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The Suburban Rail Loop Megaproject:

An Independent Review of Business Case Strength and Associated Risk

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EXECUTIVE SUMMARY

The Suburban Rail Loop (SRL) project is economically unsound. It overcapitalizes on its design objectives by at least $20 billion. As such, it has the potential to become one of the biggest infrastructure boondoggles in modern peacetime world history. To become more economically sound, the project needs to be re-engineered with a cheaper mode/grade solution. The State of Victoria is exposed to the combined risks of a cost overrun, a benefits shortfall, a funding shortfall, the seriousness of which are exacerbated by the project's 'too big to fail' status. The nature and size of these risks make the project too risky for the State to proceed with in its current form. The time to address these issues is now – not in a few decades' time at a Royal Commission into why Victoria's economy went pear-shaped.

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V. Introduction

The purpose of this document to provide an independent review of the strength of the business case of the Suburban Rail Loop megaproject and associated risk.

This report is prepared by Pezala Consulting. Its author is Anders Axelson. The author wishes to thank those who have assisted in its production.

VI. Invitation to Provide Feedback

Readers are more than welcome to provide their feedback on this report by email to srlfeedback@pezala.com.

VII. About the Reviewer

Anders Axelson is a professional expert on risk, delay, cost and dispute resolution in the context of transportation and infrastructure projects. He holds degrees in engineering and law, from the Universities of Melbourne and London respectively. He has testified extensively before courts as an expert witness. Mr Axelson is both a practitioner and a scholar, and has contributed widely to relevant professional literature. In a career that has spanned five continents, he has advised clients on rail, light rail, monorail, tram and bus operations, railway development, rolling stock procurement programs, station construction, roadways, and other types of capital development initiatives. Relevantly for this report, Mr Axelson has extensive first-hand knowledge of the London Crossrail project, having co-authored a peer review on the business case of that megaproject which ultimately recommended to a standing committee of the UK Parliament that associated enabling legislation be given the green light. Mr Axelson was also a co-founder of the Society of Construction Law Australia.

VIII. Abbreviations

ABCR	absolute benefit-cost ratio
ABS	Australian Bureau of Statistics
AJM	Aurecon Jacobs Mott McDonald
ASC	alternative-specific constants
ATAP	Australian Transport Assessment and Planning (guidelines)
BCR	benefit-cost ratio
BRT	bus rapid transit
CBA	cost-benefit analysis
CBD	central business district
CEB	conventional economic benefit
DELWP	Department of Environment, Land, Water and Planning (Victoria)
DLR	Docklands Light Railway
DoT	Department of Transport (Victoria)
DTF	Department of Treasury and Finance (Victoria)
GDP	Gross domestic product
GSP	Gross state product
IA	Infrastructure Australia
IBCR	incremental benefit-cost ratio
KPI	key performance indicator
KPMG	Klynvend Peat Marwick Goerdeler
LUTI	Land use and transport interaction model
MABM	Melbourne Agent and Activity-Based Model
MAC	metropolitan activity centre
MARL	Melbourne Airport Rail Link

MCT	medium capacity transit
MRS	marginal rate of substitution
NEIC	National Education and Innovation centre
NPV	net present value
RFI	Rail Futures Institute
SALUP	Small Area Land Use Projections (Victorian Government land use forecasts) based on DELWP Projections 2018 (Unpublished)
SCGE	spatial computable general equilibrium (model)
SRL	Suburban Rail Loop
SRLA	Suburban Rail Loop Authority
TBM	tunnel boring machine
TOD	transit-oriented development
UCB	urban consolidation benefit
VCAT	Victorian Civil and Administrative Tribunal
VISTA	Victorian Integrated Survey of Travel and Activity
VITM	Victorian Interactive Transport Model
VKT	Vehicle kilometres travelled
VLUTI	Victorian Land Use and Transport Integrated (model)
VPA	Victorian Planning Authority
WEB	wider economic benefit
WFH	working from home

IX. Glossary

absolute benefit-cost ratio (ABCR)	The ratio of benefits to costs (= B/C).
activity and agent based model	A system for modelling transport demand across a city's transportation networks, that simulates individuals and the activities they perform across a day. It provides an alternative to the four-step model.
activity density	Job density plus residential density, conventionally expressed on a per hectare basis. This is the traditional metric for gauging the demand for public transport.
agglomeration	A clustering together, particularly for economic purposes.
alternative-specific constants (ASCs)	Constants that are incorporated within transport demand models so as to represent the relative attractiveness or unattractiveness of a particular mode of transport to the extent not explicable by other variables within the model, so as to bring the model in line with observed reality. For instance, when modelling the choices that residents of Broadmeadows need to make between public transport and private car transport, VITM currently adds the time value of 4.3 minutes as an alternative-specific constant to the time that the model predicts public transport journeys should take, so as to reflect the predilection that the residents of Broadmeadows have for automobiles over public transport.
AM Peak	The two-hour period from 7:00am to 9:00am on a typical weekday.
base case	The scenario against which a modelled scenario is compared, equivalent to a model of the state of the universe as it would exist *but for* the presence of the thing that is being represented by the model.
benefit-cost ratio (BCR)	The ratio of benefits to costs, particularly as is used to assess the economic viability of a project or venture.
black swan	A risk event that is highly consequential but is not predictable by conventional means. The name alludes to sightings of black swans by Dutch explorers in Western Australia in the seventeenth century, which disproved a widely held European assumption that swans could only be white.
broad gauge	The traditional rail gauge used in Victoria: 5 feet, 3 inches. Not to be confused with standard gauge.

Brownian motion	The random fluctuations that gas or liquid particles make in a fluid. This is often used as an analogy for other things that fluctuate randomly, such as commodity prices.
bus rapid transit (BRT)	A bus system that is relatively fast because it has relatively few stops and/or dedicated way.
chaos theory	A branch of science dedicated to the study of chaotic systems.
CityPlan	The Victorian Government's current model for simulating future changes in land use and associated effects such as property prices.
cost benefit analysis (CBA)	A traditional method for assessing the feasibility of a project by deriving monetary values for (welfare) benefits and costs, and comparing the two.
crush load	The number of passengers that a train set can accommodate when passengers are crammed together in the aisles, as occurs at peak times.
cut-and-cover	A tunnelling method that entails excavating a trench close to the surface and then covering it. It is cheaper than boring.
decision threshold	The value of a decision variable that forms the boundary between the two outcomes of a binary decision-making process. For instance, if no margin of safety is used, the conventional decision threshold for a one-shot cost-benefit analysis is 1.0, where the decision variable is the benefit-cost ratio.
decision variable	A parameter that determines whether or not a decision is made. For instance, the benefit-cost ratio is often the decision variable in respect of a decision of whether or not to proceed with a project.
dedicated way	A corridor of land reserved exclusively for a particular transport mode.
diminishing marginal productivity of capital	The economic principle that the 'bang' for each buck diminishes with each extra buck.
discount rate	The annualised percentage by which the value of a future cost or benefit is reduced so as to represent its value in the present.
East-West Link	A cancelled two-stage tunnelled tollway road project linking the western suburbs of Melbourne with central Melbourne. Its western stage was superseded by the Westgate Tunnel project and its eastern section was aborted.

endogenous variable	A variable whose value is assigned internally within a mathematical model.
engineering options appraisal	A quantification of the advantages and disadvantages of project alternatives with different conceptual designs.
ensemble	In statistics and probability theory, the collection of possible future scenarios associated with a system that is modelled probabilistically.
ensemble dimension	The ensemble for a given timepoint, also known as 'probability space'.
epistemic uncertainty	The risk that a model or inputs used in a calculation may be unrepresentative of reality. Simulations of gaming processes such as a coin toss, a dice or the spin of a roulette wheel do not have epistemic uncertainty, but simulations of the real world do. Also known as 'Knightian uncertainty' or simply 'uncertainty'.
ergodicity	A property of a time dynamical system whereby the behaviours or properties of things across the temporal dimension of the system resembles the behaviours or properties of things across either spatial dimensions or the ensemble dimension. Ergodicity has a profound effect on the appropriateness of different strategies for risk management.
ergodicity economics	A sub-branch of economics that concerns itself with the relative economic effects of ergodic and non-ergodic systems.
exogenous variable	A variable that is entered as an input into a mathematical model.
expectation value	A measure of value across the ensemble dimension, it is the sum of the value of each element of the ensemble multiplied by its probability.
fat tail	A phenomenon whereby a statistical distribution exhibits a dramatically high skewness and kurtosis in a manner that defies explanation by traditional statistical models. The probability distribution of time and cost overruns on projects, for instance, may be said to display 'fat tails'.
fat-tailed distribution	A distribution that contains at least one fat tail, most commonly on the high or right-hand side of the distribution.

four-step transport network model	A widely used system for modelling transport demand across a city's transport networks that entails four looped steps: (1) trip generation; (2) trip distribution; (3) modal split; (4) trip assignment.
fractal	A mathematical object that arises in chaos theory and exhibits properties such as surface roughness, self-similarity and scalability. It resembles natural phenomena as trees, cities and coastlines.
fractional Kelly	A conservative implementation of the Kelly Criterion that entails reducing bet or investment size suggested by the formula so as to provide a margin of safety.
Gaussian distribution	A standard probability distribution that falls into a symmetrical bell-curve shape.
gold-plating	Overcapitalizing, or spending an economically unjustifiable amount money on solving an engineering solution.
grade	Vertical elevation relative to a horizontal plane.
Grand Paris Express	An extensive underground suburban circular metro line under construction that will form the sixteenth line of the Paris Metro. It is probably the train line in the world that most closely resembles the SRL.
gauge	The distance between the two rails on a railway.
half-Kelly	A conservative implementation of the Kelly Criterion that entails halving the bet or investment size suggested by the raw formula so as to provide a margin of safety and hedge against epistemic uncertainty.
hedonic multiplier	A quantification of the proportion by which a real estate value improves as a result of a qualitative improvement.
heterogeneity, unobserved	Variations across a statistical distribution that are not explicable by modelled variables.
heteroskedasticity	The extent to which the local variance of a range changes across a domain.
hybrid bill	A type of legislative bill used by the UK Parliament to initiate major infrastructure projects: a hybrid between a public bill and a private bill.
incremental benefit-cost ratio (IBCR)	The ratio of the change in benefits to the change in costs (= $\Delta B / \Delta C$) where the change is relative to the next cheapest alternative under consideration.

