Australasian Transport Research Forum 2024 Proceedings
27-29 November, Melbourne, Australia
Publication website: https://australasiantransportresearchforum.org.au/

What transport problems can high speed rail address and what opportunities can it enable? A route geography approach

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Abstract

The paper applies a 'route geography' approach to, first, the transport problems that high speed rail services, at 300 to 350 kilometres per hour (kph) and sub-high speed ones, at 200 to 250 kph, could address and, second, opportunities that could arise in consequence. Drawing on international experience applied to Australia's economic geography, the paper references a high speed rail infrastructure footprint comprising Brisbane-Sydney, Sydney-Melbourne and Melbourne-Adelaide corridors. Four route geographies connect a major capital with: an adjoining major capital predominantly via high frequency air transport (RG1); with the furthest regional significant urban area (SUA) that has frequent train service (RG2); a low frequency distance range between that regional SUA and 350 km (RG3); and a further low frequency range, one augmented by air transport, between 350 and 450 km (RG4). The transport problems are: potential future capacity shortfall at conveniently sited Sydney Kingsford Smith Airport, placing at risk growth in air-reliant day return travel (RG1); commuting train service times lengthier than self-drive (RG2); long day return travel times, for train, coach and also self-drive, at distances mostly too short for viable air services (RG3); and costly air transport (RG4). Among transport impacts, 350 kph high speed rail could offer the conveniently sited capacity to underpin future growth in day return travel (RG1), while sub-high speed services could render regional SUAs closer to major capitals (RG2) commutable. Opportunities from addressing transport problems comprise contributing to: population growth shift (primarily RG2, also RG3); better business productivity (all regional route geographies); improved access to in-region specialist health services (RG3); and net zero emission transport (particularly RG1). For business cases, the route geography approach: draws attention to a need to accommodate contrasting RG1 and RG2 service requirements, in particular; enables diverse strategic rationales to be acknowledged; and helps anchor the economic analysis.

1 Introduction

According to Infrastructure Australia (2021), *"Defining problems and opportunities is the first step in infrastructure appraisal, setting the foundation for the whole process"*. This paper contends that the transport problems that Australian high speed rail could address, over lengthy distances, differ according to a number of distinct 'route geographies'. Resulting opportunities also vary by route geography. Particularly in a context where, as at present, implementation of high speed rail is being planned in sections or stages – with Sydney to Newcastle a 'crucial waypoint' (King 2024) – a clear understanding of the different route geographies may assist business case formulation, including service planning.

A study commissioned by the Commonwealth government (AECOM et al 2013) analysed the high speed rail travel market in a scheme of 'short regional' trips of up to 250 kilometres, 'long regional' trips of greater than 250 kilometres and 'inter-city' (ie intercapital) trips. This paper employs a four-way categorisation, extending here a 'distance band' notion in Potterton 2022, which distinguished between routes 200 to 350 kilometres from a capital city that are mostly

without air transport links to the capital and routes above 350 kilometres, where almost all Australian regional centres have access to an airport with these links. The paper draws also on the literature of the economic impact of high speed rail: notably, Chen and Hall 2011, Crozet 2013, Nash 2017, Preston 2013 and Venables et al 2014.

Definitions of high speed rail can include rail systems with maximum train operating speeds between 200 and 250 kilometres per hour (kph), where there is no air competition and with geographical or temporal separation of freight and passenger traffics, as well as systems with top operating speeds above 250 kph, often between 300 and 350 kph (UIC 2018). In each case, services are electrified, enabling the necessary train acceleration capability and speed. This paper encompasses both types, but reserves the term 'high speed' for the latter, consistently with the *High Speed Rail Authority Act 2022* (Federal Register of Legislation 2022). 'Sub-high speed' denotes 200 to 250 kph electric train services and infrastructure. High speed freight services, as operated on high speed lines in Italy in recent years (RailFreight.com 2024), are beyond the paper's scope.

The paper: opens with a methodology overview (Section 2); identifies, drawing on international experience, a high speed and sub-high speed rail network and service footprint for use in the paper (Section 3): outlines the paper's dataset (Section 4); delineates four route geographies (Section 5); details the transport problems of each route geography (Section 6); discusses how high speed rail and sub-high speed rail might address these problems (Section 7); links a range of resulting opportunities to the route geographies (Section 8); and sets out implications for business case formulation (Section 9.

2 Methodology

The first step is to determine the geographic and service scope of an Australian high speed rail network for purposes of the paper. To inform this, international experience is briefly reviewed, in the context of Australia's economic geography.

Second, the existing public transport service profile within the paper's high speed rail network footprint is analysed with the aim of identifying different route geographies. A route geography is a distinct grouping of city pair routes that connect a major capital with either another regional significant urban area (SUA)[1] or another major capital. Route geographies are distinguished by differences in mode profile, service frequency and/or fare level. The emphasis on major capitals in each route geography reflects these cities' size and importance in travel patterns, whether for employment, business, services, sport, culture, or visiting family and friends.

Third, drawing on the existing service profile, actual or potential service deficits ('transport problems') are identified in each route geography.

Fourth, how high speed rail, or, as appropriate, sub-high speed rail, could address these problems is described, by reference to the Sydney-Melbourne corridor.

The fifth step is to identify economic and other (environmental, social) opportunities that could result from addressing the transport problems in each route geography.

Finally, the paper considers implications of the transport problems, together with the high speed and sub-high speed solutions and the opportunities identified through the route geography approach for business case formulation.

