction in additions to the private capital stock. In the other direction, there is evidence of "crowding in" of private investment as public investment has fallen. Makin

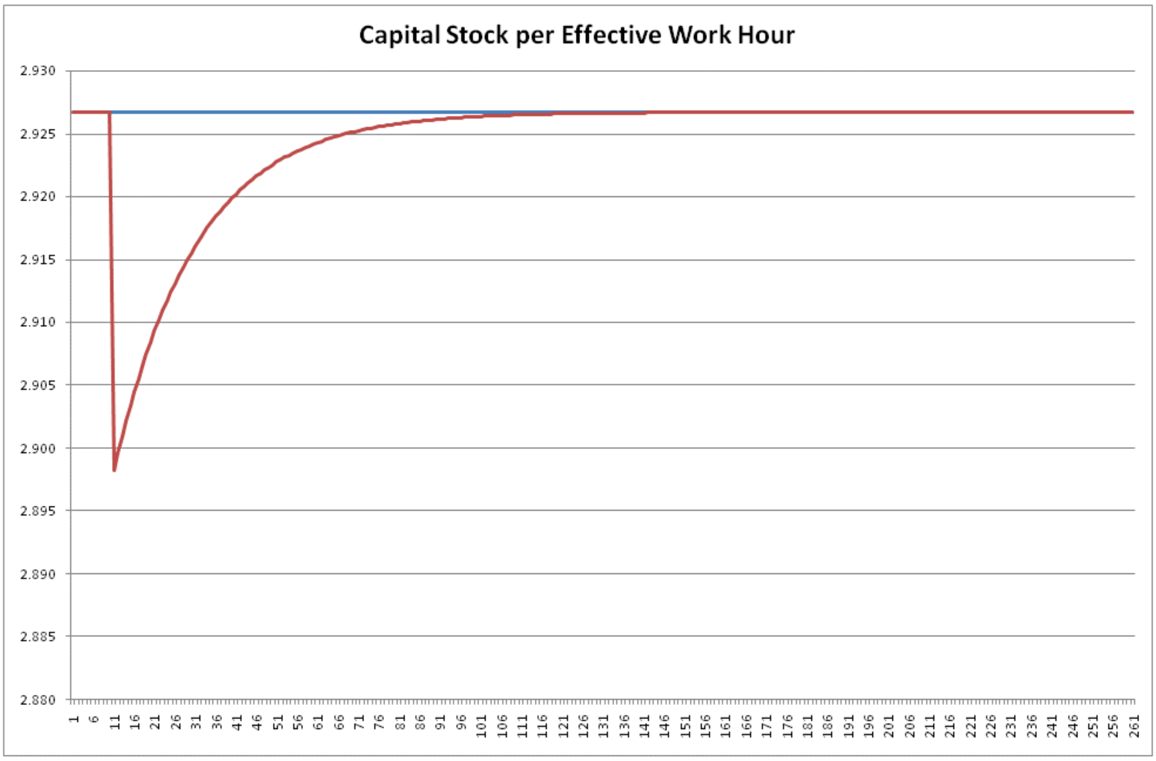
[65] If the spending is spread out over eight years, the cost estimates are slightly higher, since output per effective worker is falling less sharply but for a longer period, and the same spending increase represents a slightly higher fraction of GDP.