Inland Rail	A major national rail project currently under development that entails extending and upgrading a long-distance freight line between Melbourne and Brisbane via Dubbo.
inter-peak	The period from 9:00 am – 3:00 pm on a typical weekday.
Kaldor-Hicks efficient	A state of affairs where there are no ultimate losers. This arises on projects because stakeholders who are made *prima facie* worse off by the project can be compensated so that they are not ultimately worse off.
Kelly criterion	An investment, gambling and risk management strategy designed to maximise the long-term rate of capital growth in a strongly non-ergodic environment.
kinematic envelope	The integrated envelope of space that a transport vehicle passes through on its journey
kurtosis	A mathematical property of a statistical distribution (the third moment) that represents the extent to which matter is concentrated in the shoulders rather than the tail of the distribution.
law of large numbers	The principle that after a sufficiently large number of trials of a random process, the distribution of actual results will converge on their theoretical probabilities. For instance, after four tosses of a coin, the results will not necessarily match the theoretical probabilities of 50% tails and 50% heads, but after four million coin tosses, they will.
Level Crossing Removals Program	A long-term program by the Victorian government to replace successive level crossings on Melbourne's suburban rail network with grade-separated intersections.
light metro	An urban rail system with the characteristics of a metro system but whose train sets have fewer than six cars.
light-rail	A tram system with dedicated way.
Likert scale	A five-point scale used to convert questionnaire responses into a numerical variable.
Lindy effect	The rule of thumb used by futurists that the best guess for how much longer a technology will last before extinction or obsolescence is the same as the amount of time that it has already been in existence. Named after the venerable 'Lindy's' restaurant in New York City.

logit	A logistic unit function. This is a type of mathematical function whose abscissae (or y-values) range between 0 and 1 but whose ordinates (or x-values) are unbounded. It is used to model probabilities associated with binary variables such as yes/no or true/false.
London Crossrail	An underground rail megaproject in London, recently opened and formally renamed the 'Elizabeth Line'. It is designed to relieve congestion on the London Underground network across an east-west axis.
loop	In railway engineering terminology, a type of rail line that reverses the direction of travel without reversing the direction of locomotion.
margin of safety	A quantity that is added to a decision-making threshold to reduce the risk of failure and to account for epistemic uncertainty.
marginal rate of substitution	The rate at which a consumer is willing to give up one good or service in exchange for another, for instance, exchange a bus trip for a train trip.
medium capacity transit	Articulated light rail or light metro: a rail system that contains sets with more than one but fewer than six cars.
Melbourne Activity and Agent Based Model (MABM)	An activity and agent based model for modelling Melbourne's transport demand; (used to complement or supplement VLUTI).
Melbourne City Loop	The double-decker four-line underground rail tunnel that loops around the Melbourne CBD.
Melbourne CityLink	The portion of Melbourne's tolled motorway network that runs between the Tullamarine Freeway, Monash Freeway, and Westgate Freeway, and includes the Bolte Bridge, Burnley Tunnel and Domain Tunnels. It was constructed around the turn of the millennium.
Melbourne Metro Rail (MMR)	A underground (not quite metro) heavy rail line under construction in central Melbourne between North Melbourne and Caulfield, mainly in a north-south orientation.
Melbourne Metro Rail 2 (MMR2)	A proposed underground (not quite metro) heavy rail line for central Melbourne between Newport and Clifton Hill in a mainly east-west orientation.
metro	A designation for a particular type of high-quality urban rail network that includes exclusive dedicated way, train sets of at least six cars and regular running times.

ministerial call-in powers	The overriding power that the Victorian planning minister has to overturn development approval decisions, normally taken at the local council level, as is prescribed by legislation.
mode	In the context of transport engineering, the type of transport vehicle associated with a network such as car, suburban passenger train, metro train, light metro train, light-rail tram, street-running tram, monorail, bus or bicycle.
moment (of area)	A mathematical measure of the amount of 'oomph' that a mass or probability distribution exerts about an axis, or a mathematical derivative thereof. For instance, in the context of probability distributions, the mean, variance, skewness and kurtosis are the first, second, third and fourth moments (of area) respectively.
monocentric	Having a single centre.
Monte Carlo analysis	A probabilistic modelling technique that entails inputting parameters into a computer simulation whose values are randomised over a given range of probabilities and making observations from the resultant ensemble of outputs.
net benefits	Benefits less costs.
net present value (NPV)	The standard measure of the value of a project. This is the aggregated sum of net benefits for every present or future year, discounted in line with a discount rate.
non-ergodicity	A property of a dynamic system that exhibits characteristics such as path dependence, multiplicative dynamics, power laws or covariance across its time dimension so as to make the time dimension dissimilar to the spatial or ensemble dimensions. Non-ergodicity subdivides into strong and weak non-ergodicity.
off-peak	The period from 6:00 pm – 7:00am on a typical weekday
one-shot	A simple type of cost-benefit analysis where only one project alternative is considered.
Option A	Timing for delivery of SRL – Cheltenham to Airport to be completed in 2053
Option B	Timing for delivery for SRL – Cheltenham to Airport to be completed in 2043
opportunity cost	When money is committed, the cost of not being able to put it to alternative use.

optimism bias	A psychological phenomenon whereby a wishful planned scenario not too far from a best case scenario is adopted in place of a more realistic estimate.
optionality	The economic benefit arising from maintaining a choice between courses of action.
orbital rail line	A rail line that arcs or circles about a central area.
order of magnitude	A factor of *n*, where *n* is the base of the numbering system used for measurement (usually $n = 10$). For instance, 20 is an order of magnitude greater than 2.
P-value	A value within a probability distribution in the form P*n* where *n* is the probability of the value not being exceeded by a random data point expressed as a percentage. For instance, the P50 value of a distribution is its median, while P75 represents the lower boundary of its upper quartile.
path dependency	Dependency on a previous state of affairs. A coin toss, for instance, is not path dependent.
patronage	The number of passengers on a transport service, usually cited either annually or for a typical working day.
planning fallacy	Optimism bias when applied to planning timescales.
PM peak	The three-hour PM peak period (3:00 – 6:00 pm) on a typical weekday
polycentric	Having many centres.
power law	A mathematical function that governs a statistical distribution whose values spread out in an exponential fashion and resemble a straight-line when plotted on a log-log chart. City and town populations in virtually every country, for instance, are distributed according to power laws.
precautionary principle	A guiding principle for risk management in strongly non-ergodic systems encapsulated by the maxim *primum non nocere* or 'first, do no harm'.
program case	The representation of a project so as to compare against the base case scenario.
Rail Futures Institute	An independent Melbourne-based rail engineering think-tank, responsible for the *Melbourne Rail Plan 2020-2050*.
real options analysis	An assessment of different options for expenditure and investment in a project (or otherwise) so that a business case is assessed relative to actual alternatives rather than a generic rate of capital growth.

reference case	A representation of the real world from which the program case and base case are derived.
reference class forecasting	Forecasting that is objectively grounded and based on observations from the past, rather than optimism and wishful thinking.
regression coefficient	A mathematical variable designed to model how closely associated two variables are.
ring metro	A metro system designed in a circular configuration.
risk of ruin	The risk that an unrecoverable major loss will occur (such as a gambler losing all of his or her bankroll, a batsman in cricket losing his or her wicket or, more relevantly, an uneconomic project causing serious irreversible damage to economy of the jurisdiction that has to pay for it).
satellites	In the context of urban planning, an urban centre that has a subordinate relationship to a central business district.
scalability	A property that applies or holds true at different scales or orders of magnitudes; for instance, the critical path method of scheduling is scalable because it may be used to plan a $100,000 home renovation as well as a $1 billion project.
self-similarity	The phenomenon of taking a similar geometric form at different levels of magnification, such as, for instance, the way that the configuration of twigs around a tree branch resembles the configuration of branches around a tree trunk. Also known as self-affinity.
sensitivity	In the context of mathematical modelling, how sensitive a model is to changes in a particular variable.
sigmoid	A mathematical function that when plotted forms an 'S-curve', as with a project whose cumulative progress that starts and finishes at a relatively slow rate but picks up the rate of production between those two endpoints.
skewness	A mathematical property of a probability distribution (the second moment) that represents the extent to which the distribution is skewed to the right.
Small Areas Land Use Projection (SALUP)	The Victorian Government's official forecasts for how many people will inhabit each (small) region in future years.

spatial computable general equilibrium model (SCGE)	An economic model for determining macroeconomic impacts, or impacts on the broader economy, on a region by region basis.
SRL East	Section of the Suburban Rail Loop between Cheltenham and Box Hill.
SRL North	Section of the Suburban Rail Loop between Box Hill and Melbourne Airport.
SRL precinct	An area which is a 1600m radius around an SRL station. The SRL East precincts are: Cheltenham, Clayton, Monash, Glen Waverley, Burwood, Box Hill. The SRL North precincts are: Doncaster, Heidelberg, Bundoora, Reservoir, Fawkner, Broadmeadows, Melbourne Airport.
standard gauge	The traditional rail gauge used in England, New South Wales and on interstate rail lines: 4 feet, 8.5 inches.
standard load	The number of passengers that a train set can accommodate under normal circumstances. To be distinguished from 'crush load'.
strong non-ergodicity	A property of a non-ergodic time dynamical system whose optimization is affected by the risk of ruin.
Suburban Rail Loop Authority	The state government agency responsible for delivering the Suburban Rail Loop and associated precinct developments.
sunk cost fallacy	The irrational tendency that people have to follow through on a project that they have already invested in, even if benefits do not exceed outstanding costs.
Sydney Metro	A three-stage scheme to provide Sydney with an underground metro rail network that extends from the northern suburbs, across the harbour, into central Sydney and then westwards.
thin-tailed distribution	A probability distribution that has a bell-curve shape that is the same as or similar to a Gaussian distribution.
time dynamical system	A system with a time dimension, or where changes across time are modelled.
(train)set	The set of 'cars' that are coupled together to form a train.
tram, driverless	An emerging technology whereby a tram's kinematic passage is guided by computer rather than rails.

transit-oriented development	A high-density residential or commercial development in close proximity to a railway station or other major node on a transport network.
tunnel boring machine	A large self-propelling automated machine for boring tunnels and performing auxiliary work tasks including conveying spoil to the surface, neutralizing earth or groundwater pressure and placing a structural lining around tunnel walls.
unity	one (1).
value capture	A scheme for taxing the economic beneficiaries of a project in order to help pay for the project.
VFL Park	A stadium purpose-built for Australian rules football in the Waverley/Mulgrave area (near planned SRL precincts) that existed between the 1970s and 1990s.
Victorian Integrated Transport Model (VITM)	The Victorian Government's model for simulating likely future changes in transport patronage for a given infrastructure configuration, population distribution and various other parameters.
Victorian Land Use and Transport Integrated (Model) (VLUTI)	The Victorian Government's model for simulating future changes in transport patronage and land use; it integrates together the Victorian Integrated Transport Model (VITM) and CityPlan.
weak non-ergodicity	A non-ergodic dynamical system but whose optimization and risk management strategies do not need to take into account the risk of ruin.

1. Factual Background

1.1 Recognition of Demand for Better Public Transport Connectivity Between Melbourne's Middle Suburbs Generally

THE rationale for the SRL may be understood from two documents. The first is an article entitled 'Proposal: Melbourne Ring Metro'. It was written by Sydney-based transport expert Dr Garry Glazebrook and appeared within the blog *The Urbanist*, a section of the current affairs website *Crikey*, in March 2017. Dr Glazebrook opined as follows:[1]

> '[M]elbourne has well-developed radial rail and tram networks focusing on its CBD, a legacy of rapid growth after the Gold Rush when rail technology was the dominant form of urban transport in cities. The CBD is also relatively centrally located within the metropolitan region, with new development spreading north and west to balance the East and South-Eastern suburbs. It's also relatively unconstrained compared to cities such as Sydney and Brisbane, and the addition of Melbourne Docklands and Southbank in recent decades has provided ample space for residential as well as commercial development. However Melbourne's rapid growth is generating major congestion on both road and rail networks. The heavy rail network is close to capacity, while the tram network suffers from partly sharing road-space with traffic. There is a growing gap between opportunities available to people living in the inner city suburbs and the those in the outer suburbs, who are facing increasing commute times to reach the job-rich inner suburbs.
>
> London has long had its "Circle Line", which is a form of inner ring; a few cities, such as Berlin, Tokyo and Moscow, have had ring metros some distance out from the city centre for many years. Others such as Shanghai and Paris have recently built or are building such circumferential systems – in the case of Paris, two rings, using both metros and light rail. However for such a strategy to be effective, such a "ring metro" needs to have certain characteristics. It needs to operate at high frequencies throughout the day – typically headways of 3-4 minutes – since many people using it will be transferring from the radial network. It needs to have well-integrated interchanges with the

[1] Garry Glazebrook (2017) 'Proposal: Melbourne Ring Metro', *Crikey/The Urbanist* (blog). <https://blogs.crikey.com.au/theurbanist/2017/03/13/proposal-melbourne-ring-metro/>; empahsis added.

radial train and tram networks, as well as with major bus routes. It needs to operate in its own right of way and be grade separated fromroads and existing public transport systems so as not to cause delays to its own patrons or to the rest of the transport system. It needs to have reasonable capacity (e.g. 3,000 – 10,000 passengers per direction per hour in peaks) to accommodate current travel patterns and potential growth, especially as the sub-centres themselves grow in importance. *It needs to be relatively low cost to build* and operate, and to be capable of staged construction.