3 What network footprint, services for Australian high speed rail?

"High speed rail", writes Steer Davies Gleave (2004), *"enables journeys over medium distances to be made quickly"*. The mode, it is argued, is sandwiched between the greater competitiveness of conventional rail, with closely spaced stations, at short distances and that of air, with its higher speeds, at long ones. What exactly are 'medium distances'? Commenting on high speed rail in China, where numerous routes have top speeds of 350 kph (Table 1),

[1] Australian Bureau of Statistics 'significant urban areas' have populations of at least 10,000.

Lawrence et al (2018) write that *"The impact … is… significant up to 1,000 km (three to four hours), rather further than is customarily expected in Europe."* In particular, three to four hour service times are compatible with day return travel, where, as Crozet (2013) puts it, *"it is possible to make the return journey the same day and still do a meaningful day's work at the other end".*

Table 1: High speed rail and air services on long routes, various countries, June-July 2024

Country	Route	Rail distance km	HSR max. speed kph	HSR av. speed kph	HSR service time mins	Air service time mins	HSR-air excess mins	HSR fare $A	Air fare $A	HSR service share
France	Paris-Marseille	660	320	198	200	85	115	197	424	63%
Spain	Barcelona-Malaga	769	310	310	381	100	281	235	148	10%
Japan	Tokyo-Hiroshima	816	300	213	230	85	145	188	161	67%
China	Beijing-Nanjing	1,038	350	251	248	115	133	161	292	70%
Japan	Tokyo-Fukuoka	1,062	300	215	297	115	182	338	141	31%
China	Beijing-Wuhan	1,229	350	316	243	125	118	175	161	46%

Source: Various (see Section 4) and author analysis

Three to four hour service times also serve to keep the high speed rail 'excess' time relative to air at about two hours: in Table 2, this applies to Paris-Marseille, Tokyo-Hiroshima, Beijing-Nanjing and Beijing-Wuhan routes. Passengers accept this excess, it is argued, due to stations that are often more conveniently located than airports, faster boarding and disembarkation processes and comfort and reliability factors (Preston 2013, Nash 2017). So with a three to four hour service time short enough to attract time-sensitive (and higher fare-paying) day return travellers, high speed rail market shares of around 50 per cent or higher are recorded (Crozet 2013, Michell 2024), proxied in the table by service share information.

In Australia, with the distances between adjoining major capitals in Australia's southeastern quadrant (ie Brisbane-Sydney, Sydney-Melbourne, Melbourne-Adelaide) well inside 1,000 km[2], a high speed rail network footprint, comprising these city pairs is compatible with the international experience. From a commercial operations perspective, low population density (Terrill 2020) and mature low cost airline competition (Bukovac and Douglas 2019) represent challenges. The former precludes large intermediate markets between the major capitals, as found in Japan and, to an extent, France (Nash 2013), while the latter would work to cap the fares that price-sensitive travellers could be willing to pay. However, for a network of limited size, there would be assets also. These include: the large proportion (above 60 per cent, ABS 2024) of the country's population resident in just five cities, four of which would be included; Australia's internationally high per capita propensity to travel (Millard-Ball and Schipper 2011); and an underlying passenger preference around the world to choose rail over air, on grounds including superior comfort and reliability (Nash 2017) [3.] Mode preference considerations may also contribute to high speed rail's strong record in generating new passenger traffic.[4]

Recent development of shorter, commuting-oriented high speed services, notably in the United Kingdom (Steer 2019) and Spain (de Urena et al 2017), are also relevant to the service profile of a future Australian high speed rail infrastructure network. Key features of short distance services on the HS1 Line from London to the Channel Tunnel, connecting from there to Paris (Table 2), are: a sub-high speed rail maximum speed, at 225 kph[5]; two commuting-

[2] See Table 3 below.

[3] The first two of these features contribute to the Sydney-Melbourne air route's status as the world's fifth largest by number of seats and third largest over land (OAG 2024). See also Potterton 2021, 2023.

[4] For China, see Lawrence et al 2019 and for Europe, AECOM et al 2013 (Appendix 1A).

[5] The London-Paris Eurostar service top speed is 300 kph. Operating speed differences of up to 100 kph are not unusual. Lawrence et al (2019) note that in China 250 kph trains to operate on lines built for 300-350 kph.

oriented stations served, at 40 to 50 km spacings; service times well inside a 'commutable' one hour benchmark maximum time; high service frequencies at these stations; and costly fares, at the lesser of the two distances especially. Sub-high speed trains also operate on conventional lines that connect to HS1, accessing additional regional centres.

Table 2: Shorter services on HSR track connecting large cities, UK and Spain, Jul.-Aug. 2024

Inter-city route, with shorter distance stations	Population	Road distance km	Rail distance km	Return services pw	Service time mins	Av. service speed kph	Fare $A per 100 km
LONDON-PARIS							
Ebbsfleet International (HS1, UK)	171,634	39	32	473	19	101	130
Ashford International (HS1, UK)*	132,700	97	82	271	38	129	37
Paris (France)	11,277,060	456	339	103	137	149	66
MADRID-SEVILLE							
Ciudad Real	74,743	190	171	131	67	153	30
Puertollano	47,881	242	210	101	85	148	29
Seville	1,305,342	531	460	148	163	169	15

*Sub-high speed Javelin trains also connect from here to Canterbury and Margate, using conventional track.
Source: Various and author analysis (see Section 4).

Five of Australia's 24 regional centres with populations exceeding 50,000 are located within 200 km of a major capital on one of the three major capital to major capital corridors: in decreasing size order, Gold Coast-Tweed Heads, Newcastle-Maitland, Central Coast, Ballarat and Shepparton-Mooroopna. Drawing on the United Kingdom's HS1 service model, frequent shorter distance sub-high speed services, might be considered in relation to these locations, in addition to full corridor services.

