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Estimating net benefits of high speed rail: How fit for purpose is Australia's economic appraisal guidance?

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Abstract

High speed rail (HSR) is a planned new mode for Australia. Additions or changes to transport economic appraisal guidance in the following areas could ensure fuller and more accurate accounting for HSR projects' net benefits: the value of travel time savings, adding 'cross-mode' and distance to existing valuation approaches, thereby accommodating mode switching over longer distances as the new mode's main demand source; capacity relief benefits in those other modes; 'commutable' housing welfare, valuing residential relocation responses to HSR's lengthening of city commuting distances; alignment of the appraisal period with the economic life of HSR assets (up to 100 years); valuing long term carbon reduction impacts; and better alignment of strategic and economic appraisal cases, including through adding project-specific objectives. A Commonwealth review of discount rate-setting is recommended, intended to: take account of a longer appraisal period; ensure assessment consistency between projects of differing lifetimes; and scrutinise underlying rate rationale. A review could consider both changing from a social opportunity cost to a social rate of time preference basis and reduction in the existing seven per cent real rate. In inter-urban productivity impacts (not parameterised internationally), requiring a strategic case which addresses coordination market failure risk by considering complementary measures, including land use change planning, would assist.

1 Introduction

Old modes that are newly prioritised, such as cycling, light rail, or metro rail, test the limits of an evolving body of transport economic appraisal guidance. The emergence of 'active transport', comprising cycling and walking, has led to physical health benefits being added to guidance, while the opportunities for high density living and for place-making that light rail and metro rail can enable, are also now parameterised for appraisal purposes. So it is with a planned new mode of high speed rail. High speed rail collapses distance[1], linking cities along its path, so resulting opportunities for inter-urban productivity gains should be considered. High speed rail also shares issues with other modes that are yet to be fully addressed in Australian guidance. These include permitting an appraisal period that aligns fully with the economic life of the primary assets and valuing travel time savings at different distance ranges. The former affects all rail projects requiring earthworks, tunnels and structures for new alignments, while the latter is particularly relevant to regional aviation.

In 2022 the newly elected Albanese Labor Commonwealth (federal) government legislated for a High Speed Rail Authority to plan a high speed rail network to connect Brisbane, Sydney, Canberra and Melbourne. A 160 km link between Sydney and Newcastle is to comprise the first stage (King 2024). Against this background, the purpose of the paper is to identify

[1] High speed rail "enables journeys over medium distances to be made quickly" (Steer Davies Gleave 2004). Medium distances are longer than those at which conventional rail is typically the most convenient public transport mode (up to 150 km) and shorter than those at which air travel is faster, even allowing for time to, from and at airports (beyond 800 km). Drawing on China experience, Lawrence et al (2018) place high speed rail's competitive limit at around 1,000 km.

economic appraisal issues meriting attention in Australia's transport economic appraisal guidance[2], to ensure that future high speed rail projects are assessed as fully and accurately as possible. With a number of 'candidate' issues, the discussion of each one is necessarily brief. The paper focuses primarily on benefits, with costs considered only in relation to appraisal period and discount rate-setting issues. Modelling specifics are also out of scope.

The paper, which builds from a consultancy report for the former National Faster Rail Agency (Economic Connections 2020), refers extensively to the United Kingdom (UK) Department for Transport's Transport Analysis Guidance (TAG). Recent changes in this guidance to alignment between a project's strategic and economic cases, the length of the appraisal period and the value of travel time savings (in 'cross-mode' situations and over distance) take account inter alia, of experience with appraisal of a high speed line (HS2) between London and the north of England during the 2010s. Without parameterisation as yet of inter-urban productivity impacts, relevant theoretical and appraisal research literature is drawn on, as are ex post evaluative sources. A decade-old strategic, economic and planning study of a high speed rail network for the Commonwealth government (AECOM et al 2013) is also a reference point.

The paper is organised as follows. Section 2 outlines methodology. Section 3 presents issues in appraising direct benefits (ie impacts relating to travel time and capacity) of high speed rail. Section 4 focuses on indirect benefits, in areas of inter-urban productivity and commutable housing welfare. Section 5 addresses three issues influencing valuation of costs and benefits over long time horizons – the appraisal period, valuing carbon emissions and discount rate-setting. Section 6 discusses issues in aligning the strategic and economic case for a high speed rail project. Sections 7 and 8 provide recommendations and conclusions respectively.

2 Methodology

The paper's methodology combined literature and interview research and resulting analysis and consideration. The purpose of the interviews was to gain insights into and improve currency regarding: appraisal guidance best practice and planning; research for appraisal guidance purposes; the literature of the economic and social impacts of high speed rail; and relevant theoretical developments. Accordingly, the interview research targeted appraisal guidance agencies (Australia, New Zealand, UK), academics and a small number of practitioners and others with knowledge and interests in high speed rail appraisal.

The interview invitation included a two page listing of ten potential appraisal areas (Table 1). Fifteen on-line interviews (see Acknowledgements), scheduled at 45 minutes, were conducted, mostly in March and April 2025. Interviewees were invited to speak to as few or as many topics as they chose. The interviews, together with follow-up correspondence, helped confirm topics for the paper, provided insights and yielded additional literature references. 'Cross-mode' valuation of time savings and assessing network capacity relief impacts were subsequently added to the topics list. Valuing time savings for regional centres with less than median income, the relationship between major city diseconomies and regional city spare capacity and computable general equilibrium (CGE) and other supplementary modelling, were set aside. The interviews nevertheless confirmed the importance of progress in the latter, with an evolving subset of spatial CGE modelling, quantitative spatial modelling[3] especially noted.