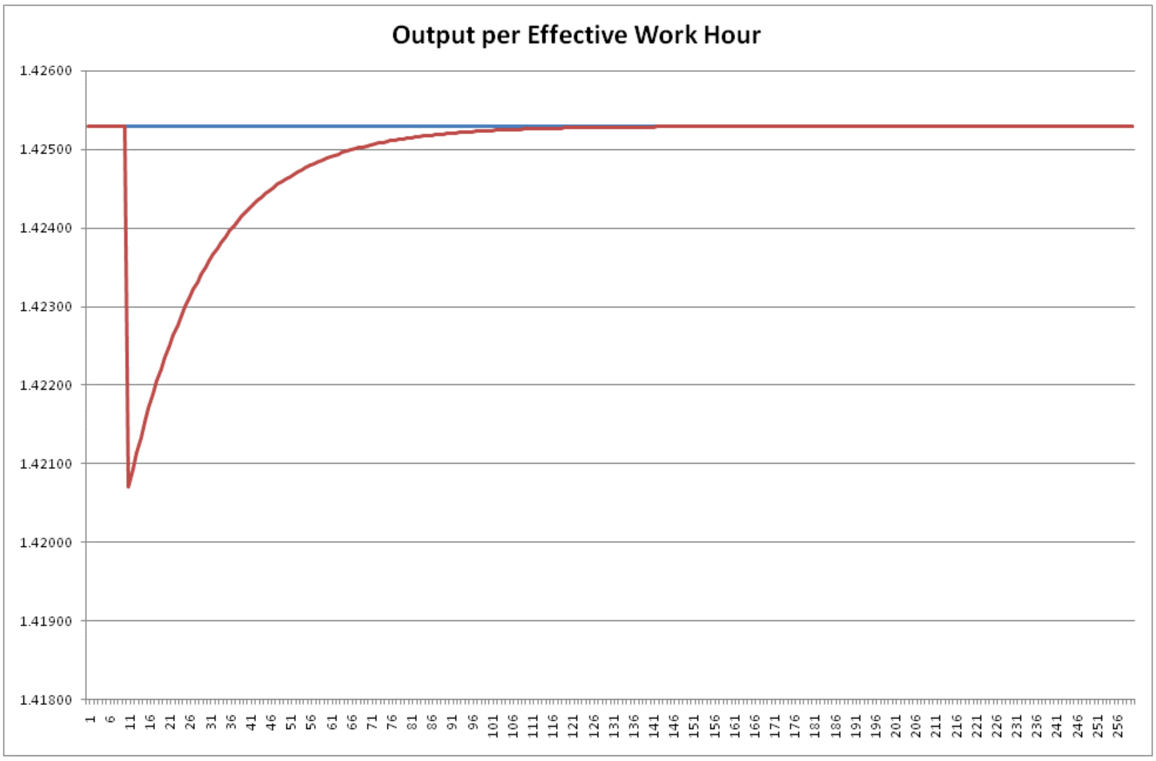
(2003) notes for Australia that since the 1990s relatively lower public capital spending has been more than offset by relatively higher private capital expenditure in the economy. The Reserve Bank of Australia has also recently noted that in 2008 private business investment in Australia reached growth rates not seen since the 1970s.