4 Existing service data

Australian existing service data covers services in three public transport modes (train, coach and air), together with self-drive times, between, in the first place, adjoining major capitals (Brisbane-Sydney, Sydney-Melbourne, Melbourne-Adelaide, Table 3) and, secondly, regional centres (regional SUAs) in the intercapital corridors and each regional centre's nearest major capital (Table 4).

Data were compiled from publicly available operator schedules and booking systems, between March and April 2024, for services offered between two and three weeks ahead (ie in April and May 2024).Weekly return frequencies were estimated based on direct (and largely no change) services available on the Thursday – a generally higher frequency weekday – and the Saturday, for a weekend estimate. All mode seat capacity was also estimated, using operator website fleet information and Wikipedia sources. Seat capacity data are shown only at a total (ie not mode-specific) seats level, due to limitations of space.

Service times included are those with the largest number in the schedule on the relevant days. For air and coach – modes where most routes have more than one operator – service times are those of the operator with the greatest frequency.

Self-drive times are sourced from Google Maps, collated on an April-May 2024 weekday between 7am and 8am, to align with work-related travel. Where applicable, self-drive times allow for a 15 minute rest period taken every two hours (RACV 2024).

Non-concession adult fares were collated. Fares for Sydney to Newcastle-Maitland and Sydney to Bowral-Mittagong train services are peak period fares, again proxying work-related trip purposes. Other train fares are mostly offered at the one price level for all services. Air fares shown are those with the largest number of occurrences for the operator with the greatest service frequency. Air and coach fares shown are in all cases exchangeable for another service, subject to cancellation notice periods and are generally not refundable. A distance-standardised (dollars per 100 kilometre) fare indicator is shown, using the rail, road or air distance, as applicable.

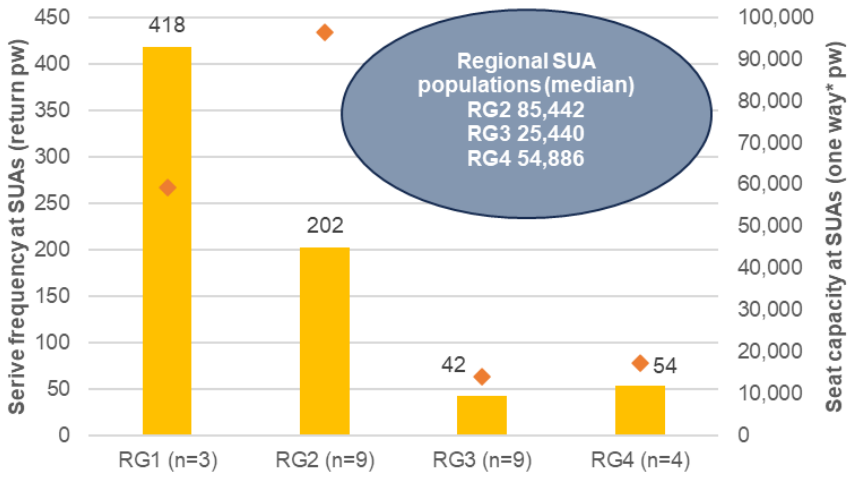
The data analysis categorises weekly return service levels as follows: high frequency, 210 and above; frequent, 140 to 209; moderately frequent, 70 to 139; low frequency 20 to 69; very low frequency, below 20.

A small international data set, comprising high speed rail and air modes for longer distance routes and solely high speed rail for shorter routes (Tables 1 and 2), follows the same approach. International booking websites, including www.highspeedtrains.com and www.skyscanner.com.au, are used.

5 Distinguishing route geographies

At a median weekly return service level of 418, the three routes between adjoining major capitals (RG1) operate at high frequency (Figure 1). With air services comprising over 90 per cent of total services, these routes are also air-dominant (Figure 2)..

Figure 1: All mode weekly return service frequencies and seats at regional SUAs, 4 RGs



*A return trip uses two one-way seats.

Key: Major capital to: adjoining major capital **RG1** end point of frequent train service (80-190km) **RG2** 80-190 km to 350 km range, most without air **RG3** 350 to 450 km range, with air **RG4**

In contrast, RG2 comprises frequent train routes (median 202 per week). These operate from each major capital to larger regional centres, with the closest (Gold Coast-Tweed Heads) just 79 km from Brisbane and the furthest (Shepparton-Mooroopna), 191 km from Melbourne. With the seating capacity of passenger trains typically higher than that of passenger aircraft, these routes also exhibit the highest seat capacities of the four route geographies (median 96,425 one-way seats per week).

RG3, from major capitals to a range stretching from the RG2 frequent service endpoint up to 350 km, consists primarily of low frequency train and coach routes (median 42 return services per week) with intercapital stopping services providing a majority of services.

Finally, RG4, from major capitals to distances between 350 and 450 km, comprises still low frequency services (median 54 per week), where air is the larger of the three public transport modes. As elsewhere across Australia (Potterton 2023), the four regional SUAs situated more than 350 km from a major capital (Table 5) either have an airport with service to the nearest major capital city, or, as in Kempsey's case, are within 50 km of such an airport (at Port Macquarie). No RG4 regional SUA is more than about 450 km from a major capital.