[2] For the paper's purposes, this comprises: the Australian Transport Assessment and Planning (ATAP) guidelines (see Commonwealth of Australia 2020 for an overview), with a steering committee comprising the Commonwealth, the states and territories, Austroads, Infrastructure Australia and the NZ Transport Agency Waka Kotahi (observer); and the Infrastructure Australia Assessment Framework, see Infrastructure Australia 2021a. State government guidance is considered only where noted.

[3] See Graham and Horcher (2024). By using increasingly available largescale spatial data sources, QSMs can overcome a problem CGE models have of dependence on a large number of external and often unreliable parameters (interview Professor Daniel Graham 7 April 2025).

Table 1: HSR-related appraisal topics presented to interviewees, with numbers commenting

No	Topic	No commenting
1	Valuing long distance travel time savings	8
2	Valuing travel time savings for regional centres with less than median income	4
3	Valuing post-2050 carbon emission savings	3
4	Aligning appraisal period and investment life	7
5	Discount rates over lengthy time horizons	12
6	Inter-urban productivity impacts *	12
7	Commuting-related impacts	7
8	Major city diseconomies of agglomeration	3
9	Computable general equilibrium and other modelling	7
10	Aligning strategic and economic cases	7
NO INTERVIEWEES		15

* Many discussions centred on urban productivity impacts.

3 Direct benefits of high speed rail

3.1 Valuing travel time savings – including cross-mode and distance effects

International evidence suggests that high speed rail can offer superior journey quality than the car and air modes that in Australia are likely to provide the main sources of its demand[4], as well as fast travel over distance. So it is important that valuing resulting travel time savings takes due account of both journey quality ('cross-mode' or 'mode') effects and distance effects.

3.1.1 Cross-mode effects

The more comfortable the mode – that is, the better to relax in, or to work in – the lower the value of travel time savings (VTTS). In a meta-analysis of UK values, time savings were valued, relative to car: at minus 13 per cent on a conventional train (ie train amenity was 13 per cent higher than car's): on a bus at plus 18 per cent; and by air at plus 81 per cent (Abrantes and Wardman 2011). See 'cross-mode' entries in Table 2.

Table 2: Value of travel time savings, within mode, cross-mode relative to car

Within mode (mode used)		Cross-mode (mode valued by car user)	
Bus user	-33%	Bus valued	+18%
Rail user	+43%	Rail valued	-13%
Air user	324%	Air valued	+81%

All percentages are relative to car (ie at 100 per cent).

Source: Abrantes and Wardman 2011 (from Table 15, p. 9).

Whereas these valuations are as assessed by car users, the very different 'within mode' valuations in the table are those of users of the different modes, with differences in average incomes recognised as exerting a dominant influence. Abrantes and Wardman find also that within mode and cross-mode sets of values are not highly correlated.

Recommended values in Australian guidance are based solely on 'within mode' user effects. This may be sufficient where travel demand is expected to be largely sourced from the same mode. However, as Ojeda-Cabral et al (2021) note, in a report addressing appraisal challenges concerning reopening of UK passenger railway lines closed decades previously – like HSR, a new mode context – collecting *"evidence that allows the separation of VTT* [value of travel time] *by mode … would seem essential for projects involving significant modal shift".*

Whereas appraisal demand forecasting uses behavioural valuations that can be impacted by differences in income (as well as other factors) in order to ensure accuracy, values applied in the subsequent cost-benefit analysis are required to be based on a uniform 'equity value of time'. However, the UK Department for Transport now permits application of 'car to rail' and

[4] Conventional rail can also be a main demand source at distances of up to around 200 km from major capitals, where existing passenger rail services are dense.

'car to bus' multipliers to standard (equity-based) values of travel time to accommodate situations where extensive mode switching is expected (UK DfT 2025b).[5]

Comparable Australian guidance would provide informative benchmarks for evaluation of HSR projects and could be invaluable in other settings where demand is not based primarily on the same mode. Research should include a car to air pairing, as well as car to rail and car to bus.

3.1.2 Distance effects

In all modes, the value of travel time increases with distance, reflecting, in Abrantes and Wardman's words, "*the increasing discomfort of longer distance journeys and the larger opportunity cost of time spent travelling."* But mode characteristics play a role here too, with Mackie et al (2003) finding a distance elasticity of 0.26 for car travel, compared to 0.18 for other modes, predominantly rail. The difference could indicate a greater fatigue factor with car travel. Consistent with these considerations, research for the 2013 Commonwealth HSR found a value of time for business travel of $81 per hour for trips more than 250 km, predominantly by car, compared to $38 per hour for shorter trips, also mostly by car (AECOM et al 2013).

Australian guidance is yet to focus on trip distance as a key value of travel time savings differentiator. However, a forthcoming ATAP research report invites analysts, for HSR or other initiatives expected to draw travellers away from long distance car journeys, to apply higher VTTS uplift factors based on other research, pending any future ATAP recommendations.[6] UK guidance for business VTTS includes both distance banding (four bands) and a continuous (S-shaped) distance function, with values available for car and rail (UK DfT 2025b).

3.2 Assessing network capacity relief in impacted modes

Sydney to Newcastle high speed rail could add capacity on Australia's busiest rail corridor, forecast to reach its limit in the early 2040s (High Speed Rail Authority 2025). Might high speed rail also avoid road capacity augmentation to the M1 Pacific Motorway between these cities (Lunney 2022)? Over longer distances, Brisbane-Sydney-Melbourne HSR might work to supplement the ultimately constrained airport capacity that is located close to central business districts in these major capitals. This would 'future proof' fast travel accessibility to and from the cities' centres for locations throughout the country – both those on a southeastern Australia HSR network and the many that would remain air-dependent beyond it (Potterton 2023, 2024).