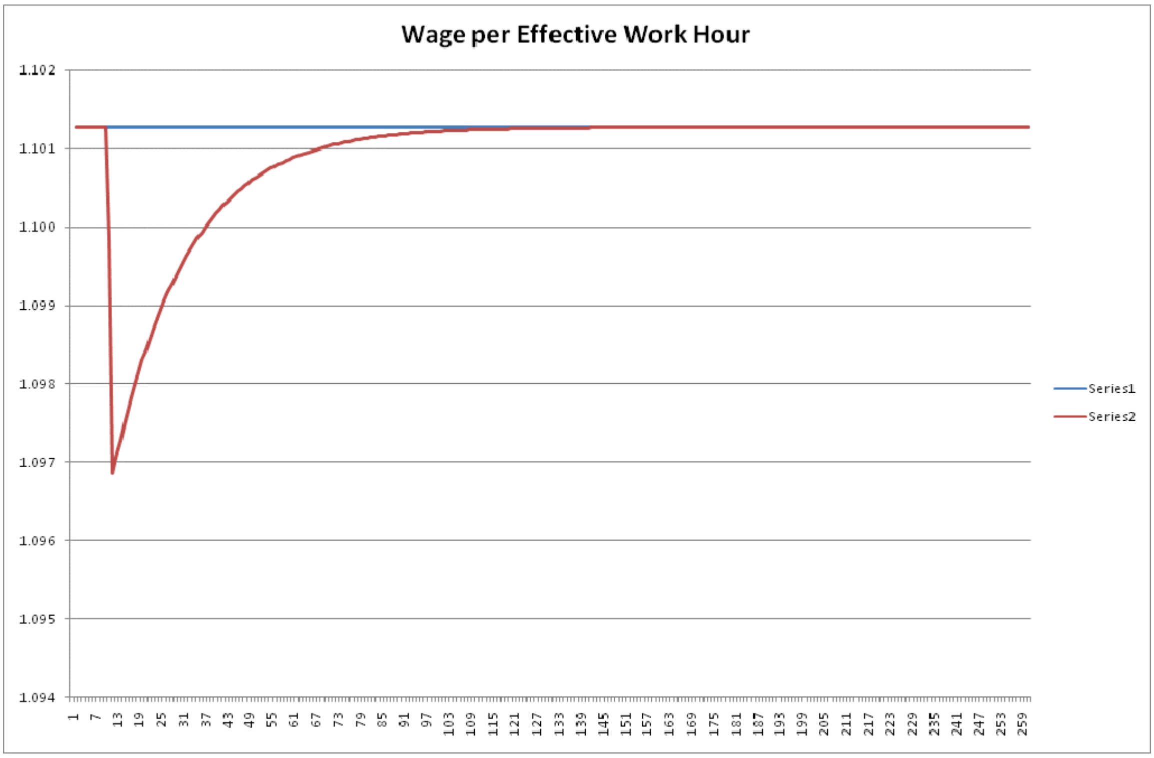
Second, there is the very real possibility that this capital stock will not be productive. Aschauer (1989) finds that public investment is productive, as a general proposition. However, Otto and Voss (1998) find no evidence of excessive returns for public investment in Australia, estimating that the average real investment return for both private and public capital is around 9 per cent.

The Solow-Swan model also measures other parameters, including real interest rates and wages. However, these are not additional costs – just different ways of reporting the same costs.

Results from one run of the model are presented below in diagrammatic form. The graphs below assume $\lambda = 0.5$. Different values of λ produce qualitatively similar results.




Output per Effective Work Hour
1.42600
1.42500
1.42400
1.42300
1.42200
1.42100
1.42000
1.41900
1.41800


Wage per Effective Work Hour
1.102
1.101
1.100
1.099
1.098
1.097
1.096
1.095
1.094
Series1
Series2

INCORPORATING POSSIBLE PRODUCTIVITY EFFECTS

The above discussion assumed that there were no productivity effects of the NBN. In modern growth models there are several approaches to modelling the supply-side effects of productive government spending. One strategy is to assume that the flow of government spending enters directly into the economy's production function. This approach is used, for example, by Barro (1990). Another approach is to assume that the government-owned capital stock enters into the economy's production function and that additions to this stock (government investment, net of depreciation) augment the economy's physical capital stock. Both approaches require estimates of an aggregate production function, with government investment estimate included as a separate variable.

In this note we use a different approach by assuming that the project increases the growth rate of total factor productivity (the parameter γ in the production function) by a constant amount in each year of the project for the first eight years. This means that there is a permanent increase in the level of productivity after the project is completed. In any case, since the NBN technology could become obsolete or the infrastructure may be built but take-up rates may be low, it cannot be assumed that every dollar of additional spending will add to the nation's productive capital stock. Therefore a range of productivity increases and crowding out scenarios were examined, with the net present value of the cumulative effect on GDP out to 2020 calculated.

The results of show that even if the NBN permanently increases the economy's total productivity level over the first eight years of the project, these gains may be outweighed by the project's economic costs. Because private savings are diverted from other productive uses in the earlier years of the project, GDP may actually be lower than it would otherwise be in those years. Over the period to 2020 the increase in the net present value of GDP depends on the sum of these effects, and could be negative even if a significant increase in productivity is assumed. If the increase in the economy's productivity level is assumed to be a more modest 0.5 per cent, then the results show that the net effects on GDP are negative under a range of crowding out scenarios.