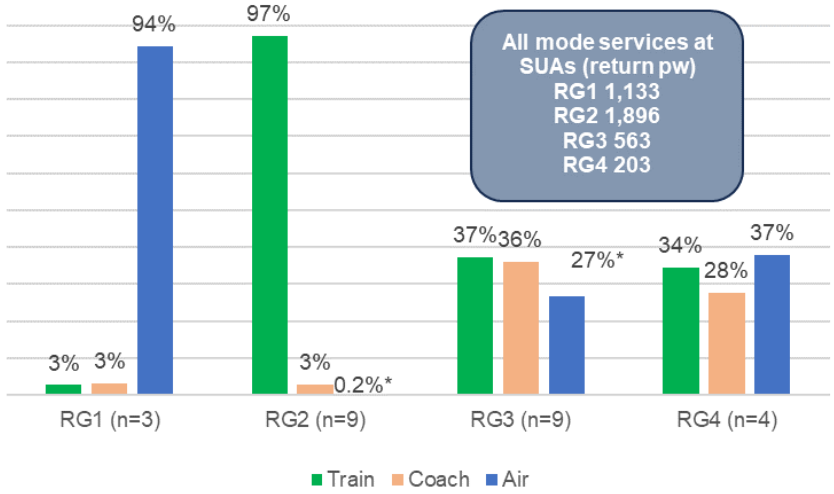
Table 3: Train, coach and air services, with self-drive, adjoining major capital routes, mainland southeast including South Australia, Apr.-May 2024

Route	Road dist. km	Self-drive time	TRAIN				COACH			AIR			ALL return servs. pw	ALL 1-way seats pw 000
			Rail dist. km	Return servs. pw	Sched. time	Fare $/100km	Return servs. pw	Sched. time	Fare $/100km	Return servs. pw	Sched. time mins	Fare $/100km		
Brisbane-Sydney	909	10h51	988	14	14h20	10	21	17h	20	390	95	27	418	59
Sydney-Melbourne	879	9h54	909	14	10h48	9	10	12h	17	534	95	37	558	108
Melbourne-Adelaide	726	8h52	828	2	10h25	20	10	9h45	15	145	80	37	157	30

Table 4: Train, coach, air services, with self-drive, regional SUAs to nearest major capitals, Brisbane-Sydney-Melbourne-Adelaide, April-May 2024

SUA (MAJOR CAPITAL, regional)	Nearest major capital km road	Regional SUA pop. 2023	Self-drive time mins	TRAIN				COACH			AIR			ALL return services pw	ALL 1way seats pw 000
				Return services pw	Sched. time mins	Sched. journey spd kph	Fare $ /100km	Return services pw	Sched. time mins	Fare $ /100km	Return services pw	Sched. time mins	Fare $ /100km		
BRISBANE															
Gold Coast-Tweed Heads	79	735,213	91	315	91	59	16	28	80	25				343	289
Ballina	186	24,373	131					28	270	28				28	3
Lismore	197	28,199	164					21	212	24				21	2
Grafton	315	19,607	219	21	244	72	12	14	480	24				35	14
Coffs Harbour	388	75,838	254	21	318	73	16	21	550	22	5	60	95	47	15
Kempsey	428	16,143	311	21	449	67	9	21	415	22				42	14
Port Macquarie	394	51,965	275	21	398	69	10	21	405	19	33	70	78	75	19
Taree	320	26,740	224	21	331	69	11	21	320	27				42	19
Maitland	175	95,957	129	191	211	50	6							191	96
Newcastle	168	430,558	133	229	164	62	6	24	145	22	4	50	148	257	118
Morisset-Cooranbong	121	29,421	97	337	115	64	8							337	170
Gosford	83	348,435	86	324	87	56	12							324	164
SYDNEY															
Bowral-M'gong	118	41,982	84	171	144	41	7							171	95
Goulburn	195	25,017	126	36	152	89	11	6	165	48				42	14
Canberra-Queanbeyan	286	503,402	199	21	248	80	12	89	210	17	150	55	107	260	39
Wagga Wagga	453	57,807	302	14	276	96	14				6	70	56	20	8
Albury-Wodonga	326	100,095	220	31	216	85	14	17	260	27				48	22
Wangaratta	251	19,969	176	30	160	88	14							30	11
Shepparton-Mooroopna	191	54,494	131	71	163	67	15							71	32
MELBOURNE															
Ballarat	116	116,390	90	202	87	82	9	13	95	77				215	91
Horsham	299	16,876	217	43	251	71	3	13	330	30				56	7
Murray Bridge	75	19,371	54					45	106	32				45	5
ADELAIDE															
AVERAGE	235	135,136	170	112	216	71	11	27	269	30	40	61	97	123	57
MEDIAN	196	41,982	148	36	211	69	11	21	260	25	6	60	95	52	19

Figure 2: Services by mode at SUAs, 4 route geographies, percentage shares



*Newcastle-Maitland and Canberra-Queanbeyan are the only regional SUAs with air service to the nearest major capital in RG2 and RG3 respectively.

Key: Major capital to: adjoining major capital **RG1** frequent train service end point (80-190km) **RG2** 80-190 km and 350 km range, most without air **RG3** 350 and 450 km range, with air **RG4**

Table 5: Route geographies and regional significant urban areas (SUAs), by corridor

Route geography	Description – Major capital to:	Median distance road km	Significant urban areas (SUAs)		
RG1 (n=3)	Adjoining major capital	879	BRISBANE-SYDNEY	SYDNEY-MELBOURNE	MELBOURNE-ADELAIDE
RG2 (n=9)	Frequent train service end point (80-190 km)	118	Gold Coast-Tweed Heads	Bowral-Mittagong	Ballarat
			Newcastle-Maitland	Shepparton-Mooroopna	Murray Bridge[1]
			Morisset-Cooranbong		
			Gosford		
RG3 (n=9)	80-190 km and 350 km range, most without air[2]	268	Ballina	Goulburn	Horsham
			Lismore	Canberra-Queanbeyan[2]	
			Grafton	Albury-Wodonga	
			Taree	Wangaratta	
RG4 (n=4)	350 and 450 km range, with air	411	Coffs Harbour	Wagga Wagga	
			Kempsey		
			Port Macquarie		

1.With no regional South Australia passenger rail services, Murray Bridge has (low frequency) coach services (Table 4).
2. Canberra-Queanbeyan, with over 500,000 residents, has frequent air service.