Measuring and valuing the transport user impacts of a project on the rest of the relevant network is a standard part of cost-benefit analysis. Congestion (in road transport), crowding (in rail transport) and travel via an alternative route, or at an alternative time, or by an alternative mode – all less preferred – can all be modelled and valued. But when, as with high speed rail, the relevant network is multi-modal, the scope of the appraisal needs to be wide enough to include impacts on these other modes.

To estimate the new mode's impacts on the aviation market, the 2013 Commonwealth HSR study used projections of suppressed demand at Sydney Airport that were commissioned for a prior study of Sydney region airport needs (booz&co. 2013). In contrast, two economic appraisals of the UK's HS2 line (UK DfT 2013b, 2017) were criticised for insufficiently analysing the new line's impact on the existing rail network (Oakervee 2019, Winch 2025). This was despite a strategic case having argued that the line would relieve capacity pressure on both long distance and commuting rail services (UK DfT 2013a).

[5] Stuart Allen (UK Department for Transport email 11 April 2025) explained: "we acknowledge the need for VTT multipliers across modes in order for the … 'Alternative Mode' method [of new mode appraisal] to work properly". The approach contrasts with a longstanding Own-Cost approach (UK DfT 2025b). To obtain reliable mode valued estimates, research that asks respondents about their time versus cost preferences for both their mode of travel and a next alternative mode, as per Flugel (2014), is considered to hold promise.

[6] Email Dr Mark Harvey BITRE 11 April. See CoA forthcoming in References.

Guidance on measuring and valuing demand that is redirected and/or suppressed in response to constrained 'same mode' and 'other mode' capacity would be helpful for HSR appraisal.

4 Indirect benefits

4.1 Inter-urban productivity impacts

4.1.1 Inter-urban and urban productivity impacts – what's different?

Appraisal methods for urban productivity impacts, centring on agglomeration, are well established and the parameters are available for use in inter-urban appraisals (Table 3). However, as Professor Anthony Venables notes, transport agglomeration arguments *"were originally developed specifically for London's Cross-Rail, and getting more workers into an existing cluster"*.[7] In contrast, an inter-urban HSR network, that better connects separate cities, can alter a city's comparative advantage, bringing new patterns of specialisation (Venables 2017[8]). It follows that low inter-urban travel time costs can lead to economic convergence between regional centres and major cities, in contrast to a 'core-periphery' pattern, at higher transport costs, where larger centres gain most due to industry scale effects (Vickerman 2017). And business travel is the inter-urban trip purpose of main interest. The greater speed and convenience of business travel, compared to car or air alternatives, allow relationships to be fostered between firms (and separate parts of the same firm) that are a distance apart.

Urban transport improvement, as per the guidance, builds agglomeration economies by enabling positive business productivity externalities over short distances, typically up to around 10 km, beyond which the impact tapers off. The three sources of agglomeration economies that proximity induces, in Marshallian theory, are: sharing inputs, matching labour and learning knowledge. The three are undifferentiated in the urban appraisal approach, but in the inter-urban context each one can be associated with differing distances and/or behaviours and so each is important to identify and analyse. To take the first, *"if the primary benefit of agglomeration … is the sharing of inputs between firms, then clustering can occur over much longer distances* (than with local clustering) – *potentially several hundred miles"* (Laird and Tveter 2023). Japan's 500 km Tokaido Shinkansen that connects Tokyo, Nagoya and Osaka exemplifies this effect, with Hayakawa et al (2021) finding that, in the absence of the line, national welfare would be 6.5 per cent lower (Table 4)[9].

Secondly, learning and knowledge creation is seen, in the urban sphere, as enabled by the greater ease of face to face communication for nearby businesses and workers. In the inter-urban context, Sun et al (2021) suggest that similar tacit knowledge acquired through meetings at conferences and the like for businesses, universities and research institutes may be the source of a statistically significant difference in the number of patents recorded at HSR-connected cities compared to others in China. The results hold at all journey times, from under half an hour to above three hours, the latter equivalent to distances above 750 km. Finally, high speed rail can underpin productivity growth through improved labour market matching over 'commutable' distances of up to around 100 km. At each of three small towns along the 200 km Cologne to Frankfurt line, reverse commuting from these two large metropolitan areas underpinned labour productivity growth of around seven per cent, measured six years after opening (Ahlfeldt and Feddersen 2018).

[7] Email 7 April 2025. See Venables (2007) for a theoretical model of productivity gains from improved urban public transport.

[8] Venables writes here of 'city-task specialisation' which may occur at a more finely grained scale than of an industry sector. Professor Roger Vickerman describes the spatial effects of HSR as involving specialisations in 'skills': for example, in the context of France, rather than centralising into Paris, accounts and advertising can be conducted in two different places (interview 14 April 2025).

[9] This is a general equilibrium quantitative spatial modelling study (Section 2) that includes displacement. It also finds that, absent the Shinkansen, Tokyo's and Osaka's populations would grow (by 6.3 per cent and 4.4 per cent) and Nagoya's would fall (by 23 per cent).