APPENDIX D A SUMMARY OF THE DEVELOPMENT OF TRANSPORT FUNDING IN AUSTRALIA

Road provision in the late 19th and early 20th centuries largely was the responsibility of Local and State Governments. By the late 1920s, most States had established State road authorities to administer 'road funds' for the construction and maintenance of main roads. In addition, State Governments collected a per ton mile tax and licence fees from interstate trucking operators from the 1930s until 1954 when these charges were declared invalid. The per ton mile tax was then replaced with a 'maintenance tax' of one third of one penny per ton mile and in response to increasing evasion, the maintenance tax was replaced with diesel franchise fees in the early 1980s.

The Commonwealth government began providing funds to the States for road infrastructure projects in the 1920s in the form of annual tied grants which were financed by the partial hypothecation of customs and excise duties on fuels, and taxes on vehicle chassis. Commonwealth assistance for specific roads was introduced in the 1940s and continued until they were incorporated into annual road grant funding in the early 1970s.

In the late 1940s and throughout the 1950s, the Commonwealth greatly increased its financing of road construction. In 1959, the decision was made to break the nexus between road grants and fuel tax revenues. Commonwealth grants paid in the five years following this decision increased considerably (in acknowledgement of, amongst other things, the trend toward heavier and faster vehicles).

By the mid-1970s, the Commonwealth had assumed full responsibility for funding the construction and maintenance of 'National Roads' (the major links between the State and Territory capital cities) and became considerably more involved in road expenditure decisions.

A substantial upgrading of the road network, particularly of National Roads, was undertaken in the 1980s. This was funded by the full hypothecation of an additional surcharge on the existing fuel excise. Hypothecation was re-introduced in 1982 under the *Australian Bicentennial Road Development Trust Fund Act 1982 (ABRD Act)* to substantially upgrade the road network, particularly National Roads. The ABRD program and surcharge ended in 1988.

Although a small proportion of the fuel excise was earmarked for road funding under the *Land Transport Development Act 1988* from 1989 to 2000, the Commonwealth Government has set road funding in the budget process since 1991-92.

Throughout the 1990s, the Commonwealth Government continued funding National Roads. It increased the coverage of the network and also began funding urban links. State and Territory Governments formally accepted responsibility for funding arterial roads and Local Governments for funding local roads.

Accompanying this formalisation of responsibility, Commonwealth Government local road funding was untied in 1991-92 and thereafter provided as general purpose assistance. Arterial road assistance to the States and Territories was similarly untied in 1994, then absorbed into GST payments to the States and Territories in 2000.

In 2004-05, the national land transport policy ‘AusLink’ was implemented to achieve more consistent national land transport funding and investment decision-making across the modes. Over three quarters of Australian Government directed land transport funding and investment is now undertaken through AusLink.

AusLink has the following core components:

- A defined National Network of important road and rail infrastructure links and their intermodal connections. This includes major road and rail links connecting capital cities and major industrial centres (including connections through urban areas), links to ports and airports and other rail, road and intermodal connections.

- The National Land Transport Plan, which outlines the Government’s approach to improving and integrating the National Network, and the investments it will make.

- Separately earmarked funding for local and regional transport improvements under the Roads to Recovery, Strategic Regional and Black Spot programmes.

- New legislative, intergovernmental and institutional mechanisms. These include arrangements with the States and Territories and the private sector to share the costs of some projects in the AusLink Investment Programme.

Funding provided independently of AusLink includes ‘Identified/Untied Local Road Grants’; some grants tied to South Australian local roads; the Federation Fund; Australian Rail Track Corporation (ARTC) grants; an upgrade of the mainline interstate railway track in Victoria; and the Eyre Peninsula rail upgrade.

The most recent road funding-relevant measure is the Building Australia Fund (BAF) which was established on 1 January 2009 by the Nation-building Funds Act 2008 to finance capital investment in transport infrastructure (such as roads, rail, urban transport and ports), communications infrastructure (such as broadband), energy infrastructure and water infrastructure.