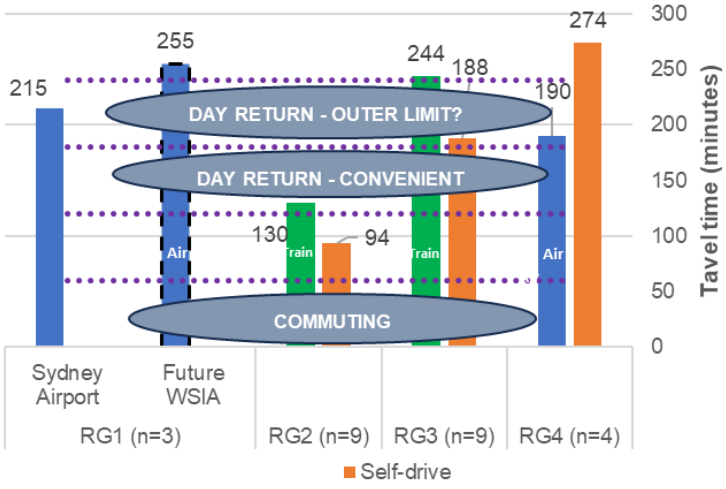
6 Transport problems and route geographies

6.1 Intercapital routes – future conveniently sited airport capacity shortfall

The main transport problem between adjoining major capitals (RG1) concerns the limited capacity of the airports in use and the difficulty in replicating elsewhere their convenient siting. Brisbane, Sydney and Melbourne airports are all close to city centres, a location that serves to keep end to end journeys within a three and a half to four hour total time (Figure 3), thereby enabling manageable business and other daytrips. While both Sydney and Melbourne airports were effectively at capacity during the weekday morning peak in 2019, prior to the COVID-19 pandemic (APAC 2022, Australian Aviation 2019), Melbourne Airport has a parallel runway in planning that would enable a doubling of aircraft movements and Brisbane Airport's parallel runway, constructed via land reclamation, opened in 2021. However Sydney Kingsford Smith

Airport (Sydney Airport), with approaching half (44 per cent) of all domestic aircraft movements in the paper's HSR footprint (Figure 4)[6], lacks additional runway options.[7]

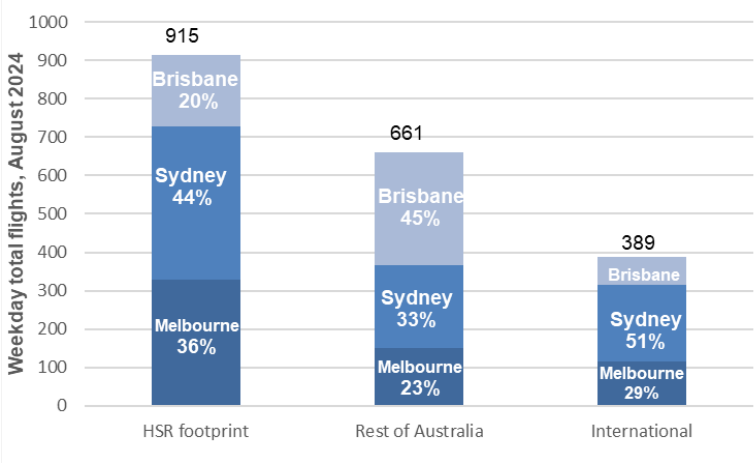
Figure 3: Median route travel times*, incl. future Western Sydney International Airport, 4 RGs



*Air travel times are estimated with a 120 minute air-rail 'excess' added to service times (Section 3). The future WSIA time includes a further 40 minutes to allow for longer travel to and from central Sydney compared to Sydney Airport.

Key: Major capital to: adjoining major capital **RG1** frequent train service end point (80-190km) **RG2** 80-190 km to 350 km range, most without air **RG3** 350 to 450 km range, with air **RG4**

Figure 4: Flights at Brisbane, Sydney, Melbourne airports, HSR footprint, other Aust., internat.



Source: Airport arrival and departure schedules, Monday 26 August 2024 and author analysis

Will peak weekday travellers to and from central Sydney be willing to traverse the additional 46 kilometres (40 minutes by road) needed to travel via future Western Sydney International Airport, due to open in 2026? If not, costs will rise, as travel is either suppressed, or day trips are converted to longer trips. Beyond this, if and when rising air transport demand exceeds infrastructure capacity at Brisbane and Melbourne airports also, travel via peripherally sited airports in those cities would, in each case, add a further 30 to 40 minutes to intercapital trips. This would yield a more than five hour total trip time, well beyond feasible day return limits. Air travellers from outside the HSR footprint, particularly in locations close enough for day return

[6] In air terms, the HSR footprint comprises 25 routes: 24 'east coast' intercapital and regional routes between Brisbane and Melbourne, together with the Melbourne-Adelaide route (BITRE 2024). See also Table 9 below.
[7] Sydney Airport's parallel runway was completed in 1994.

travel, including Hobart and regional centres in all eastern states and South Australia, would be similarly affected.

6.2 Regional route geographies – variously slow, infrequent, costly

In RG2, close to major capitals, with frequent train service, train service times (median 130 minutes) are longer than self-drive (median 94 minutes). Just two SUAs, Ballarat and Gold Coast-Tweed Heads, have train service times faster than self-drive – in the Gold Coast-Tweed Heads case reflecting slow self-drive speeds (52 kph, compared to a median self-drive speed of 75 kph), on account of road congestion on approaches to Brisbane (Borg 2023). No regional SUA has a service time within a benchmark commuting limit of 60 minutes.