Table 3: Urban and inter-urban HSR agglomeration[1] impact appraisal, key differences

	URBAN	INTER-URBAN HSR
Main trip purpose	Commuting	Business travel; also commuting ≤≈100-150km
Transport problem	Insufficient PT capacity	Slow long distance trips, insufficient PT capacity
Transport solution	Increased capacity, faster trips	Trips faster than: road at ≤350km; air at 350-1000km
Agglomeration impact	Local cluster productivity	City 'task' specialisation
Agglomeration source		
Sharing inputs	Yes (urban size-related)	No (industry size and urban size-related)
Matching labour	Yes (urban size-related)	Yes, within commutable distance only
Learning knowledge	Yes (urban size-related)	No (industry size and urban size-related)
Agglomeration parameters	Yes (within city), no (intra-industry)[2]	No (within city), no (intra-industry)[2]
Agglomeration distance decay	Up to 10 km[3]	"potentially several hundred miles"[3]
Decay parameters	Yes	No
Coordination failure	Risk exists	Risk exists
Coord. risk mitigator	Complementary measures: near station land use change, place-based incentives	
Appraisal approach	Include impact of risk mitigators in agglomeration and transport demand scenarios	

1. Agglomeration is the central, but not sole, wider economic (productivity) benefit in the ATAP appraisal suite, which also includes imperfect competition, labour supply, 'move to more (or less) productive jobs' and higher value land use (see Section 4.2) benefits.
2. UK within city (urbanisation) parameters are in use due to data-related gaps in Australia (CoA 2023). Parameters are uniform across all three agglomeration sources. There are no UK or Australian intra-industry (localisation) parameters.
3. Sources are Graham 2009 (urban) and Laird and Tveter 2023 (inter-urban).

Table 4: High speed rail productivity impact estimates, various locations

Location	IMPACTS		Years following opening
	Output[1]	Labour productivity	
Montabaur, Limburg, Siegburg (Cologne-Frankfurt line)	6.5-8.5%	6.5-7.2%	3-6
Lleida, Tarragona (Madrid-Barcelona line)	2.3%[2]	1.1%[2]	4
Shinkansen planned network extensions[3]	5.5%		N/A
'No Tokyo-Osaka Shinkansen' counterfactual	-6.5%		N/A

1. Output measures are regional GDP (Cologne-Frankfurt), regional GVA (Madrid-Barcelona), national welfare (Shinkansen).
2. Excluding Madrid and Barcelona from the study's control locations, the effect is 2.4 per cent (regional output) and 2.1 per cent (regional labour productivity).
3. The planned extensions are: Hokuto–Sapporo, Shin-Tosu–Nagasaki, Kanazawa–Kyoto and Tokyo–Osaka (Maglev).
Source: Ahlfeldt and Feddersen 2018, Carbo et al 2019, Hayakawa et al 2021.

Productivity impacts of six to seven per cent, as per Tokyo-Osaka and Cologne-Frankfurt respectively (Table 4), are consistent with the expected urban productivity range, where agglomeration elasticities by industry range from two to eight per cent, with an average of four per cent (as per UK guidance, based on Graham 2009). However, the appraisal challenge is to estimate such impacts ex ante, in the absence of inter-urban-specific guidance.[10]

4.1.2 Coordination market failure and implications for appraisal guidance

In many instances where high speed rail is associated with strong productivity growth, complementary measures, emanating from national, sub-national or local economic development strategies and often with industry involvement, are also in place (Harman 2006).[11] On the Cologne-Frankfurt line, measures included business parks established near stations in three intermediate towns and a light rail line from Bonn (in the Cologne metropolitan area) to one of the stations. Ahlfeldt and Feddersen write: "*We believe the economic effects*

[10] Intra-industry 'localisation' economies may be more relevant than UK guidance 'urbanisation' ones (Table 3). TAG invites practitioners to use localisation/urbanisation elasticities and spillover decay parameters "drawn from the literature" or to "estimate their own" (UK DfT 2025a).

[11] Professor John Preston commented that "push-pull incentives", the one deterring major city development, the other encouraging development in regional areas, were not part of HS1 planning between London and the Channel Tunnel and with domestic services to Kent (interview 1 April 2025).

are best understood as originating from the combination of a substantial accessibility benefit and complementary measures that facilitate firms taking advantage of it".

At a theoretical level, Venables (2017) explains that transport costs may not fall far enough to restructure a regional city economy unaided: both 'specialised' and 'non-specialised' equilibria (steady states) are potential outcomes. This is the 'coordination' or 'first mover' market failure that complementary measures, often centring on planned land use change, can avert. However, the economic appraisal process is constrained by whether or not planning for complementary land use change actually eventuates.[12] In its absence, appraisal teams may not command the mandate, information, time and resources needed to develop an appropriate set of change scenarios. Guidance, however, could call for a prior strategic case for each HSR project – and others where productivity and other indirect benefits may be important – that identifies complementary benefits and how they could be achieved (see also Section 6).

Looked at from another perspective, it is hard to control where jobs are located, as Marion Terrill[13] comments. To aid both planning and strategic appraisal, guidance could advise on how to research responsiveness of business to the altered travel opportunities, including how these may impact location choice. For the economic appraisal, where near-station land use change is planned, development scenarios may include agglomeration externalities above estimates under fixed land use.[14] Additional travel demand arising from the land use change will be included in user benefits, as provided for under existing guidance (CoA 2023).

4.2 'Commutable' housing welfare impacts

By lengthening the distance covered in an up to one hour commute, high speed rail may 'unlock' additional land for housing that would sit within a newly 'commutable' range of jobs in capital cities. High speed commuting services in the UK (Preston 2023, Steer 2019) and Spain (de Urena et al 2017) offer precedents. While the improvement in accessibility could reduce differentials in land prices between capital cities and regional areas, the increase in supply of suitable land for new housing could increase housing affordability, choice and welfare.