The Government has also established Infrastructure Australia (IA), which was set up by the Infrastructure Australia Act 2008 that came into effect on 9 April 2008. IA is a policy advisory body with the role of providing advice to Australian governments about infrastructure gaps and bottlenecks that hinder economic growth and prosperity. It will also identify investment priorities and policy and regulatory reforms that will be necessary to enable timely and coordinated delivery of national infrastructure investment.

In particular section 1 of the Act states:

> *Infrastructure Australia has the primary function of providing advice to the Minister, Commonwealth, State, Territory and local governments, investors in infrastructure and owners of infrastructure on matters relating to infrastructure, including in relation to the following:*
>
> *(a) Australia’s current and future needs and priorities relating to nationally significant infrastructure;*
>
> *(b) policy, pricing and regulatory issues that may impact on the utilisation of infrastructure;*
>
> *(c) impediments to the efficient utilisation of national infrastructure networks;*

> *(d) options and reforms, including regulatory reforms, to make the utilisation of national infrastructure networks more efficient;*
>
> *(e) the needs of users of infrastructure;*
>
> *(f) mechanisms for financing investment in infrastructure.*

IA is also charged with guiding the national audit and infrastructure priority list of the Building Australia Fund announced in the 2008-09 Federal Budget. Thus section 2 of the Act states:

> *Infrastructure Australia has the following additional functions:*
>
> *(a) to conduct audits to determine the adequacy, capacity and condition of nationally significant infrastructure, taking into account forecast growth;*
>
> *(b) to develop lists (to be known as Infrastructure Priority Lists) that prioritise Australia's infrastructure needs;*
>
> *(c) to review and provide advice on proposals to facilitate the harmonisation of policies, and laws, relating to development of, and investment in, infrastructure;*
>
> *(d) to evaluate proposals for investment in, or enhancements to, nationally significant infrastructure;*
>
> *(e) to identify any impediments to investment in nationally significant infrastructure and identify strategies to remove any impediments identified;*
>
> *(f) to promote investment in infrastructure;*
>
> *(g) to provide advice on infrastructure policy issues arising from climate change;*
>
> *(h) to review Commonwealth infrastructure funding programs to ensure they align with any Infrastructure Priority Lists;*
>
> *(i) to undertake or commission research relating to Infrastructure Australia's other functions;*
>
> *(j) any functions that the Minister, by writing, directs Infrastructure Australia to perform;*
>
> *(k) any other functions conferred on Infrastructure Australia by this Act or any other law*

IA is also required to produce an Annual Report (section 26).

Regarding Ministerial directions to IA, the extent of these directions is limited. Section 6 of the Act states:

> *Minister may give directions to Infrastructure Australia*
>
> *(1) The Minister may give written directions to Infrastructure Australia about the performance of its functions.*
>
> *(2) The Minister may have regard to any decisions by COAG in giving directions under subsection (1).*
>
> *(3) Directions given by the Minister under subsection (1) must be of a general nature only.*
>
> *(4) The Minister must not give directions about the content of any advice that may be given by Infrastructure Australia.*
>
> *(5) Infrastructure Australia must comply with any direction given by the Minister under subsection (1).*

> *(6) A direction given by the Minister under subsection (1) is not a legislative instrument.*

Section 28 of the Act states that IA is to be assisted by an Infrastructure Coordinator, who will lead a small professional Office of Infrastructure Coordination within the Infrastructure, Transport, Regional Development and Local Government portfolio:

IA is comprised of 11 members and a Chair (Sir Rod Eddington). The 11 members are comprised of:

- 5 Commonwealth nominated members from the private sector including the Chair;
- One member representing local government;
- 3 Commonwealth representatives;
- 3 representatives of the States and Territories.