In RG3, between the furthest regional centre with frequent service (80-190 km) and 350 km, median train service time is four hours four minutes. Leaving aside Canberra-Queanbeyan, with air service, only Albury-Wodonga and Wangaratta have train or coach service times that match self-drive times. Moreover, at these distances, the self-drive option is not necessarily compatible with working week day return travel (Potterton 2022).

Figure 5: User cost of the highest frequency mode & self-drive, 4 route geographies, $/100 km

* Self-drive costs comprise fuel, servicing and tyre costs for a 2023 Toyota Camry Ascent 2.5 Hybrid CVT Sedan at 11,400 annual km travelled (ABS 2020, RACQ 2023 and author analysis).

Key: Major capital to: adjoining major capital **RG1** frequent train service end point (80-190km) **RG2** 80-190 km to 350 km range, most without air **RG3** 350 to 450 km range, with air **RG4**

In RG 4, at distances between 350 and 450 km from the nearest major capital, air service times around one hour and city centre to city centre times of three hours are – in contrast to RG3's service times – consistent with day return travel. However, with high ground-related costs per passenger km on comparatively short routes (Zhang et al 2018) and with small aircraft in use lacking opportunity for economies of traffic density, airfares at $78 per hundred km (Figure 5) are almost three times those of the second costliest mode, coach.

In addition, regional air services to Sydney (Port Macquarie and Wagga Wagga, in RG4) are protected by a Commonwealth-legislated 'ring fence' which reserves peak period takeoff and landing slots for regional airlines, regardless of any higher revenue that Sydney Airport might earn if the slots were available for allocation to larger aircraft. However, with capacity limits at site-constrained Sydney Airport, the number of reserved peak period slots remains at 2001 levels (DITRDC 2020), notwithstanding population growth since then at regional centres.

7 High speed and sub-high speed rail – addressing problems

To examine how high speed (300 to 350 kph) and sub-high speed (200 to 250 kph) services could address the transport problems (Table 6), indicative service times are estimated for the Sydney-Melbourne corridor, including for all intermediate regional SUAs.

Table 6: Transport problem summary, 4 route geographies

ROUTE GEOGRAPHY Major capital to:		PUBLIC TRANSPORT				SELF-DRIVE
		Frequency	Capacity	Speed	Affordability	
RG1	Adjoining major capital, with high frequency air		Potential future shortfall in conveniently located airport capacity could lengthen end to end journey times			
RG2	Frequent train service end point (80-190 km)			Train service times lengthy and slower than self-drive		Can be affected by road congestion
RG3	80-190 km and 350 km range, low frequency	Low train and coach frequency		Train and coach service times slower than self-drive		Inconvenient for business/working week travel
RG4	350 and 450 km range, low frequency, with air	Low train, coach and air frequency	Tight major capital airport capacity limits air frequency	Slow train and coach service times	Costly air fares on a distance basis	

Service times (Table 7) are based on the rail corridor distance of the 2013 AECOM et al study. At 824 km, this is 14 per cent shorter than the existing rail corridor (953 km). However, with more stations (ie at SUAs) and slightly slower average speeds than in that study, the service times shown are not necessarily consistent with station stops at all SUAs.

Table 7: Service times, 200-350 kph maximum speeds, Sydney to Melbourne, all RGs and SUAs

Route geography	City pair	Rail distance km (est.)[1]	INDICATIVE SERVICE TIMES (MINS)			
			SUB-HIGH SPEED		HIGH SPEED	
	Maximum speed kph		*200*	*250*	*300*	*350*
	RG2 average speed kph (0.6 av/max ratio)		*120*	*150*	*180*	*210*
	RG3-4 av. speed kph (0.7 av/max ratio)		*140*	*175*	*210*	*245*
RG1	SYDNEY – MELBOURNE	824	356	284	237	203
RG2	Bowral-Mittagong – Sydney	100	50	40	33	29
RG3	Goulburn – Sydney	179	84	67	56	48
RG3	Canberra-Queanbeyan – Sydney[2]	301	136	109	91	78
RG4	Wagga Wagga – Sydney	411	183	147	122	105
RG3	Albury-Wodonga – Melbourne	296	138	111	92	79
RG3	Wangaratta – Melbourne	235	112	90	75	64
RG2	Shepparton-Mooroopna – Melbourne	160	80	64	53	46
RG1	MELBOURNE – SYDNEY	824	356	284	237	203

1. The Sydney-Melbourne rail distance is sourced from AECOM et al 2013, with other distances interpolated as necessary. Note also that Goulburn and Wangaratta are additional to station locations in AECOM et al 2013.
2. This route includes an estimated 66 km Gunning-Canberra 'T-line' spur from the Sydney-Melbourne line.

Key: Up to 60 mins | 120 mins | 180 mins | 210 mins

Between Sydney and Melbourne (RG1), at a 350 kph top speed, the table shows a Sydney-Melbourne service time (3 hours 23 minutes) that, with centrally sited stations in both cities, would underpin a feasible end to end day return trip. Express service times, with limited stops, would be shorter. In these ways, HSR service would add to the fast, convenient intercapital public transport infrastructure capacity constrained by site limitations at Sydney Airport. Mode shift to HSR would also release Sydney Airport capacity for growth in flights to and from other parts of Australia.

In RG2, in contrast, at a top speed of 200 kph (average speed 120 kph), regional centres with stations within 100 km of a major capital would have service times of one hour or less, compatible with major capital commuting. For RG2 regional centres at distances of 150 to 200 km to become similarly commutable (Shepparton-Mooroopna in the table), a 250 kph top speed would be necessary. In addition, by limiting growth in road travel, services at this speed might defer, if not eliminate, a need to expand freeway capacity near major capitals.[8]

In RG3, with 200 kph top speeds, all regional centres could have service times to the nearest major capital within two and a half hours, offering relatively convenient day return travel.