In terms of potential rights of way, several possibilities exist: alongside or in the median strip of existing circumferential freeways. Underground (probably in cut-and cover tunnels), especially as they approach the key centres. Above ground where the environmental impacts are acceptable and the corridor space is available.

Taking these factors into consideration suggests the ideal system would be some form of automated light metro rather than the traditional train or tram systems used in Melbourne. It is likely that the vehicles used in such a system will need to be relatively small in length and cross section, able to climb significant gradients and negotiate tight curves, and operate automatically on short headways (down to 2 minutes). Examples of such systems overseas include the VAL system developed in France and used in a number of countries: SkyTrain in Vancouver; and the Docklands light railway (DLR) in London. There over 50 cities world wide with "light metro" systems, some of which would have the desired characteristics. In Vancouver the Skytrain system operates underground in the city centre like a traditional metro, but is largely elevated elsewhere, with stations integrated into high-density activity centres.

In London the DLR was able to utilize some existing underground and above ground rights of way near the Central Business District, but again was largely built on new above ground structures through the Docklands area, where it was also integrated into major new development. In the case of Melbourne, the existing ring freeway system offers some potential for minimizing the impacts of any new ring metro. However unlike freeways, which ideally skirt major centres, the ring metro must penetrate to the heart of such centres and interchange with existing stations if it is to be useful. Thus some underground sections and stations will be required. One of the advantages of a light metro with automated trains is that a network can be built up over time, providing high frequency services across a variety of routes, minimizing interchange times. This is how both the Skytrain system in Vancouver and the DLR system in London have developed. The cost of any "Ring Metro" for Melbourne will depend on its extent and on the technology used. Light Metros typically have lower axle

> loads, shorter trains and stations, and driverless trains, which make them significantly less expensive per kilometre than conventional rail like Melbourne's new 9 km Metro tunnel or the new Sydney metro – the latter is costing approximately $200 m – $300 m per kilometre, and is mostly underground. Assuming a mix in the order of 50% surface in freeway reserves, 25% in other surface or above ground locations, and 25% underground, a typical average cost of $150 million per kilometer suggests a likely capital cost of the order of *$10 billion for a 66 km ring light metro* for Melbourne. Such a system could connect centres such as Frankstown [sic], Dandenong, Monash, Box Hill, Latrobe [sic], Epping, Broadmeadows, Melbourne Airport and Sunshine. In this context, the lower operating costs and relatively high speeds (compared with street-running light rail) of an automated light metro should mean that farebox revenue should be capable of covering 100% of operating costs, with the potential to fund a component of the capital costs. In addition, application of land value capture mechanisms at key centres on the route would provide further opportunities for recovering part of the capital costs. Subject to more detailed assessment, it is assumed that the project could return 50% of the capital costs.
>
> [A]s noted, construction of any "ring metro" would need to be staged. It is suggested that the first stage could include a number of the key centres identified earlier, as well as Melbourne Airport. In addition to interchanges with radial rail and tram routes which cross the ring route, additional park and ride stations could be built on the ring metro for people accessing the system by car or bus. This could allow many people to access Melbourne airport without adding to road congestion on Tullamarine Freeway. Assuming typical spacing between stations on the ring metro of 1 – 1.2 km the system would be able to average 40 kph or more, making it much faster than Melbourne's trams and competitive with car-based travel for many circumferential trips.In addition to integrating the ring metro with other transport modes, the opportunity to add medium density housing along the ring metro route, as well as higher density nodes at key centres, should also be taken. Close integration with land use is a key to the success of any public transport system achieving its potential to transform the urban fabric of the city and to maximize the urban accessibility benefits public transport can provide.'

Glazebrook's vision for a rail line with dedicated way may be described as 'mixed grade driverless light metro'. A not dissimilar concept was endorsed for this part of suburban Melbourne by the independent rail engineering think-tank the Rail Futures Institute (RFI) in a document entitled *Melbourne Rail Plan 2020-2050*, which was pub-

lished in 2019. The Rail Futures Institute proposed a flexible system which they termed 'medium capacity transit' (MCT):[2]

> 'MCT infrastructure will be on the surface, elevated or underground, as determined by individual route conditions. MCT technologies are rapidly evolving, ranging from conventional light rail using upgraded trams, light metro railways to high capacity guided buses with electric and hybrid traction systems. In Melbourne [under RFI's plan], MCT will use one or more of these systems. It will fully complement other modes to form one network with interchanges making it convenient to transfer between modes.'

Primarily because of the high cost of tunnels, the institute recommended that tunnelled designs for such networks be avoided except where required as a matter of engineering necessity:[3]

> 'MCT routes are ideally installed in freeway or wide boulevard medians but can also use elevated structures in suitable thoroughfares. Many potential MCT corridors in inner and middle suburbs of Melbourne *can utilise wide arterial road easements and boulevards*, a legacy of previous generations of sensible road planning. Where this is not practicable, new infrastructure on high patronage corridors may need to be built to provide completely segregated [rights of way] for increased capacity and speeds, including on *elevated structures or lowered [rights of way]* in cut and cover trenches. Tunnelling may be unavoidable in high value areas that are fully developed and where retrofitting a new corridor into the existing built environment is not feasible.'

1.2 Recognition of Demand for Better Public Transport Connectivity in the Monash/Clayton Area in Particular

Also in March 2017, the Victorian Planning Authority (VPA) released its vision for the future of the Monash/Clayton area (known in the document as the 'Monash Cluster'). The VPA highlighted the large numbers of jobs in the area, the area's future growth potential, and argued that there was a strong case for improving transport connectivity in the precinct. It stated:[4]

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[2] Rail Futures Institute (2020) The *Melbourne Rail Plan 2020-2050*, <www.rfi.org.au> , p. 41.

[3] Rail Futures Institute, *op. cit.*, p. 45. Emphasis added.

[4] Victorian Planning Authority (2017) Monash National Employment and Innovation Cluster Draft Framework Plan. Emphasis added.

> 'The Monash Cluster is located 20km south-east of central Melbourne and is a significant contributor to the national economy. It supports approximately *75,000 jobs* across a diverse range of industries and contributes over $9.4 billion to the Victorian economy each year. It is anticipated that employment numbers within the Monash Cluster *have the potential to double* over the next 35 years.
>
> With the *highest concentration of jobs* outside the Melbourne Central Business District, nationally significant facilities, important institutions and a skilled local workforce, the Monash Cluster has all the ingredients for a successful modern business destination. …
>
> The business and worker amenity is at *risk of decline* in some parts of the cluster. Consistent feedback on these issues have resulted in this framework plan seeking to raise the profile of the cluster, implement *public transport improvements*, promote *public realm enhancements* and establish *new business town centres* as destinations that are home to restaurants, cafes, hotels and retail supporting key employment areas. …
>
> Unifying the existing world class facilities and enhancing the image and identity of the Monash Cluster as a globally competitive destination for the brightest minds and greatest innovations will support the vision for more jobs closer to where people live. Strategic sites, activity centres and neighbourhoods close to railway stations provide focal areas for addressing future housing shortages.'

1.3 'Operation Halo'

According to an article that appeared in the *Sunday Age* in August 2021[5], the genesis of the SRL lay in a secret government initiative codenamed 'Operation Halo'. Under the leadership of the Premier, Hon. Daniel Andrews MP, the Victorian government sought to develop policies that it could take to the November 2018 election. According to media reports, Operation Halo was conducted from early 2017 until late August 2018, concluding a few months prior to that election.[6] The operation involved a group of political advisors and senior public servants. They also included on their team consultants from the private sector firms, including Aurecon and PricewaterhouseCoopers. The team does not seem to have included personnel

[5] Timna Jacks, Chip Le Grand and Paul Sakkal, 'Out of the Loop', *The Sunday Age*, August 31, 2021; Section: News, p. 15.

[6] *Ibid.*

who possessed much by way of actual knowledge of railway engineering or risk analysis. They were all required to sign strict confidentiality agreements. The usual state government agencies responsible for major project development—the Department of Transport, Infrastructure Victoria and Development Victoria—were not directly involved: they were sidelined. Together, this team developed the conceptual outline for the SRL known as the *Strategic Assessment*.

Transparency rather than opacity is usually the order of the day and best practice for large public infrastructure projects.[7] This is so because the vision needed to develop such projects usually only evolves following numerous rounds of expert advice and stakeholder consultation: nobody has a monopoly on engineering and economic wisdom, least of all for a megaproject of this magnitude. Both the London Crossrail and Melbourne Metro Rail projects, for instance, were developed off the back of highly transparent studies on the future transport needs of Melbourne and London, respectively, both of which were conducted by teams led by Sir Rod Eddington.[8]

This secrecy meant that opposition political parties, the media, Parliament, the voting public, and media commentators did not have much time to digest, understand and analyse the proposal when it was placed in the public domain in the lead-in to the election.

After the government won the general election in November 2018, furthermore, it treated the proposition that the project ought to proceed as a *fait accompli*.

1.4 Release of the *Strategic Assessment*

The 'Strategic Assessment' was released in September 2018. It set out the high-level conceptual design choices for the SRL.

The SRL as proposed in many ways corresponded with both Dr Glazebrook's vision and the VPA's ideas for the 'Monash Cluster'.

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[7] See Kris Nielsen in Patricia Galloway, Kris Nielsen and Jack Dignum (eds, 2013) *Managing Gigaprojects: Advice from Those Who've Been There, Done That*, ASCE Books, pp. 5 – 30.

[8] Sir Rod Eddington (2006) *Eddington Transport Study*, UK Department of Transport; Sir Rod Eddington (2008) *East-West Link Needs Assessment*.

Key aspects of the project as prescribed in the *Strategic Assessment* include:

- Stations at thirteen locations in the eastern and northern suburbs: Cheltenham, Clayton, Monash, Glen Waverley, Burwood, Box Hill, Doncaster, Bundoora, Heidelberg, Reservoir, Fawkner, Broadmeadows and Melbourne Airport. These were to be delivered in two sections: first, Cheltenham to Box Hill ('SRL East'); then, Box Hill to Melbourne Airport ('SRL North'). Delivery of SRL North would be further subdivided into two sections on either side of Reservoir. A later extension of the scheme to the western suburbs ('SRL West') was mooted so as link up with the Melbourne Airport Rail Link (MARL) at Sunshine and then go through Werribee, but this part of the scheme was not developed to the level of detail as SRL East and SRL North. Sections of the mooted western section are shown on maps as dotted rather than solid lines and most planning documents only concern themselves with SRL East and SRL North.