For economic appraisal, the comments, including a warning, in Duranton and Venables (2018), regarding an analogous bus rapid transit outer urban project context, are noteworthy. They write that residents relocating "in newly developed peripheral areas may be willing to incur higher transport costs through longer distances because it allows them to consume more housing at lower cost", adding that "the calculation of these gains is extremely challenging". However, by adapting existing recently introduced wider benefit methodologies, it may be possible to estimate the welfare gain of these new resident high speed rail users more accurately than via conventional ('rule of a half' or 'logsum') transport user benefit methods. Both an ATAP higher value land use method and a UK dependent development one measure land use benefits that a transport improvement project can 'unlock' and, in different ways, avoid double-counting of any associated transport user benefits (Table 5).

5 Net benefits across the HSR time horizon

This section explores two issues relevant to valuing benefits and costs across a lengthy HSR time horizon, determining the length of the appraisal period and valuing carbon emission abatement, each of which interacts with a further issue, discount rate-setting.

To provide discount rate context, countries divide into those, like Australia, that adopt a social opportunity cost of capital (SOC) – or 'rate of return on displaced investment' – conception, those preferring the alternative social rate of time preference (SRTP) 'forgone consumption'

[12] The scope for 'value capture' of land value uplift from HSR accessibility provides governments, given a suitable legislative framework, with a financial incentive to plan near-station land use change.

[13] Interview 4 April 2025.

[14] Ahlfeldt and Feddersen (2018) is a possible source for a distance decay parameter in labour market expansion cases near major capitals. They estimate a distance decay half-life of 30 minutes. For a train averaging 160 kph, this would translate to at least 'half strength' spillover impacts up to 80 km.

Table 5: Existing methodologies for valuing commutable housing impacts

	ATAP Higher value land use	UK TAG Dependent development
Dependency test[1]	Yes	Yes
Location type	Primarily urban densification	General, if mainly for smaller rather than larger transport initiatives
Transport user benefits	Yes[2]	No for new residents[2]
Transport externalities	Yes	Yes
Land valuation approach	Base case residual land value[2] multiplied by change in gross floor area, adjusted for displacement	Land value uplift based on gross development value less development costs, adjusted for displacement
Non-transport externalities	Yes, but only positive ones (energy saving, public health) are identified	Yes, environmental, social, land amenity

1 That is, the development must be dependent on the transport improvement, in the sense that it could not occur otherwise.

2. TAG avoids double-counting by excluding new resident user benefits (user benefits for others are included). ATAP includes user benefits but excludes land value uplift, valuing land use intensification impacts at base case, rather than project case, values.

Source: CoA 2022b, UK DfT 2025b and author analysis

approach, which generally yields rates below SOC levels and those that can be described as 'mixed', including USA, Canada and New Zealand (Groom et al 2022).[15] Infrastructure Australia recommends a seven per cent real discount rate for appraisals (IA 2021a), while noting that *"lower discount rates are often adopted for projects with a long stream of benefits expected to accrue across multiple generations …"* (IA 2025) [16]. Sensitivity testing, at four and 10 per cent, is a feature of Australian guidance, one "reflecting the uncertainty about the 'true' discount rate" (Office of Best Practice Regulation 2020). This OBPR guidance for environment projects also includes a seven per cent-based declining discount rate schedule.

5.1 Better aligning appraisal period with investment economic life

5.1.1 A 100 year economic life

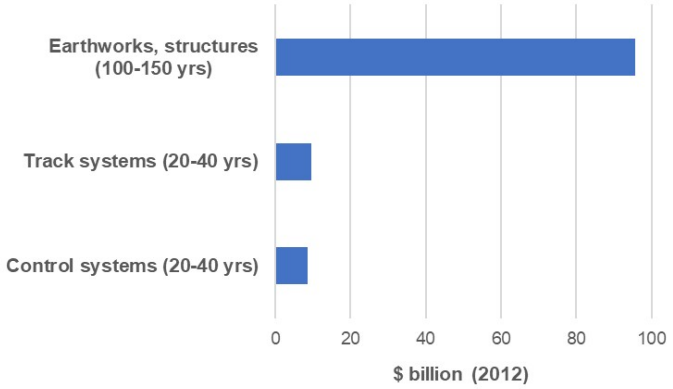
HSR projects, like others, involve multiple assets. ATAP, in acknowledgement, states that the appraisal period should be set at the expected life of the primary asset (CoA 2022a). It then adds: "*It is typical to assume a 30-year life for road construction initiatives (except bridges, which have much longer lives) and a 50-year life for rail initiatives."* Infrastructure Australia (IA 2021a) says similarly that the appraisal period should align with a project's expected economic life, but omits ATAP's 'primary asset' qualification. It cites 30 years for road projects (without ATAP's bridge exception) and 50 years for rail ones. New South Wales states that analyses should not use an appraisal period above 50 years (Transport for NSW 2024).

At around 100 years, HSR projects, like other rail investments involving new alignments that include tunnels and structures, are likely to have most of their capital costs in assets of double a 'typical' length of life. An estimated 83 per cent of the $114 billion cost of the HSR network analysed in the 2013 Commonwealth study resided in assets with an economic life of 100 or more years (Figure 1). Yet the appraisal period adopted was just 50 years (after an eight year first stage construction period) plus a residual value period of 23 years, 73 years in total.