[8] See AECOM et al 2011 (Appendix B) for estimates of road use that high speed rail could divert between Sydney and Newcastle.

In RG4, 250 kph trains could provide service times within two and a half hours, outperforming existing city to centre air transport times. Also in this route geography, given 'through' RG1 services, the high fare levels associated with small aircraft use should reduce, as travellers shift to rail, with its economies of scale in train operations (Amos and Bullock 2007).

Similar high speed rail and sub-high speed rail 'solutions' would apply in the two other major capital to major capital corridors. At a Brisbane-Sydney rail distance of 797 km (AECOM et al 2013), service times in all four route geographies could be similar to those indicated for the Sydney-Melbourne corridor. Between Melbourne and Adelaide, Melbourne Airport should have sufficient capacity to absorb growth in flights between the two cities for some decades to come, assuming a third runway receives government approval and is constructed. If and when required, a Melbourne-Adelaide high speed rail alignment might deliver a service time within three hours at a 350 kph top speed, due to the corridor's shorter distance (Table 3).

8 From transport problems to non-transport opportunities

Opportunities that arise from addressing transport problems with high speed and sub-high speed rail are in four main areas. These are contributing to: population growth shift away from major capitals; improved business productivity in both major capitals and regional centres; better in-region accessibility to specialist health services; and net zero emission transport. As do transport problems, opportunities differ by route geography (Table 8).

Table 8: Opportunities of high speed rail, 4 route geographies

Opportunity	MAJOR CAPITAL TO							
	Adjoining major capital **RG1**		End point of frequent train service (80-190 km) **RG2**		80-190 km to 350 range, most without air **RG3**		350 to 450 km range, with air **RG4**	
kph	*200-250*	*300-350*	*200-250*	*300-350*	*200-250*	*300-350*	*200-250*	*300-350*
CONTRIBUTE TO:								
1. Population growth shift			✓	✓		✓		
2. Better business productivity			✓	✓	✓	✓		✓
3. Better in-region specialist health service access					✓	✓		
3. Net zero emission transport	✓	✓			✓	✓	✓	✓

8.1 Population growth shift

Both high speed and sub-high speed rail provide opportunities to underpin population growth shift away from the major capitals towards regional centres. With facilitative planning, individuals and households could opt to access a lower cost of housing, while continuing to work in the capital city (Kohler 2023), or to pursue new regional employment opportunities that result from the improved connectivity for businesses. As noted in Section 7, for 200 kph trains, regional centres within 100 km could access one hour service times. For 350 kph trains, the relevant distance could reach beyond 200 km. In either case, integrating the new network with the existing one, as with the United Kingdom's HS1 (Section 3), would increase the number of regional centres receiving reduced train service times and accordingly expanded housing development opportunities.[9]

The high cost of land in major cities that limits housing affordability can be viewed as one of the 'diseconomies of agglomeration' (Preston 2013). Population concentration in cities is a source of both the economies of agglomeration – ie those generated by close proximity between firms and people – and of the diseconomies. Other diseconomies that high speed rail and sub-high speed rail may help alleviate include: transport congestion (Economic Connections 2019); low income suburbs poorly connected to major capital employment zones

[9] See Glazebrook (2024) for a proposed approach to integrating a new Sydney-Newcastle line with existing rail lines and stations.

(NIEIR 2020): and urban development of areas within and near major capitals, where flooding risk is being heightened by climate change (NSW Independent Flood Inquiry 2022).

8.2 Better business productivity

High speed rail can also, it is contended, extend the agglomeration economies found in the larger cities to other centres, building productivity in both. Whereas earlier thinking was that a larger 'core' centre would out-compete a smaller 'peripheral' one through the workings of imperfect competition and increasing returns to scale, adding to regional inequality, more recent research supports the notion of a convergence in economic outcomes for newly better connected cities or regions (Chen and Hall 2011, Cheng et al 2013, Vickerman et al 2015, Venables 2017). A central idea is that opportunities arise for business reorganisation and specialisation, as the time costs of transport fall to very low levels. In these circumstances, business locational decisions can be made according to wherever land and labour is cheapest, rather than being unduly influenced by moderate or high transport costs (Venables et al 2014).

How far could these opportunities reach? Chen and Hall, researching the impact on Britain's economic geography of 200 kph trains, introduced from the 1980s onwards, find evidence that, within a one hour service time radius around London, business growth in regional centres was incentivised, as also was population growth, the latter underpinned by commuting-range satellite housing development. A two hour radius was conducive for business growth impacts, which occurred along with unconfirmed and unquantified population growth in surrounding areas. Applying this finding, business growth impacts could be experienced in all three regional route geographies with high speed rail, while consequential population growth effects are less clear. Sub-high speed rail business growth could exclude RG4 regional centres.

In addition, economic growth in the 2010s in Sydney (2.7 per cent per year) and Melbourne (2.9 per cent) exceeded the national rate, at 2.5 per cent, while air passenger growth between the cities (3.0 per cent annually) was also higher than in Australia as a whole (2.0 per cent).[10] These statistics point to a continuing close relationship between business growth and fast, convenient connectivity between major capitals.

8.3 Better in-region specialist health service access

Beyond the end point of frequent public transport services at 80 to 190 km from a major capital and within 350 km (RG2) – a distance range too close to major capitals for viable air service, but often too far for convenient self-drive – high speed or sub-high speed rail could bring with it a social opportunity to improve access to services. In particular, for smaller regional centres, it could help improve availability at hospitals of visiting health service specialists who are based in capital cities (AECOM et al 2013, Potterton 2022). Excluding Goulburn, 90 km and an hour by road from the federal capital of Canberra, these SUAs are: Ballina, Lismore, Grafton, Taree, Wangaratta and, in the Melbourne-Adelaide corridor, Horsham.