- The whole scheme is to arc along a radial band of about 16 to 20 kilometres away from Melbourne's central business district (CBD). In other words it goes nowhere near the CBD.

- Special planning powers were to be (and have been) legislatively conferred upon the Strategic Rail Loop Authority (SRLA) to develop and administer station 'precincts'.[9] Station precincts consist of land within a 1.6 km (or one mile) radius around each station. This is essentially a large-scale densification initiative – to develop transit-oriented development (TOD) districts full of high-rise and medium-rise buildings so as to bring about economies of density in suburbs that have previously been much more sparsely populated. The Clayton and Monash precincts overlap (their respective stations are less the 1.6 km radius apart); thus, 'Clayton/Monash' may be considered a single precinct. Each station precinct covers about 8 km^2, an area slightly more than six times (or 2π times[10]) the size of Melbourne's CBD. So in total, excluding

[9] See *Suburban Rail Loop Act* 2021 (Vic.).

[10] This neat piece of arithmetic arises because the Melbourne CBD is exactly one half-mile by one mile, so its area is 0.5 square miles, whereas the area of each station precinct is π square miles.

the Melbourne Airport precinct, the precincts of SRL East and SRL North cover about 96 km^2, or about 70 CBDs.

- Three of the precincts are anchored by university campuses, namely: Monash (Monash University), Burwood (Deakin University) and Bundoora (La Trobe University). Four precincts are also anchored by large indoor shopping malls, namely: Cheltenham ('Westfield Southland', owned by ASX-listed Scentre Group), Glen Waverley ('The Glen', owned by ASX-listed Vicinity Group), Box Hill ('Box Hill Central', also owned by Vicinity) and Doncaster ('Westfield Doncaster', also owned by Scentre).

The *Strategic Assessment* was 'undertaken by Development Victoria, supported by Rail Projects Victoria, with commercial and technical advice provided by Pricewaterhouse Coopers (PWC) and Aurecon'.[11] Although some of its content has been superseded by subsequently released documents, the *Strategic Assessment* remains important, particularly as it formed the basis of the government's claimed political mandate for proceeding with the project. Its final conclusion was:[12]

> 'This Strategic Assessment has confirmed that investment in the Suburban Rail Loop is warranted.'

The *Strategic Assessment* departed in one important way from Dr Glazebrook's proposal (and the subsequently published proposal of the Rail Futures Institute). Dr Glazebrook contemplated construction through surface and elevated corridors to be be supplemented with some cut-and-cover tunnels, subject to the caveat that 'it needs to be relatively low cost'.[13] The government, on the other hand, opted for a much more expensive design: twin tunnels bored with tunnel boring machines (TBMs). The *Strategic Assessment* gave '$35 billion to $50 billion' as its ballpark estimation of likely cost.

The *Strategic Assessment*'s rationale for its grade choice was stated as follows:[14]

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[11] Suburban Rail Loop Authority (2018) *Suburban Rail Loop Strategic Assessment*.

[12] *Ibid*.

[13] Glazebrook, *op. cit.*

[14] Suburban Rail Loop Authority (2018) *Suburban Rail Loop Strategic Assessment*, p. 25. Emphasis added.

> 'Cheltenham to Box Hill (south-east)… Fully underground *to minimise impacts*…
>
> Box Hill to Melbourne Airport (north-east)… Fully underground *to minimise impacts*…
>
> Melbourne Airport to Sunshine (north-west, Airport Rail Link)… Fully underground *to minimise impacts*…
>
> Sunshine to the Werribee line (south-west)… Potential sections of underground and surface rail…'

TBM-bored tunnels are extremely expensive to construct. TBM tunnelling costs can be understood as somewhat akin to a cab fare—with a fixed component, a distance-based component and a time-based component. Very roughly, TBM-bored rail tunnels cost about a few hundred million dollars per TBM, a few hundred million dollars per kilometre of tunnel, a few hundred million dollars per station, and several million dollars per week. So presumably, 'impacts' refers to physical impacts on the surface environment rather than monetary or financial impacts.

Legislation to create the SRLA was passed by Parliament in 2019.[15] The SRLA was to develop and deliver the scheme. Other government agencies and external consultants were commissioned to develop detailed designs and plans in line with the *Strategic Assessment*. A joint venture between three engineering firms Aurecon, Jacobs and Mott MacDonald, unimaginatively known as the 'Aurecon Jacobs Mott MacDonald Joint Venture' (AJM) was engaged as technical advisor. Quantity surveying firm WT Partnership (WTP) was engaged as cost advisor. KPMG were engaged as commercial and economic advisor.

1.5 Release of the *Business and Investment Case*

In August 2021, the government published a document entitled *Business and Investment Case*. Thousands of pages long, it was much more comprehensive and detailed than the *Strategic Assessment*. It contained numerous attachments and supplements, the most significant of which are:

- A revised version of the *Strategic Assessment.*

[15] See *Suburban Rail Loop Act* 2021 (Vic.).

- The SRLA's central document entitled 'Business and Investment Case'.

- An appended *Demand Modelling Report* prepared by KPMG (Appendix C1).

- An appended *Economic Appraisal Report* prepared by KPMG (Appendix C2).

The *Demand Modelling Report* (Appendix C1) reported the results of modelling undertaken using transport demand models known as the 'Victorian Land Use and Transport Integration' (VLUTI) model and the 'Melbourne Activity and Agent Based Model' (MABM). VLUTI combines a four-step road and rail network simulation tool known as the Victorian Integrated Transport Model (VITM) with a spatial model of Melbourne's geography and demography known as 'CityPlan'. VITM and CityPlan interact dynamically within VLUTI to model how changes in the transport network cause changes in property development and demographics, and how changes in property development and demographics change patronage patterns on the transport network. Each of VLUTI, VITM, CityPlan and MABM are models whose methodologies have been developed over several decades, are well known to industry, and are used around the world.[16] They are technologically advanced and highly sophisticated.

The *Economic Appraisal Report* (Appendix C2) reported the results of a cost-benefit analysis, macroeconomic assessments, proposed financing and funding arrangements, and various other key performance indicators. Its macroeconomic appraisal drew upon a model known as 'KPMG-SM' which stands for 'KPMG SCGE model'. SCGE stands for 'spatial computable general equilibrium'. This is a sophisticated but well-established type of model for calculating macroeconomic effects.[17]

The results of the *Demand Modelling Report* and *Economic Appraisal Report*, both authored by KPMG, were then summarized in the

[16] See e.g. Infrastructure Victoria (2018) *Model Calibration and Validation Report* (by Arup and KPMG); Infrastructure Victoria (2021) *Victorian Land Use and Transport Integration (VLUTI) Model Architecture Report: Overview of the Victorian Land Use & Transport Integration Model*.

[17] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*: *Appendix C.2: Economic Appraisal Report* (by KPMG), Attachment D, pp. 174-183.

SRLA's main report, which forms the main section of the *Business and Investment Case*.

The results of the cost-benefit analysis are reported in ranges claimed to be '95% confidence intervals' for two 'program case' options ('Option A' and 'Option B' respectively). These were derived from a Monte Carlo analysis. Option B is delivered faster and entails much work being carried out in parallel that in Option A is carried out in series. Across both options, the reported costs range from $30.7 billion to $50.6 billion. The benefits range from $48.5 billion to $65.8 billion.

For cost-benefit analyses, 'benefits' may be subdivided into 'conventional economic benefits' (CEBs, whose legitimacy is well-established and accepted) and 'non-conventional' benefits (whose legitimacy is subject to ongoing debate). Non-conventional benefits in this case include two subcategories: 'wider economic benefits' (WEBs) and 'urban consolidation benefits' (UCBs).

Across both timing options, reported conventional economic benefits range from $33.6 billion to $45.2 billion.[18] In other words, conventional economic benefits alone are not enough to get the absolute benefit-cost ratio above unity.

Reported net present value (NPV) ranges from $3 billion to $25.2 billion.[19] NPV is the aggregate time-discounted sum of net benefits (or benefits less costs) for each year, derived with the application of a discount rate. The discount rate used was four percent.[20] The reported benefit-cost ratio (BCR) ranges from 1.0 to 1.7. This is a 'one-shot' or absolute BCR (ABCR), which considers a single project proposal, as distinct from an incremental BCR (IBCR), which considers a range of project alternatives.[21]

The *Demand Modelling Report* assumes that the SRL will open first in 2036 from Cheltenham to Box Hill, then from Box Hill to Reservoir in 2038 or 2041, then from Reservoir to Melbourne Airport in 2043 or

[18] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*: — Appendix C.2: *Economic Appraisal Report* (by KPMG), p. 9.

[19] *Ibid.*

[20] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case,* p. 293.

[21] See discussion below at section 7.5.

2053. When the first stage opens, it predicts patronage of about 70,000 passenger journeys on peak days. Between stage openings, it predicts that as precincts grow and develop, patronage will rise steadily at rates of about 9%-10% per annum. When the second stage opens, the report predicts daily workday patronage of about 170,000 in 2041 for the first later-delivery option or 280,000 in 2041 for the earlier-delivery option. By 2056 this grows to daily workday patronage of 435,000 for both options.[22]

This forecast certainly raises eyebrows. According to the Rail Futures Institute, as a general proposition cross-suburban corridors only need around 30% to 50% of the capacity of radial corridors.[23] Indeed, on the Melbourne tram network, the tangential suburban tram routes 78 and 82 average about 20% of the patronage of the nineteen tram routes that pass through the CBD.[24] Similar observations may be made in respect of urban rail networks elsewhere.

Nevertheless, the forecast patronage of about 435,000 passenger journeys on peak workdays would make the SRL the busiest line on Melbourne's network. The main patrons of the SRL would be 'low and medium income workers and students', as the report puts it.[25] In 2018-19, Melbourne's *entire* suburban rail network carried about 439,000 passenger journeys on peak workdays. Despite going nowhere near the densely populated centre of Melbourne, the SRLA predicts that the SRL in 2056 *on a single line* will carry almost as many passengers as the *entire network* does now. If this forecast were to materialise it would make Melbourne an extraordinarily unusual city - possibly the only city in the world with a rail network whose busiest line goes nowhere near its centre or most densely populated area.

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[22] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*: Appendix C.1: *Demand Modelling Report* (by KPMG), p. A90.

[23] Rail Futures Institute (2020), *op. cit.*, p. 125.

[24] Daniel Bowen (2020) *Australia's Top Tram Routes* <https://www.danielbowen.com/2020/03/02/top-tram-routes/>; Transport for London (2021) *Statistics on Journeys By Type*, <www.tfl.gov.co.uk>.

[25] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case: Appendix C.1: Demand Modelling Report* (by KPMG), p. C39.

1.6 Doubts About SRL Voiced by Experts

The leaders of the Rail Futures Institute have not been the only experts to express misgivings or concerns about the viability of the SRL publicly. They have been joined by various academics and other subject matter experts. These include: Professor John Stanley[26] (professor of transport economics, University of Sydney), Ms Marion Terrill[27] (director, Grattan Institute), Professor Jago Dobson[28] (professor of urban policy, RMIT), prominent economist Mr Leith Van Onselen[29], Dr John Stone[30] (lecturer in transport planning, University of Melbourne) and the evocatively named Dr Crystal Legacy[31] (senior lecturer in urban planning, University of Melbourne). These are not people to whom a political agenda can necessarily be readily ascribed.