[15] USA has a default SOC-based rate of seven per cent and three per cent is often used in environment projects (US Office of Management and Budget 2003). Canada uses a SOC-based seven per cent for regulatory proposals and a three per cent SRTP rate for health and environment projects (Treasury Board of Canada 2022). Three per cent is also nominated for regulatory proposals "over the long term (50 years or more)" (Government of Canada 2024). New Zealand has a two per cent SRTP rate for 'mainly non-commercial' projects and eight per cent for 'mainly commercial' ones (The Treasury 2025).

[16] However Infrastructure Australia adds, in a report on Victoria's Suburban Rail Loop East, "use of a 4% discount rate does not align with the majority of current national, state and territory guidelines on economic appraisal in Australia" (IA 2025). Commonwealth discount rate leadership is understood to also include the central agencies of Treasury and Finance and the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts. New South Wales' SOC-based five per cent discount rate is sensitivity tested at three and seven per cent (NSW Treasury 2023).

Figure 1: Australia's 2013 HSR study – investment cost category shares and lengths of life



'Management and contingency costs' comprised $10.4 billion of a $114 billion project total. These costs are prorated across the three cost categories. Track systems include rolling stock.

Source: AECOM et al 2013, Standing Committee on Infrastructure Transport and Cities 2020 (Professor A McNaughton, Southampton University, UK evidence 14 September 2020) and author analysis

Appraisal guidance should include, or reference, information on the length of life of the range of assets that a rail project could potentially include.[17] The UK introduced a 100 year sensitivity test length of life in 2021, in part in recognition of projects such as the HS2 line.[18] For Australia a 100 year length of life could be explicitly permitted, where warranted by the ATAP primary asset principle and where supported by investment cost share analysis. To operationalise a 100 year HSR appraisal period, track, signalling and other shorter lived assets would be renewed as necessary over the period.[19]

5.1.2 A 100 year appraisal period, uncertainty and discount rates

Two main issues present in adopting a lengthy 100 year appraisal period, greater forecasting uncertainty in estimates of future costs and benefits and choosing a discount rate that gives sufficient emphasis to net benefits that accrue over the full project lifetime.

A certainty equivalent response to the forecasting uncertainty problem involves adopting declining growth rate schedules for all costs and benefits where growth rates apply and including the discount rate itself (Abelson and Dalton 2023, Arrow et al 2014). In altering these various rates, it is necessary to monitor the interaction of cost or benefit growth rates and a lower discount rate, to ensure that the 'net' discount rate – ie the difference between the growth in appraisal values and the discount rate – remains positive (IA 2021a, UK DfT 2020).

Turning to the second issue, Table 6 explores the interaction between discount rates and appraisal periods. At a seven per cent discount rate for a standard 30 year project, the present value assigned to each year is at least 13 per cent of the starting (year zero) value.[20] In contrast, a seven per cent discount rate applied to a 100 year project yields a final year discount factor of one tenth of one per cent of the starting value. Even at year 50, the present value is quite low at 3.4 per cent of initial value. Only at around a two per cent discount rate

[17] See UK DfT 2023a for a more disaggregated asset type length of life break-down than in Figure 1.

[18] Stuart Allen commented that, with 60 years the UK's standard period, "100 years … under quite strict guidance on when it can be used as a sensitivity test was felt to best balance demonstrating the potential long-lasting benefits of schemes, without delving too far into the future, where uncertainty can deem analysis meaningless." (email 11 April 2025). New Zealand also uses a 60 year appraisal period, introduced in response to KiwiRail's investment circumstances, with 40 years found insufficient to earn a return (interview Bryce Hartell, NZ Transport Agency Waka Kotahi 4 April 2025).

[19] At the end of 100 years, a residual value would likely result for these assets. See Nellthorp and Ojeda-Cabral (2021) for discussion of this and other issues in estimating residual values.

[20] That is, with a 0.131 year 30 discount factor. Put differently, a year 30 dollar is valued at 13 cents.

can the final year of a 100 year project receive the emphasis that a seven per cent discount rate places on the equivalent year of a 30 year project.

Table 6: Discount factor for an appraisal period final year, various discount rates, durations

Year	2%	3%	3.5%[1]	4%	5%	6%[1]	7%
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000
30	0.552	0.412	0.356	0.308	0.231	0.174	0.131
50	0.372	0.228	0.179	0.141	0.087	0.054	0.034
60	0.305	0.170	0.127	0.095	0.054	0.030	0.017
81[2]	0.201	0.091	0.062	0.042	0.019	0.009	0.004
100	0.138	0.052	0.032	0.020	0.008	0.003	0.001

1. In 2003 the UK moved from a standard appraisal period of 30 years and a discount rate of 6 per cent to a 60 year appraisal period and a 3.5 per cent discount rate (UK DfT 2020).
2. The 2013 HSR study had an appraisal period of 81 years (including an eight year construction period before the opening of stage one) and a 4 per cent main discount rate, with results at 7 per cent also reported.

It is therefore important, whether as an exception for longer lived projects or by means of a review of discount rate-setting for all projects (see Section 5.3), that lower discount rates are used in appraising HSR projects. A three per cent discount rate, as available for projects of 50 years or more in Canada[21], would offer discount factors above five per cent of starting value for all years. Given a degree of convergence through time of discount factors at different rates (as the table shows), this could be considered a sufficient reduction.[22]

5.2 Valuing carbon abatement beyond 2050

By diverting travel demand from air, currently without a pathway or timing to decarbonise large passenger jets, high speed rail, using zero emission electricity, could offer carbon abatement benefits on domestic air routes where it would operate. Guidance carbon emission values are geared to achieving net zero emissions by 2050 and involve a rising cost of abatement, as different technologies are introduced (IA 2024). Values increase, in a central case, at a rate of 7.6 per cent per year between 2024 and 2050, from $56 to $377 per tonne of carbon dioxide equivalent emissions, in 2023 prices (Table 7). Values are then held constant thereafter.