8.4 Net zero opportunity of high speed rail

With future zero emission electricity generation, electrified high speed rail, offering three to four hour service times, could provide a decarbonised transport alternative for the one third of domestic air passenger kilometres in a Brisbane-Sydney-Melbourne-Adelaide air route footprint (Table 9).[11] Today both the pathway and the timing for decarbonisation of large passenger jet aircraft are uncertain.[12]

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[10] See SGS Economics and Planning 2019 for GDP by major capital city from 2008-09 to 2018-19. Air passenger growth statistical analysis is based on BITRE 2023 and 2024 (earlier years).

[11] For indicative estimates of a high speed rail network's potential contribution to net zero emission transport, excluding net 'upstream' construction and manufacturing impacts, see Potterton (2023).

[12] Eliminating emissions on long-haul flights may require complete aircraft redesign to accommodate temperature-cooled liquid hydrogen storage tanks in the fuselage rather than in the wings, with an introduction timing of 2050 or later. For the present, crop-based sustainable aviation fuel can reduce emissions (Prisco 2023).

Table 9: Air transport flights, passengers, revenue passenger km, HSR corridors 2022-23

AIR ROUTE FOOTPRINT	FLIGHTS		PASSENGERS		REVENUE PASSENGER KM	
	No	%	No	%	No m	%
Brisbane-Sydney-Melbourne-Adelaide (25 routes*)	226,446	38.0%	26.2	47.5%	21,513	32.5%
Rest of Australia	368,833	62.0%	29.1	52.5%	44,716	67.5%
TOTAL	595,279	100.0%	55.3	100.0%	66,228	100.0%

* 24 intercapital and regional routes between Brisbane and Melbourne, plus the Melbourne-Adelaide route.

Source: BITRE 2024 and author analysis

Alternatively, 200 or 250 kph links between adjoining major capitals would indicate six hour and five hour times respectively between Sydney and Melbourne (Table 7). While time-sensitive travellers would remain with air transport, some price-sensitive ones could shift to rail, given general customer preference considerations for rail over air (Nash 2017) and provided that fares matched those available on low cost airlines. This suggests sub-high speed rail over longer distances might also contribute to the decarbonisation task, albeit by less.

9 Business case formulation – what implications?

The route geography approach set out in this paper has three principal implications for business case development, in addition to early stage detailing of problems and opportunities.

The first, also a threshold matter, involves acknowledging the contrasting service requirements of different route geographies, particularly those involving the longest and shortest distances and the importance of accommodating both sets. On the one hand, the transport problem/opportunity mix of RG1, between major capitals, calls for air-competitive service times of three to four hours, achievable through limited stops and, desirably, 350 kph maximum operating speeds. On the other, the transport problem/opportunity mix of RG2, over distances of 80 to 190 km from major capitals, calls for facilitating residents' access to the new railway. This, in turn, would require either more closely spaced stations than necessary for RG1 services and/or the capability for trains on the new line to also operate on existing lines, so reaching more stations and more residential areas. Trains operating at 200 to 250 kph on the new line would fit these services.

Secondly, the route geography approach can help ensure that all aspects of the strategic case for a new network are identified. Table 10 includes seven strategic policy objectives that high speed and sub-high speed rail can contribute to, both within and outside the transport sector.

Table 10: Transport problems, opportunities and strategic alignment, HSR and sub-HSR

Route geography	TRANSPORT PROBLEM	OPPORTUNITY	STRATEGIC POLICY OBJECTIVE
RG1	Shortfall in conveniently sited major capital airport capacity, placing day return travel at risk	Net zero emission transport contribution	Efficient air transport (by releasing scarce airport capacity for use by air services beyond the HSR footprint, where no HSR option applies)*; net zero economy
RG2	Long commuting times, peri-urban road congestion	Avoided new road construction; increased commutable housing supply; business growth	Efficient road system; housing supply and affordability; economic growth
RG3	Long day return times, low train and coach frequency	Improved in-region access to specialist capital city based health services; business growth; net zero emission transport contribution	Regional health workforce challenge; economic growth; net zero economy
RG4	Costly air service, low all-mode frequency	Business growth*; net zero emission transport contribution	Efficient regional air transport; economic growth; net zero economy

* High speed (300-350 kph) services only and excluding sub-high speed (200-250 kph) services.

Thirdly, the route geography approach similarly allows business case travel demand analysis and the resulting economic analysis, which includes investigation of wider economic benefits (ie additional production, labour and housing market impacts), to take account of the

differences that apply at different distance ranges in: existing travel barriers; the service times that high speed and/or sub-high speed rail could offer; and 'off network' opportunities.

10 Conclusion

This paper has identified four distinct 'route geographies', differing by public transport modes in use, service frequency and/or fare levels, that characterise three transport corridors between southeastern major capitals and including Adelaide. These corridors are referenced for high speed and sub-high speed rail services, drawing on international experience applied to Australia's economic geography. The transport problems of the route geographies take account of commuting (one hour) and day return (up to three to four hour) service time benchmarks and, particularly nearer major capitals, self-drive times. Opportunities that arise from addressing transport problems with high speed and sub-high speed services also take account of benchmark service times. The paper, finally, considers implications of the route geography framework for business case development.

Both service planning and business cases could benefit from improved knowledge of day return and short trip travel behaviour. Research into the potential scope for business relocation, reorganisation, specialisation and productivity at all distances on an Australian high speed rail network would also be helpful.

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