Professor Stanley was a primary author of *Plan Melbourne*, which sets out the case for Melbourne to embrace polycentrism rather than monocentrism: a key rationale for the SRL.[32] He was also the primary author of an academic study that made the case for so-called 'social inclusion' benefits to be added to the tally of benefits within project business cases, a finding that has been enthusiastically embraced by the SRLA.[33] If the latter paper is anything to go by, Professor Stanley is no economic conservative.[34] Notwithstanding his close involvement in providing the platform upon which it has been built, Professor Stanley has distanced himself from any suggestion that he en-

[26] Timna Jacks, 'Experts question rail loop's value', *The Age*, Tuesday, August 24, 2021; Section: News, p. 9.

[27] Adam Carey, 'Expert warns on suburban rail loop', *The Age*, Tuesday, May 14, 2019; Section: News, p. 13.

[28] Timna Jacks, *op. cit*.

[29] Van Onselen, Leith, *Experts Line Up to Denounce Dan's $50b Rail Loop White Elephant*, Unconventional Economist, 3 October 2019 <www.macrobusiness .com>.

[30] Adam Carey, *op. cit.*

[31] *Ibid.*

[32] Adam Carey, *op. cit.*

[33] See section 6.7 below.

[34] See also John Stanley and Anton Roux (eds, 2014) *Infrastructure for 21st Century Australian Cities: Papers from the ADC Forum National Infrastructure and Cities Summit*, Australia Davos Connection.

dorses the SRL's business case. For instance, Professor Stanley has reportedly stated as follows: [35]

> 'Other than the section between Monash University and Box Hill, the loop [will] struggle to draw enough passengers to justify anything greater than a priority bus service…'
>
> 'There isn't the population density and jobs density there to justify the kind of patronage you're going to need on a rail system.'
>
> 'With a project like this, that has so much uncertainty about what the cost will turn out to be, I would want a higher benefit-cost ratio than that…'
>
> 'I wouldn't be comfortable with that BCR range to build a project like this.'

Marion Terrill of the Grattan Institute, furthermore, has opined as follows:[36]

> 'There is a significant question whether the proposed precincts will attract sufficient rail patronage to justify the project cost, particularly if population continues to shift outwards...
>
> Given this dynamic, the SRL is unlikely to be viable as a development proposition if it is not accompanied by tightening of the urban growth boundary to reorient new housing to the precincts. But that runs counter to current growth area expansion and would challenge the Victorian development model of cheap suburban lots. It also requires home owners to switch decisively to apartment living. Conversely, weakening the hold of the CBD on high-wage jobs runs counter to prevailing COVID-recovery policy and urban renewal plans. This planning confusion is a result of the closed SRL planning process.'

If there are subject matter experts out there who are independent from the government and KPMG and who are willing to endorse the business case publicly, they have been yet to make themselves heard. The disapproval of this project from this community of academic experts stands in stark contrast to the support that academics provided

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[35] Adam Carey, 'Expert warns on suburban rail loop', *The Age*, Tuesday, May 14, 2019; Section: News, p. 13.

[36] Marion Terrill, 'Rail loop sounds great until you run the figures', *The Age*, Wednesday, 13 March 2019; Section: News, p. 18.

to previous rail projects within the government's pipeline such as the Level Crossings Removals Program and Melbourne Metro Rail.

2. Developments in Project Risk Theory

2.1 Introduction

This section discusses modern studies and theories of risk in the context of rail megaprojects, particularly as they relate to cost overruns and benefit shortfalls. The studies and theories inform the analysis that follows. Some readers may wish to skip this section.

2.2 Prevalence of Cost Overruns and Benefit Shortfalls

Models and methodologies for cost, time and demand forecasting that have been used for the SRL and for transportation projects elsewhere in Australia are used worldwide. Internationally, a climate of skepticism about cost, time and demand forecasts on projects generally, and for rail megaprojects specifically, has emerged.

In a study that has become famous within the industry, Professor Bent Flyvbjerg of the University of Oxford (who is probably the world's leading scholar on the issues surrounding project cost overruns and benefit shortfalls) researched demand and cost forecasts for rail megaprojects around the world and compared them to outturn costs.[37] He concluded that rail passenger forecasts (the most important input in the calculation of benefits) were overestimated in nine out of ten cases by amounts that averaged out to a shortfall of 50.4%. Furthermore, such projects experienced an average cost overrun of 45%. Professor Flyvbjerg found:[38]

> 'Forecasts here become part of the political rhetoric aimed at showing voters that something is being done – or will be done – about the problems at hand. In such cases it may be difficult for forecasters and planners to argue for more realistic forecasts, because politicians here use forecasts to show political intent, not the most likely outcome. …'

Flyvbjerg went on to conclude as follows:[39]

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[37] Bent Flyvbjerg (2009) 'Survival of the Unfittest: Why the Worst Infrastructure Gets Built - and What We Can Do About It', *Oxford Review of Economic Policy* 25(3):344-67.

[38] Bent Flyvbjerg, Nils Bruzelius and Werner Rothengatter (2003) *Megaprojects and Risk: An Anatomy of Ambition*, Cambridge University Press, Cambridge, p. 125.

[39] *Ibid.*, p. 133. Emphasis added.

> '[I]t is highly risky to rely on forecasts of travel demand and cost in developing large transportation infrastructure schemes. Rail passenger forecasts are overestimated in nine out of ten cases. … Moreover, nine out of ten projects have underestimated costs and cost overrun. Average cost overrun for rail is 45 per cent in constant prices …. All averages have large standard deviations, indicating that risks of individual forecasts being very wrong are high. Finally, forecasts have not become more accurate over time.

Finally:[40]

> '[T]he traffic estimates used in decision making for rail infrastructure development are highly, systematically and significantly misleading. Rail passenger traffic forecasts are consistently and significantly inflated. On this background, decision makers are well advised to take with a grain of salt any traffic forecast that does not explicitly take into account *the risk of being very wrong*. For rail passenger forecasts, and especially for urban rail, a grain of salt may not be enough.'

Flyvbjerg then examined the causes of such forecasting errors. He concluded that the causes of cost overruns and benefit shortfalls fall into three categories: (1) 'technical', (2) 'psychological' and (3) 'political-economic'.[41] These categories are discussed below.

Flyvbjerg's studies have given credence to what experienced industry practitioners had long realized: that major projects are vulnerable to chronic cost overruns, time overruns[42] and benefit shortfalls, and that the bigger the project, the more pronounced becomes this phenomenon.

2.3 Technical Causes

Technical causes are the usual way in which project parties seek to explain deficits. Technical causes include: lack of forecasting experience, imperfect forecasting techniques, inherent problems in predicting the future, human error and inadequate data.[43] Just as it is harder for a weather forecaster to predict the weather in one month's time

[40] *op. cit*., p. 137. Emphasis added.

[41] *Ibid*.

[42] See also Keith Pickavance (3rd edition, 2005) *Delay and Disruption in Construction Contracts*, LLP London, p. 13.

[43] Bent Flyvbjerg, Nils Bruzelius and Werner Rothengatter, *loc. cit.*

than it is to predict tomorrow's weather, so too is it difficult for project proponents to make accurate forecasts of the costs and timing at the later stages of bigger and longer projects. The cost and benefit forecasts for a megaproject such as SRL are especially susceptible to error for this reason alone.

2.4 Optimism Bias and the Planning Fallacy

Psychological causes have links to the phenomena that psychologists know of as the 'planning fallacy' and 'optimism bias'. The 'planning fallacy' is optimism bias applied to time planning. These causes are often underappreciated and unacknowledged. As Flyvbjerg put it:[44]

> '[I]n the grip of the planning fallacy, managers make decisions based on delusional optimism rather than on a rational weighting of gains, losses, and probabilities. They overestimate benefits and underestimate costs. They involuntarily spin scenarios of success and overlook the potential for mistakes and miscalculations. As a result, managers pursue initiatives that are unlikely to come in on budget or on time, or to deliver the expected returns. Over-optimism can be traced to cognitive biases, that is, errors in the way the mind processes information. These biases are thought to be ubiquitous, but their effects can be tempered by simple reality checks, thus reducing the odds that people and organizations will rush blindly into unprofitable investments of money and time.'

Flyvbjerg's concerns have not escaped attention in Australia. The widely used Transport and Infrastructure Council's *Australian Transport Assessment and Planning* (ATAP) *Guidlines* include a section on countering optimism bias. Those guidelines state:[45]

> 'Optimism bias occurs when overly favourable estimates of net benefits are presented as the most likely or mean estimates. They note that this could occur as a result of overestimating future benefits (often linked to an unrealistically high estimate of the annual rate of growth of benefits) or underestimating future costs (often linked to excluding relevant costs)… A UK report claims that optimism bias is an endemic problem associated with cost-benefit analysis. The Productivity

[44] *Ibid.*

[45] Commonwealth of Australia (2021) *Australian Transport Assessment and Planning Guidelines* <www.atap.gov.au> Vol. O2 'Optimism Bias', pp. 2-3.

> Commission (2015) has further reinforced its concerns by observing that "there is a systematic tendency for project appraisers conducting cost-benefit analysis to be overly optimistic — the bias is toward overstating benefits, and understating timings and costs, both with respect to initial capital commitment and operation costs. Over estimates of traffic forecasts on toll roads and tunnels are a particular problem."'

In Australia, public-private partnerships to build urban tolled roads through tunnels in the first couple of decades of the millennium have illustrated this phenomenon in relation to benefit shortfalls. Brisbane's 'Airport Link', Sydney's 'Cross-City Tunnel' and Sydney's 'Lane Cove Tunnel' are three leading examples.[46] For the Brisbane Airport Link, forecasters Arup had predicted that 135,000 vehicles per day would use the road one month after its opening in 2012. This was eventually to climb to 291,000 vehicles per day by 2026. When the project went into receivership in 2013, however, the average daily traffic was only 48,000 vehicles.[47] The forecasts for Sydney's Cross-City tunnel, similarly, predicted 85,000 vehicles per day, but actual patronage proved to be just 30,000 vehicles per day.[48] Forecasts for Sydney's Lane Cove Tunnel predicted 90,000 vehicles per day but actual patronage was just 45,000 vehicles per day.[49] In all three cases, the private ventures set up to finance the projects went into receivership. Fortunately for taxpayers, it was private investors rather than taxpayers who had to shoulder the burden of the losses; attendant risks had been effectively transferred to the private sector.

Flyvbjerg's antidote to the planning fallacy and optimism bias is 'reference class forecasting'.[50] This means forecasting that is objectively grounded in comparable measurements from the past and that is justifiable from an outsider's perspective. At the time of writing this report, for example, the Essendon Football Club is putting in place a

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[46] Anders Axelson (2009) 'The Future of Public-Private Partnerships in the Asia-Pacific Region: Lessons From Problematic Infrastructure Projects Down Under', *Inter-Pacific Bar Association*, Manila, Philippines; Antonino de Fina in Patricia Galloway, Kris Nielsen and Jack Dignum (eds, 2013) *Managing Gigaprojects: Advice from Those Who've Been There, Done That*, ASCE Books, pp. 315-320.

[47] *Ibid.*

[48] *Ibid.*

[49] *Ibid.*

[50] Bent Flyvbjerg (2009) 'Survival of the Unfittest: Why the Worst Infrastructure Gets Built - and What We Can Do About It', *Oxford Review of Economic Policy* 25(3):344-67, pp. 353-358.