Table 7: Target-consistent value of carbon dioxide-equivalent emission savings, $2023/tonne

Financial year	Low	Central	High
2024	44	56	66
2030	107	148	180
2040	210	282	340
2050	287	377	469
2050+	287	377	469
Average annual change			
2024-50	*7.5%*	*7.6%*	*7.8%*
2024-2100	*2.5%*	*2.5%*	*2.6%*

Source: IA 2024 and author analysis

While the time frame of main interest, to 2050, is a short one, lower discount rate assumptions and a longer timeframe turn out to underpin the adopted abatement and emission value time paths. Riahi et al (2021), referenced in a report that underpins the guidance (CIE and WSP Australia 2023) comment:

"The perceived overall cumulative cost of each pathway depends critically on the discount rate and how one weights the near-term GDP losses [ie from meeting the costs of abatement] *against the long-term GDP gains … We find that discount rates of less than about 2% would make the perceived cumulative costs of the majority of 1.5˚C and 2˚C scenarios overall less*

[21] See Footnote 15.

[22] As practised, declining discount rate schedules do not solve the discount rate alignment problem. The OBPR (2020) schedule commences at seven per cent for years 1 to 30 and declines (step 6) to 3.7 per cent after year 300. The schedule's 'flat' rate equivalent is 6.7 per cent (author analysis).

costly without [temperature] *overshoot… . Assuming higher discount rates on the other hand would favor more delayed mitigation with overshoot."*

Strictly, for Australia to adopt a a lower discount rate for climate change benefits than for the generality of impacts, an SRTP-based core discount rate would be necessary. With the expected future rate of growth of consumption typically the largest component of an SRTP rate[23], the rationale for 'dual discounting' centres on the limited substitutability between normal consumption goods and ecosystem services (or environmental 'goods'). Evidence that ecosystem services are either in absolute decline, or are increasing at a lower rate than manufactured goods, strengthens this argument (Baumgartner et al 2015[24]). However, in the absence of SRTP-based settings, Canada's mixed discount rate regime (Footnote 15) may provide a pragmatic model that merits consideration. In 2023 Canada lowered its three per cent environmental (and lengthy project) rate to two per cent for carbon emission impacts, "due to the especially long intergenerational analyses required to comprehensively evaluate climate change impacts" (Government of Canada 2023).

5.3 Discount rate setting – a general review?

Use of a lower discount rate for HSR (and other similarly long-lived) projects may be opposed on grounds that consistency necessitates uniform discount rates across all projects and that 'the tail should not wag the dog'. However, the case for moving to an SRTP conception for all budget funded investment projects, with a consequentially lower rate, is itself a strong one.[25]

Two arguments stand out. The first is that SOC-based discount rates misconceive the actual opportunity cost of public funds. Net of any private equity contributions, public investments are funded not through commercial financing necessitating a rate of return, but through taxation, with borrowings smoothing the tax burden through time. As Spackman (2025) argues, the social cost of taxation is the cost of the dollars taken from the private sector in forgone consumption and saving "plus the marginal excess tax burden (METB), which is the cost of all the other impacts … of extra taxation", including those on labour supply and investment. While mostly omitted from countries' SRTP rates, the METB could entail a shadow pricing increase to capital costs of between 25 and 50 per cent.

Secondly, as Mehra and Prescott (1985) show, the private equity premium, that feeds into estimates of the SOC, greatly exceeds the variability of aggregate consumption. It is the latter that measures the systematic risk impacting on a portfolio of public projects and warrants, these scholars suggest, a risk premium of just half a percentage point, rather than the equity premium's five or six percentage points. The return to private equity is, in Spackman's words "not a net social benefit but an equity-specific cost", compensating investors for risk from holding periods of 35 years or more and, as Grant and Quiggin (2003) suggest, adverse selection (information asymmetry) challenges. Except, to an extent, when governments themselves invest in equities[26], the cost has no analogue in publicly funded investments.

Applying, illustratively, the UK's discount rate approach and with a notional future per capita consumption growth rate of two per cent, an SRTP discount rate would align with the UK's 3.5 per cent. Again illustratively, following Baumgartner et al 2015, a corresponding lower discount

[23] The UK's Ramsey formula-derived rate of 3.5 per cent comprises a time preference rate of 0.5 per cent, a catastrophic and systematic risk component of 1.0 per cent, an income elasticity of marginal utility of 1.0 and a future per capita consumption growth rate of 2.0 per cent (UK Treasury 2022).

[24] This study finds that ecosystem services should be discounted at a rate between 0.6 per cent and 1.2 per cent lower than the rate for manufactured consumption goods.

[25] Interviewees did not enter the 'SOC versus SRTP' debate (Table 1). However, five said that the Australian discount rate should be lower and none that it should be higher. Professor John Quiggin proposed use of the market rate for riskless debt, ie the real government bond rate at around two per cent, plus a "tiny adjustment" for systematic risk. Project analyses, he added, could be "sharper on cash flows than we usually are" in addressing (particularly downside) project risk (interview 31 March 2025).

[26] While governments require specific purpose legislative backing to invest in equities, this alternative is prominent in the general case to retain a SOC approach (Abelson and Dalton 2018, Harrison 2010).

rate for carbon valuation would be 2.5 per cent. While guidance agency mandates may not extend to altering the Commonwealth discount rate, these agencies could propose a general review, with central and environmental agencies involved.