APPENDIX E INSTRUMENTS MANDATING USE OF CBA

	Instruments specifying use of project evaluation	Relevant Guides	Applicability	Post-completion evaluations required?
Commonwealth	Infrastructure Australia's Prioritisation Methodology Bilateral Auslink agreements between Commonwealth and States National Guidelines for Transport System Management in Australia Volume 3	Infrastructure Australia's Prioritisation Methodology National Guidelines for Transport System Management in Australia Volume 3 Handbook of Cost-Benefit Analysis	Infrastructure Australia to apply prioritisation methodology which includes CBA to determine priority list for funding of national projects	Only for Auslink funded projects

	Instruments specifying use of project evaluation	Relevant Guides	Applicability	Post-completion evaluations required?
NSW	Revised Project Size /Risk Thresholds for the Submission of Business Cases and Gateway Reports (TC08/07) WWG Guidelines for Privately Financed Projects Section 95 of Auslink bilateral agreement with NSW	NSW Government Guidelines for Economic Appraisal WWG Guidelines for Privately Financed Projects Determination of Appropriate Discount Rates for the Evaluation of Private Financing Proposals	Economic appraisal required for all individual projects with a total cost in excess of $1 million. Full appraisals are required of projects over $10 million and summaries only required for projects worth between $1 million and $10 million. Appraisals to be submitted to Treasury. Treasury then makes recommendations to Budget Committee based on review of appraisal. More generally this economic appraisal is part of a requirement on agencies to submit a business case to Treasury. SOCs (State Owned Corporations) generally required to submit economic appraisals for PFPs (privately financed projects) only. National PPP Guidelines applicable to other types of PPPs than PFPs. Projects likely to have potential to provide value for money using a PPP delivery method are those with a total capital value exceeding $50 million and therefore projects of these value trigger evaluation of PPP as procurement method.	"Selection of major projects undertaken by an agency should be subject to ex-post evaluations as should major ongoing programs which may involve a series of smaller project. These involve: re-evaluation of benefits and costs of selected option to assess whether the anticipated benefits were realised and the forecast costs kept to; reconsideration of alternative options; examination of the project design and implementation to assess scope for improvement to option adopted. "

	Instruments specifying use of project evaluation	Relevant Guides	Applicability	Post-completion evaluations required?
Victoria	Investment Lifecycle Guidelines Section 82 of Auslink bilateral agreement with Vic	1) Investment Lifecycle Guidelines (ILG): Options Analysis and Business Case 2) Partnerships Victoria requirements supplementing National PPP Guidelines 3) Dept of Transport Guidelines for cost-benefit analysis (consistent with National Guidelines for Transport System Management)	Requirements under ILG mandatory for major investments, defined as investments requiring more than $5 million in funding. Dept. of Transport Guidelines apply to all ‘significant new projects’ subject to review by Dept of Transport’s Project Review Committee (expenditure of at least $10 m).	Yes in ILG Yes for Auslink funded projects

	Instruments specifying use of project evaluation	Relevant Guides	Applicability	Post-completion evaluations required?
Queensland	Project Assurance Framework Value for Money Framework (for PPPs) Section 104 of Auslink bilateral agreement with Qld	Project Assurance Framework: Cost benefit analysis guidelines National PPP Guidelines	Project Assurance Framework requires Department of Infrastructure and Planning to produce documents accompanying six generic project stages: - preliminary evaluation - business case development - supply strategy development - source suppliers - establish service capability - deliver service. CBA is required at stage of analysis of project options.	Yes for Auslink funded projects No for other projects

	Instruments specifying use of project evaluation	Relevant Guides	Applicability	Post-completion evaluations required?
South Australia	Treasurer's Instructions No. 17 Section 86 of Auslink bilateral agreement with SA	Guidelines for the Evaluation of Public Sector Initiatives	Cabinet approval is required of any initiative with an estimated cost equal to or greater than $11 million. This will be based on evaluation prepared in accordance with Guidelines. The Evaluation to include Identification of the Service Need; Identification of Options to Deliver the Service; Substantiating the Project; The Determination of Funding and Post Implementation Review.	Yes as set out in Guidelines. Yes for Auslink funded projects

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