'plan' to win the 2023 AFL Premiership, despite having finished in only fifteenth position in the 2022 season. A team in the grip of optimism bias would act as if this 'plan' is going to be realized. On the other hand, an outsider disciplined in 'reference class forecasting' might predict Essendon's ladder position in 2023 from the average final ladder position of the team's last five seasons: (11, 8, 13, 8 and 15) that is, to give an expectation of about eleventh place.

2.5 Political-Economic Causes

Political-economic causes often also go unacknowledged. They arise because:[51]

> '[P]roject planners and promoters [are] deliberately and strategically overestimating benefits and underestimating costs when forecasting the outcomes of projects. …[They] purposely spin scenarios of success and gloss over the potential for failure. …[T]his results in the pursuit of ventures that are unlikely to come in on budget or on time, or deliver the promised benefits. Strategic misrepresentation can be traced to agency problems and political and organizational pressures…[D]eliberate misrepresentation of costs and benefits is lying… but misrepresentation and lying can be moderated by measures of accountability.'

Van Wee also alludes to rent-seeking behaviour by project stakeholders:[52]

> '[S]eemingly rational forecasts that underestimate costs and overestimate benefits have long been an established formula for project approval… Forecasting is here just another kind of rent-seeking behaviour. …. The consequence is a Machiavellian make-believe world of misrepresentation, which makes it extremely difficult to decide which projects deserve undertaking and which do not…'

2.6 Recognition that Project Cost Distributions are 'Fat-Tailed'

The most common probability distribution in nature, at least according to classic textbooks, has a symmetrical bell-curve shape. It is

[51] Bent Flyvbjerg, Nils Bruzelius and Werner Rothengatter, *loc. cit*., p. 359.

[52] Hugo Priemus, Bent Flyvbjerg and Bert van Wee (eds.)(2008) *Decision-Making on Mega-Projects Cost–Benefit Analysis, Planning and Innovation*, Edward Elgar, Cheltenham UK, p. 48.

known as a Gaussian distribution.[53] Distributions of this sort and variants thereof are known as 'thin-tailed' distributions.[54] Properties of thin-tailed distributions are well-described using metrics such as mean, standard deviation, variance, skewness and kurtosis. The distributions may also be described by a '95% confidence interval' which is essentially equivalent to a range of two standard deviations either side of the mean.

It has been established, however, that the probability distributions that arise from megaproject costs do not follow this mould. To the contrary, they are 'fat-tailed', and notoriously so.[55] Distributions of megaproject cost have a skewness, kurtosis and other properties that tend to extreme values and make them deviate very far from the thin-tailed or Gaussian shape at the upper or right tail of the distribution.[56] Flyvbjerg describes this as 'regression to the tail' rather than 'regression to the mean', a phenomenon that makes it come under the purview of 'fat-tailed risk' theory.[57] Simply put, this means that mathematical and statistical properties change over the spread of the distribution such that the upper tail values are much more widely dispersed than values in the centre of the distribution. 'Fat tails' are associated with 'power laws' and fractal-like properties such as scalability and self-similarity.[58]

2.7 Merge Bias

A human body may be thought of as an organism containing many critical parallel processes (e.g. heart, brain, lungs, liver, kidneys etc.), each of which has its own life expectancy. When one of the parallel

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[53] See also Nassim Nicholas Taleb (2nd edition, 2010) *Black Swan: The Impact of the Highly Improbable*, Random House, New York, §15. Taleb refers to the Gaussian distribution as a 'great intellectual fraud'.

[54] Nassim Nicholas Taleb (2019) 'Probability, Risk and Extremes', in Duncan Needham (ed.) *Extremes*, Cambridge University Press, pp. 46-66.

[55] *Ibid.*

[56] See Bent Flyvbjerg, Alexander Budzier, and Daniel Lunn (2020) 'Regression to the Tail: Why the Olympics Blow Up,' *Environment and Planning A: Economy and Space*, published online, p. 12

[57] *Ibid.*

[58] See Bent Flyvbjerg, Alexander Budzier, and Daniel Lunn, *loc. cit.*; Xavier Gabaix (2008) 'Power Laws in Economics and Finance', *Annual Review of Economics*, 1(1): 255-294. See also Benoit Mandelbrot and Richard Hudson (2004) *The (Mis)behaviour of Markets: A Fractal View of Financial Turbulence*, Basic Books, New York, pp. 13-16.

processes fails, the whole organism fails, and an end event occurs: death. The lifespan of the host is thus more or less the *minimum* of the lifespans of the parallel critical processes. This minimum function causes a skew to the *left* or *lower* tail of the probability distribution of human life. Accordingly, deaths about fifty years prior to the average life expectancy of about 75 (i.e. about 25) are much more frequent than deaths fifty years after the average life expectancy (i.e. about 125).

On a project, an opposite tendency prevails. Projects also consist of a multitude of parallel processes. But on projects, the end event is determined by the *maximum* duration of the multiple parallel paths: the project is only finished when the work on all parallel paths is complete. The maximum function contributes a skew to the *right* or *upper* tail of the probability ensemble of project timing (and cost).

This phenomenon is known as 'merge bias'. It is best practice for a Monte Carlo analysis of time and cost (as has been used for the *Business and Investment Case*) to incorporate scheduling logic, so that the parallel paths and dependencies of the project can be modelled. But when this is done, it is not always done accurately and accordingly, the skewness (and resultant potential for cost and time overruns) can be underestimated.

2.8 Epistemic Uncertainty

'Epistemic uncertainty is also known as 'Knightian uncertainty' or simply 'uncertainty'. It refers to the risk posed from systems which employ imperfect knowledge or imperfect estimates.[59] If conducted fairly, games of chance such as dice games, roulette wheels and coin tossing contain virtually no epistemic uncertainty. There is no doubt whatsoever, for example, that the results from a series of tosses of a single six-sided dice cannot exceed six. But there is likely to be considerable doubt about the outturn cost, on the other hand, of a construction task whose cost had been initially estimated by a quantity surveyor to be in a range of $1 million to $6 million. Decision-making frameworks made in the real world that are derived from gamelike simulations, including the Monte Carlo analyses used in cost benefit

[59] Nassim Nicholas Taleb (2nd edition, 2010) *Black Swan: The Impact of the Highly Improbable*, Random House, New York, pp. 190-200.

analyses, thus need to be more conservative than decision-making frameworks made in the context of games. This is often not taken into account. Taleb refers to this phenomenon as the 'ludic fallacy'.[60] Epistemic uncertainty is a key reason for safety margins to be used in prudent decision-making.

2.9 Correlation and Covariance

Monte Carlo analyses attempt to model the ensemble of probability scenarios on a project by simulating the extents of various risks and variances which affect cost and time forecasts, and then observing the results. Another source of error that can result in an underestimate of the potential for cost and time overruns is the likelihood that risks will be *correlated*.

For instance, if commodity markets cause an increase in the price of steel, it becomes likelier that prices in other metals, such as copper and nickel, will rise in tandem with steel.

All sorts of events can be correlated. Risk events in reality are not independent from one another. While traditionally, Monte Carlo analyses modelled all events as independent from one another, it is now best practice for a Monte Carlo analysis to represent correlation between risk events using a device known as the 'covariance matrix'. But this is difficult and it is seldom done accurately.

2.10 Power Law Dynamics

Power laws provide another explanation for why project cost and time forecasts blow out.

Consider a mathematical model whereby the magnitude of a problem that arises on a construction project, *p*, is represented by the radius of a circle. The magnitude of the scope change, *s*, that is required to deal with that problem might then be represented by the area of that circle, so that $s = \pi p^2$. Then consider that the scope change itself is represented as the radius of another circle. The magnitude of the cost of implementing that scope change, *c*, might then be represented as the area of this second circle, so that $c = \pi s^2 = \pi^2 p^4$.

[60] See Nassim Nicholas Taleb, *op. cit.*, pp. 122-133.

In the real world, of course, the constant is not necessarily π^2 and the exponent is not necessarily four, but these are the kinds of mathematical relationships that occur in the real world between such variables. Indeed, such an equation may be generalized to $c = kp^n$; where k is an arbitrary constant and $n > 1$. Mathematical relationships of this nature are known as 'power laws'.[61] Compounding power law dynamics are a key reason why distributions of project costs display 'fat-tailed' behaviour and why project costs blow out so frequently and disproportionately.

2.11 Black Swans

A 'black swan' event is a risk event that is highly consequential but is not predictable by conventional means.[62] An example of a black swan event is the Covid-19 pandemic from the standpoint of the organizers of the 2020 Tokyo Summer Olympic Games. The pandemic not only caused the postponement of the Games to 2021, but also meant that the postponed Games had to be held without spectators. 9/11 is arguably the most prototypical example. Such events may also be referred to as 'unknown unknowns'. Because of their long duration, megaprojects such as the SRL are particularly susceptible to disruption by black swan events. As Flyvbjerg put it:[63]

> '….Time is like a window. The longer the duration, the larger the window, and the greater the risk of a big, fat black swan flying through it.'

The possibility of disruption by black swan events is another reason why lengthier projects are disproportionately vulnerable to blowouts and shortfalls.

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[61] Nassim Nicholas Taleb (2019) 'Probability, Risk and Extremes', in Duncan Needham (ed.) *Extremes*, Cambridge University Press, pp. 54-57.

[62] Counterintuitively for Australia, where swans are normally black. The name alludes to sightings of black swans by Dutch explorers in Western Australia in the seventeenth century, which disproved a widely held European assumption that swans could only be white. This idea was popularized in Nassim Nicholas Taleb (1st edition, 2001) *Black Swan: The Impact of the Highly Improbable*, Random House, New York.

[63] Bent Flyvbjerg, Alexander Budzier, and Daniel Lunn (2020) 'Regression to the Tail: Why the Olympics Blow Up,' *Environment and Planning A: Economy and Space*, published online, p. 11.

2.12 Ergodicity

'Ergodicity economics' is an emerging field that is shedding new light on why major projects so consistently suffer cost blowouts and benefit shortfalls.[64] In so far as it concerns major projects, the thesis of ergodicity economics is that the cost benefit models, forecasting systems and Monte Carlo[65] analyses that support project business cases are 'ergodic'. Conversely, the projects themselves are 'non-ergodic'. This means that the supporting models do not satisfactorily account for risk, underestimate time and cost and often introduce unaccounted-for error. The propensity for cost overruns and benefit shortfalls is evidence of this. By this account, orthodox cost-benefit analysis methodologies are flawed and need to be overhauled to take account of modern understandings of ergodicity.

Ergodicity economics has profound implications for the strategy and philosophy that is most appropriate for managing project risk. It essentially turns into a science that which had previously been an art – the question of when it is appropriate to take a conservative approach to investment and risk and when it is optimal to adopt a more cavalier approach that admits significant risk.

What does this mean?

In general terms, a project is a time dynamical system. Time dynamical systems may be subdivided into three categories: (1) ergodic systems, (2) weakly non-ergodic systems and (3) strongly non-ergodic systems. As will be discussed below, an example of an ergodic system is the coin toss at the start of a cricket match. An example of a weakly non-ergodic system is bowling in cricket. An example of a strongly non-ergodic system is batting in cricket.