6 Aligning strategic and economic cases

For any transport investment project, strategic appraisal precedes economic appraisal and it is important that the second aligns with the first, in the sense that methods used in the economic appraisal should align with the project's strategic narrative. This ensures that benefits expected in a broad policy context are, as far as possible, quantified and monetised.

A strategic case should answer three broad questions: first, what is the problem that the scheme can address; second, how will the scheme solve the problem; and third, why is addressing the problem important. Infrastructure Australia asks proponents to describe the 'problem or opportunity' that a proposal will address (IA 2021a). If, as may be more usual, opportunities arise through solving transport problems, rather than being, say, premised on a particular transport solution[27], identifying opportunities is a fourth element of a strategic case.

Whether viewed primarily as a response to transport problems, or as a preferred pathway to opportunities[28], the strategic case for high speed rail involves a wide range of expected benefits. In part due to experience with planning and appraisal of the HS2 high speed line between London and the north of England (see Section 3.2), the UK is seeking greater mutual accountability between strategic perspective and economic analysis. UK transport appraisal guidance now requires both that all projects have a strategic case that sets out their objectives and that net benefits are mapped to these objectives (UK DfT 2023b).

Infrastructure Australia asks proponents to demonstrate a project's 'strategic alignment' with policy and program goals (IA 2021b). Projects could, however, also have their own strategic objectives that would ensure clarity for appraisal teams on the scope of their task. Appraisals could then report systematically against the objectives, including benefit shares, where monetised, for each objective.

7 Recommendations

This section summarises and consolidates recommendations provided in preceding sections.

1. Value of travel time savings

a. ***Cross-mode*** To assist in analysis of mode switching to HSR, research and provide guidance on existing 'cross-mode' VTTS (eg car-air, car-rail, car-coach).

b. ***Distance*** Research and provide guidance on VTTS by trip distance and/or duration (eg within: 1 hour; 2 hours; 3 hours; and above 3 hours) for car and other modes.

2. Capacity relief on impacted networks Research travel responses to network capacity (rail, road, air) constraints, including congestion/crowding, alternative time or mode of travel and travel suppression, together with consequential valuation issues and provide guidance.

3. Inter-urban productivity impacts

a. Require preparation of a strategic case preceding the economic appraisal that addresses coordination market failure risk and considers risk-averting complementary measures.

b. Advise on how to research responsiveness of business to HSR travel opportunities (business, commuting and leisure), including how these may impact location choice.

3. ***Commutable housing welfare impacts*** Provide guidance on valuing increases in commutable housing supply 'unlocked' by HSR, with either ATAP higher value land use or UK dependent development methods considered for adaptation.

[27] To illustrate, the Sydney Metro-Western Sydney Airport project (IA 2021b) focuses primarily on attracting residents and businesses to particular locations, rather than on solving transport problems.

[28] Potterton (2024) exemplifies the former approach to HSR, Glazebrook and Lowrey (2023) the latter.

5. Appraisal period

a. Provide (or reference) length of life information for different HSR-relevant asset classes (eg earthworks/structures, track systems and control systems).
b. Permit a 100 year maximum length of life, where warranted by asset cost share analysis and with renewal of shorter-lived assets included as part of the cost-benefit analysis.

6. Valuing carbon abatement after 2050 Review environmental discounting, with relevant agencies and consider dual discounting (eg as per Canada's two per cent dedicated rate).

7. Discount rates, the appraisal period and carbon abatement

a. To address uncertainty over longer time horizons, provide guidance on moderating all cost and benefit growth rates over time, including a declining discount rate schedule.
b. Recognising the importance of: aligning the discount rate with net benefits that accrue throughout a project's economic life; consistency in assessment between projects with differing lengths of life; and a sound rationale for the approach to and level of the discount rate, review, with relevant agencies, the existing SOC-based seven per cent discount rate, including consideration of a move to an SRTP conceptual basis and a resulting lower rate.
c. In the event a review leads to adoption of an SRTP-based discount rate, align the carbon valuation discount rate (Recommendation 6) with this rate, eg one percentage point lower.
d. In the event a review maintains a SOC-based discount rate, consider introducing a three per cent discount rate for projects with a lifetime of 50 years or more (also as per Canada).

8. Aligning strategic and economic business cases

a. To improve alignment between a project's strategic case and its economic case, require projects to have specific objectives, ie additional to the existing requirement to show alignment with government policy settings.
b. Require cost-benefit analyses to report systematically against project objectives, including benefit shares, where monetised, for each objective.

8 Conclusion

Australian transport economic appraisal guidance relevant to the planned new mode of high speed rail could be enhanced by additions or changes in the areas of: value of travel time savings, adding mode effects and distance effects to existing user effect measurement; network capacity relief benefits in relevant modes; commutable housing welfare impacts; better alignment of the appraisal period with the economic life of HSR assets (ie 100 year maximum economic life); valuation of long term carbon abatement; and alignment of strategic and economic cases, including through requiring project-specific objectives. To align with a longer appraisal period, while ensuring both assessment consistency between projects with differing lengths of life and a continuing sound underlying rationale, a general Commonwealth government review of discount rate-setting providing is recommended, including consideration of a change in approach from social opportunity cost to social rate of time preference and a reduction in the existing seven per cent rate. Inter-urban productivity impacts, like urban ones, are subject to coordination market failure risk. Guidance could focus on requiring a strategic case that considers complementary measures, including land use change planning and on researching business responses to high speed rail travel opportunities.

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