For the purpose of illustrating this concept, think of the known universe (and systems within it) as having five dimensions. First, there are the three spatial dimensions. Second, there is a time or temporal

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[64] See Nassim Nicholas Taleb (2018) *Skin in the Game: Hidden Asymmetries of Daily Life*, Random House, New York, pp. 132-133; pp. 224-228; pp. 246-249; Ole Peters, 'The Ergodicity Problem in Economics', (2019) 15 *Nature Physics* 1216; Ole Peters and Murray Gell-Mann (2016) 'Evaluating Gambles Using Dynamics', *Chaos* 26(2) 023103 <scitation.aip.org/content/aip/journal/ chaos/26/2/10.1063/ 1.4940236.>; Mark Buchanan, *How Ergodicity Reimagines Economics for the Benefit of Us All*, 15 August 2019, <aeon.co>.

[65] Nassim Nicholas Taleb (2001) *Fooled by Randomness*, Texere, New York, pp. 40-46.

dimension. Third, there exists an 'ensemble dimension', sometimes termed a 'probability space'. The ensemble dimension co-exists with any given value of time in the future. It contains the 'ensemble' or collection of possible alternative states or probabilistic scenarios might branch out from the system (or the universe itself) in the future. The ensemble dimension is only meaningful for future values of time. For past values of the time dimension the ensemble only has a single scenario, as what's done is done.[66]

An *ergodic system* is one where the properties along the time dimension on the one hand and across spatial dimensions or the ensemble dimension on the other hand are similar, so that the averages across the respective dimensions converge with one another.[67]

Where events that affect the time dimension of a time dynamical system are subject to at least some of: path dependency[68], covariance, power law dynamics, or multiplicative dynamics, those effects will not be replicated across spatial or ensemble dimensions. That makes such a system non-ergodic.

The coin toss at the start of a cricket match to decide which team bats and which team bowls, as mentioned above, is an example of an ergodic system. For such a process, the long-term average result across flips of the coin will converge over time by the law of large numbers to be *exactly the same* as its ensemble average: 50% heads and 50% tails.[69] There is no path dependency: the result on one flip does not build on the result of previous flips. Every coin flip is independent from every other coin flip. The dynamics of ergodic systems resemble a random walk, similar to Brownian motion, or the motion of gas particles randomly circulating around a container.[70]

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[66] Nassim Nicholas Taleb (2019) 'Probability, Risk and Extremes', in Needham, Duncan (ed.) *Extremes*, Cambridge University Press, pp. 60-62.

[67] Nassim Nicholas Taleb (2001) *Fooled by Randomness*, Texere, New York, pp. 129-131. This concept is derived from physics. In particular, where the molecules of a fluid undergo 'Brownian motion' or a 'random walk' around the container containing them, the mean position of the gas particles at any point in time will the same as the average position of a single particle sampled over time.

[68] Nassim Nicholas Taleb (2019) 'Probability, Risk and Extremes', in Duncan Needham (ed.) *Extremes*, Cambridge University Press, pp. 60-63.

[69] This phenomenon is known as the 'law of large numbers'.

[70] See Burton Malkiel (11th edn, 2015) *A Random Walk Down Wall Street*, Random House, New York, pp. 16-18.

An example of a weakly non-ergodic system is bowling in cricket. If a bowler in cricket is skilled enough to be able to take wickets on five percent of deliveries or one ball in every twenty, his or her long-term strike rate may well converge more or less onto that ensemble average. The number of wickets taken by a bowler will not compound together or exhibit multiplicative or power law dynamics over time, and an ergodic simulation such as a dice or roulette wheel can do a reasonably good job of representing the variety of cricket delieveries that a batsman faces. However, this is not perfectly true. Bowling in cricket, for instance, has some path dependent effects that may arise, such as from the build up of psychological pressure and fatigue on both batsman and bowler from one delivery to the next, as well as the condition of the ball and the pitch. Because this path dependency is not replicated across the ensemble dimension, bowling does not properly qualify as ergodic: it is *non-ergodic*.

But bowling in cricket is only *weakly* non-ergodic. Batting in cricket, on the other hand, is *strongly* non-ergodic. Strongly non-ergodic systems inherit the properties of non-ergodic systems in general, but they are also affected by another consideration: the 'risk of ruin'.[71] For a batsman in cricket the 'risk of ruin' is the risk that he or she will lose his or her wicket. 'Ruin' in this context means severe irreversible harm. Unless there is only a very small number of balls left in the match, a good batsman's strategic approach to batting will be dominated by the overriding imperative of not losing his or her wicket, rather than simply maximising the expectation in terms of probable runs. Strongly non-ergodic systems require a profoundly different philosophy for managing risk to ergodic systems and weakly non-ergodic systems. In the rhetoric of Nassim Taleb:[72]

> '[S]equence matters and the presence of [the risk of] ruin disqualifies cost-benefit analyses.'

Furthermore:

> '… if there is a possibility of ruin [i.e. the system is strongly non-ergodic], cost benefit analyses are no longer possible.'[73]

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[71] Nassim Nicholas Taleb (2019) 'Probability, Risk and Extremes', in Duncan Needham (ed.) *Extremes*, Cambridge University Press, pp. 60-63.

[72] Nassim Nicholas Taleb (2018) *Skin in the Game: Hidden Asymmetries of Daily Life*, Random House, New York, p. 224.

[73] *Ibid.*

'…Buffett did not make his billions by cost-benefit analysis.'[74]

While smaller projects may be characterized as more weakly non-ergodic, a megaproject such as the SRL is *strongly* non-ergodic.

Why? Because the enormous size of the SRL confers upon it 'too big to fail' status.[75] If the outturn costs for, say, a $5 million dollar extension of the Cranbourne police station fall into the part of the probability ensembles with higher P-values (such as P95) and end up at $10 million, it is not necessarily untenable for the government can take the attitude 'you win some, you lose some'. In ergodic and more weakly non-ergodic systems, proponents can get away with a relatively cavalier attitude. On the other hand, it is not out of the question for a major project such as the SRL to experience a 100% cost overrun and a 50% benefits shortfall. Victoria will suffer severe consequences in such circumstances, which fall within the economic definition of 'ruin'.[76]

2.13 Margins of Safety

For strongly ergodic systems, a 'win some, lose some' or 'swings and roundabouts' philosophy must be replaced with the precautionary[77] principle or *primum non nocere* ('first, do no harm').[78]

Primum non nocere can be implemented in two key ways.

First, an empirically derived *margin of safety* needs to be be adopted. According to historic investment guru Benjamin Graham, a margin of safety is nothing less than 'the secret of sound investment'.[79] Scholars have suggested that Warren Buffett's investment methods

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[74] *Ibid.*

[75] Mangling the Greek language to signify that projects worth more than $US10 billion require special treatment when it comes to risk, Galloway, Nielsen and Dignum refer to such megaprojects as 'gigaprojects'. See Patricia Galloway, Kris Nielsen and Jack Dignum (eds, 2013) *Managing Gigaprojects: Advice from Those Who've Been There, Done That*, ASCE Books, pp. xv – xvii.

[76] Nassim Nicholas Taleb (2019) 'Probability, Risk and Extremes', in Duncan Needham (ed.) *Extremes*, Cambridge University Press, pp. 60-63.

[77] *Ibid.*, p. 63.

[78] *Ibid.*, pp. 62-63.

[79] Benjamin Graham (4th revised edition, 1973) *The Intelligent Investor*, HarperBusiness Essentials, p. 512. See also Charlie Munger (2011, 6th edition) *Poor Charlie's Almanack: The Wit and Wisdom of Charles T. Munger*, Walsworth Publishing, Marceline MO USA, p. 126.

are closely associated with an implicit understanding of strongly non-ergodic systems.[80] Modern bridge design methods in structural engineering provide another case study of dealing with risk in a strongly non-ergodic environment by the use of margins of safety.

Second, an investment made in a strongly non-ergodic environment needs to be scaled in accordance with how advantageous the investment is. This is the basis of the 'Kelly criterion', also known as 'fortune's formula'. The Kelly criterion maximises the expected growth rate of a gambler's bankroll while at the same time avoiding the 'risk of ruin' (i.e. the risk that the bankroll will go to zero)[81]. Conservative versions of the Kelly criterion that take epistemic uncertainty[82] and the ludic fallacy[83] into account (known as 'half-Kelly' or 'fractional Kelly') are a mainstay of successful investors in financial markets.[84]

The combined effect of these two considerations is that margins of safety need to be applied to the benefit-cost ratios of megaprojects, and that the bigger the project, the bigger the margin of safety (in percentage terms) needs to be.

Most of the standards and guidelines such as those promoted in *ATAP*[85], the Victorian Department of Treasury[86] and Infrastructure Australia[87] are intended for projects that are an order of magnitude or two smaller than the SRL and whose environments are not as strongly non-ergodic.

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[80] Mark Buchanan, *op. cit.*; Daesol Lee, 'Ergodicity: The Most Overlooked Assumption' <https://neurabites.com/ergodicity/>; Nassim Nicholas Taleb (2019) 'Probability, Risk and Extremes', in Duncan Needham (ed.) *Extremes*, Cambridge University Press, pp. 61-62.

[81] See William Poundstone (2005) *Fortune's Formula: The Untold Story of the Scientific Betting System That Beat the Casinos and Wall Street*, Hill and Wang, New York, pp. 67-78; Leonard Maclean, Edward O. Thorp and William T. Ziemba (eds., 2011) *The Kelly Growth Investment Criterion*, World Scientific Handbook in Financial Economic Series, Vol. 3: Theory and Practice, World Scientific.

[82] See Nassim Nicholas Taleb (2nd edition, 2010) *Black Swan: The Impact of the Highly Improbable*, Random House, New York, pp. 190-200.

[83] See Nassim Nicholas Taleb, *op. cit.*, pp. 122-133.

[84] William Poundstone, *op. cit.*

[85] See Commonwealth of Australia (2021) *Australian Transport Assessment and Planning Guidelines* www.atap.gov.au.

[86] See Department of Treasury and Finance (2013) *Economic Evaluation for Business Cases: Technical Guidelines*.

[87] See Infrastructure Australia (2021) *Assessment Framework*.

2.14 Conclusion

As a $50 billion project, the SRL is 'too big to fail'. Theoretically, that makes it a 'strongly non-ergodic' system. Risks across strongly non-ergodic systems are addressed by margins of safety. For a project cost benefit analysis, the decision threshold (that is, the benefit-cost ratio above which a project is greenlighted) needs to be raised from 1.0 to 1.0 + m where m is an empirically derived margin of safety that is greater than zero.

A project with 'too big to fail' magnitude requires a profoundly different and profoundly more prudent risk management strategy than that suggested by guidelines such as *ATAP*, which is designed for projects that are at least an order of magnitude smaller. In short, it needs a risk treatment that is more like Warren Buffett and less like Michael Saylor. Or, to extend the cricket analogy, more like Geoffrey Boycott and less like Glenn Maxwell.

This issue is discussed further at section 7.6.

3. Conceptual Issues

3.1 Introduction

Attention is now turned to the high-level conceptual models, methods, findings and conclusions that comprise the SRLA's *Business and Investment Case*, the *Strategic Assessment* and associated documentation. These are discussed on an issue by issue basis.

3.2 Foolish Name

In railway terminology, a 'loop' is a type of rail line that changes the direction of travel (e.g. from outbound to inbound, or vice versa) without reversing the direction of locomotion. Unlike the Melbourne City Loop, the SRL does not actually do this.

Use of the term 'suburban' is also impolitic from the state government's point of view, as it reduces the likelihood of obtaining federal government funding. Politically, it is easier to convince federal politicians (and their constituents) to fund a project that radiates national importance than one that is 'suburban' in character. According to NSW Government rhetoric, for example, Sydney Metro does not pass through a string of suburbs so much as a 'global economic corridor'.[88]

As such, the 'Greater Melbourne Rail Link' or 'Global Corridor Rail Link' would probably be better names.

3.3 Suffers From 'Early Lock-In' Syndrome

According to Flyvbjerg, one of the symptoms that often leads to economic disaster on mega-projects is an early 'lock in' or 'capture' of a project concept, leaving 'analysis of alternatives weak or absent'.[89] Furthermore:[90]

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[88] Transport for NSW (2016) *Sydney Metro City & Southwest: Final Business Case: Summary*.

[89] Bent Flyvbjerg (2009) 'Survival of the Unfittest: Why the Worst Infrastructure Gets Built - and What We Can Do About It', *Oxford Review of Economic Policy* 25(3):344-67, p. 345.

[90] Bent Flyvbjerg, *op. cit.*

> 'It is not uncommon in mega-projects for a solution to present itself early – the solution which suits the initiators and which then heads off in search of a problem. Hence the process rarely begins with a proper analysis of the problems involved and an impartial appraisal of the alternatives.
>
> Often, in the earliest phases, we see lobby groups hard at work mobilising support for a particular solution that is thought to be superior. Feasible alternatives are not even put forward, let alone analysed. Any alternatives proffered by opposing camps further down the line are usually too late. It is not unusual for the government to back the – supposedly superior – solution at an early stage. Alternatives suggested by others in later stages of the process are often whittled down to nothing. '

In the words of another commentator, Priemus:[91]

> 'At the start of the decision-making process, the focus should be on the problem, not so much on the solution.'

Early lock-in was recognized by the Grattan Institute as a particularly acute problem in Australia:[92]

> '[P]rojects announced early tend to perform worse than average against their cost estimates, not only in the early stages but also later in the project's life. …
>
> Premature announcement – when a politician promises to build a road or rail line at a particular cost, often in the lead-up to an election – is the biggest culprit.
>
> Governments and would-be governments are very fond of promising infrastructure. But while these promises might give them political advantage, politicised announcements that ignore proper process have particularly poor outcomes. Cost overruns are 23 per cent higher on average for projects announced close to a state or federal election than for similar projects announced at other times. …
>
> Politicians continue to make infrastructure promises for political advantage even though their parties have made strong statements recognising the need to spend infrastructure money better.'

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[91] Hugo Priemus, Bent Flyvbjerg and Bert van Wee (eds.)(2008) *Decision-Making on Mega-Projects Cost–Benefit Analysis, Planning and Innovation*, Edward Elgar, Cheltenham UK, p. 106.

[92] Marion Terrill (2016) *Cost Overruns in Transport Infrastructure,* Grattan Institute Report No. 2016-13, pp. 16-17.

Accordingly, the Grattan Institute recommends that:

> 'Governments should not be able to commit public money to transport infrastructure until a rigorous, independent like-for-like evaluation and the underlying business case have been tabled in the state or federal parliament.'

These tendencies were taken to extremes for the SRL. The proposal was announced less than three months before a state election. Prior to that it had been kept secret. Parliament, the media and the voting public had little time to scrutinise the *Strategic Assessment*. The *Business and Investment Case* was not commissioned until after the election and after the SRLA had been formed. An organisation whose *raison d'être* is the project is hardly going to commission a recommendation that would sound a death knell for itself and leave its own personnel unemployed. The hybrid bill that enabled London Crossrail, by comparison, triggered numerous peer reviews from independent experts from around the world and gave rise to lengthy Parliamentary committee proceedings and various other inquiries.[93] A megaproject worth tens of billions of dollars and that will shape the future fortunes of a city, state and nation should warrant nothing less.

3.4 Misleading Implication That Other Cities Have Similar Schemes

To reassure stakeholders of the integrity of the scheme, the *Strategic Assessment*[94] implies that, as an 'orbital' rail line, the SRL would deliver to Melbourne a concept that has proved successful in other world cities. In fact, as Table 1 highlights, this is more than stretching the truth. The SRL as was and is proposed is exceptionally unusual among urban metro and metro-like rail systems with an orbital or circumferential configuration, for several reasons.

[93] *Crossrail Act* 2008 (UK).

[94] Suburban Rail Loop Authority (2018) *Suburban Rail Loop Strategic Assessment*, pp. 6-9.

City	Name	Status	Elevation	Full Circle?	Type of System	Length (km)	Metro Population (millions)	Metro Population Density (km^{-2})
Berlin	Ringbahn (S-Bahn)	complete	at grade	Yes	heavy rail	37.5	4.0	2,945
Copenhagen	Cityringen	under construction	elevated	Yes	light metro	15.4	1.7	2,839
Copenhagen	Ringbanen	complete	at grade	Almost	heavy rail	10	1.7	2,839
London	Circle Line	complete	underground	Yes	metro	27	11.1	6,389
Moscow	Koltsevaya Line	complete	underground	Yes	metro	19.4	17.7	5,879
Paris	T3	complete	at grade	No	light rail	12.4	11.0	3,877
Paris	Grand Paris Express (Metro Ligne 15)	under construction	underground	Yes	metro	75	11.0	3,877
Singapore	Circle Line	complete	underground	Yes	metro	35.5	5.9	11,283
Tokyo	Yamamote Line	complete	underground	Yes	metro	34.5	39.1	4,751
Melbourne	Suburban Rail Loop	proposed	underground	No	light metro	90	4.6	1,820

Table 1 - Comparison with Other Urban Rail Lines

First, compared to these other systems, the SRL starts and remains an extraordinarily long way out from Melbourne's centre: approximately 16-20 kilometres from the central business district (CBD). In many jurisdictions, such far-flung locations would not even be considered part of the city proper, let alone candidates to host the stations of a TBM-bored underground railway.

Secondly, according to Demographia[95], Melbourne's metropolitan area has a population density of 1820km^{-2}. That is the lowest density of any world city with a population of more than 1.5 million outside of the United States, Puerto Rico and Australia.[96] Melbourne's middle

[95] Demographia (2021) *World Urban Areas Report* <www.demographia.com>.

[96] *Ibid*. On the one hand, outside of the United States, no metropolitan area which has a population of more than 1.5 million is less dense than Melbourne with three exceptions: Brisbane, Perth and San Juan, Puerto Rico. On the other hand, only four of the 33 US metropolitan areas with a popula-

ring of suburbs has population densities close to the average of the metropolitan area. For a form of transport synonymous with dense inner cities, the densities of the areas that the line traverses are exceptionally low.[97] The 'economies' that make rail networks (and other infrastructure networks) succeed are economies of density, not economies of size. High population density and underground rail go hand in hand. As Feigenbaum puts it:[98]

> 'Trains depend on population density to operate efficiently. …. Both the population size of a city and the concentration of economic activity in the central business district and near the train station(s) are important determinants in the percentage of people who ride rail transit. This means that New York City is more suited for train travel than many other U.S. cities because of the high concentration of activity on the island of Manhattan. About 35% of the city's jobs are within three miles of Wall Street.'

Thirdly, for a single line on an urban transit system, SRL is very long: that is, 90km for all proposed stages.

Fourthly, SRL is designed to be constructed using the most expensive possible method: that is, via underground tunnels bored with tunnel boring machines (TBMs) in geological conditions that do not lend themselves particularly well to TBM tunnelling.

Fifthly, the SRL is not actually a proper 'metro' system. As it has only four-car sets, it merely qualifies as a 'light metro'. The term 'light' in this context alludes to the capacity but alas not to cost.

Finally, while London, Singapore, Berlin, Moscow and Copenhagen have circular lines, the SRL is merely an arc. Both the *Strategic Assessment* and *Business and Investment Case* use the term 'orbital' line to conflate arcs and circles. But this topological distinction is far from insignificant. Among the advantages that circle lines on otherwise radial networks provide are as follows:

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tion of more than 1.5 million are *denser* than Melbourne: Las Vegas, Los Angeles, Miami and the San Francisco Bay Area.

[97] Although as a metric of a precinct's attractiveness for rail stations transport planners normally prefer to sum population density and jobs density to create 'activity' density, conventionally expressed per hectare.

[98] Baruch Feigenbaum (2013) *High-Speed Rail in Europe and Asia: Lessons for the United States*, Reason Foundation Policy Study 418, May 2013, p. 22.

- Circular lines disperse passengers away from the centre of the network, thereby reducing congestion and overcrowding in the centre.

- Congested radial networks tend to be relatively empty outbound in the AM peak but chock-a-block inbound. The opposite is true for the PM peak. This is an inefficient use of infrastructure. Circular lines avoid this inefficiency because they spread the passenger load out in both arterial directions in both peaks.

- On circular lines, the peak passenger load tends to disperse relatively evenly around the 360 degrees of the circle. This minimizes the likelihood of congestion chokepoints forming and means that the system can comfortably sustain more passengers. No part of a circle is weaker than any other part.

Arc lines such as the SRL, on the other hand, provide some of the first advantage, some of the second, but none of the third. The *Demand Modelling Report* shows, for instance, that SRL passenger numbers are expected to peak at Burwood Station in both directions of travel but taper out at the ends of the arc.[99] For a circular line, the chart of patronage plotted against the stations of the line would be flatter and smoother.

The limited set of examples of circle or arc lines available raises another awkward question for the SRLA. Why are there not more world cities with this type of rail line? Why has London, for instance, never seen fit to develop a vast circumferential underground line greater than the tiny 'Circle Line'? Due to the fractal, tree-like way in which cities organise themselves[100], the demand for travel in a tangential or circumferential direction is seldom as great as that that exists for radial travel. In nearly all cities, demand for orbital travel is catered for by transport modes with lower capacity. So, for example, London has the Croydon Tramlink extending tangentially across South London. It gets annual patronage of about 29 million - a far cry

[99] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case: Appendix C.1: Demand Modelling Report* (by KPMG), pp. A93-A94.

[100] Michael Batty and Paul Longley (1994) *Fractal Cities: A Geometry of Form and Function*, Academic Press, London.

from the 170 million to 220 million that the main tube lines get.[101] London also has plentiful bus services extending tangentially. According to the Rail Futures Institute:[102]

> 'The required capacity of orbital / cross-suburban corridors is significantly less than radial corridors… Typically, orbital / cross suburban corridors will need around 30% to 50% … of the capacity of the radial heavy rail corridors.'

As much is evident from the Melbourne tram network, which has nineteen radial lines that pass through the CBD and two tangential or circumferential lines, the 78 and 82. The radial lines get an annual patronage that averages out to about 10 million passenger journeys per line.[103] The 78, which goes between North Richmond and Balaclava along Church Street and Chapel Street, gets annual patronage of about 2.5 million passenger journeys. The 82, which goes between Moonee Ponds and Footscray, gets about 1.5 million journeys per annum.[104]

In other words, the SRL is not laid along a route whereupon demand would arise naturally. For its viability, the SRL depends entirely on the government's ability to engineer demand by attracting people and businesses to the station precincts. This makes the scheme a much riskier venture than railways which are laid in accordance with the natural fractal growth patterns of cities.[105]

3.5 Misleading Comparison With Melbourne City Loop

The *Business and Investment Case* makes numerous references to the Melbourne City Loop project.[106] It implies that taxpayers should not be too troubled by projects with weak appraisals because the Melbourne City Loop in its day would have had a benefit-cost ratio of no

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[101] Transport for London (2021) *Statistics on Journeys By Type*, <www.tfl.gov.co.uk>.

[102] Rail Futures Institute, *op. cit.*, p. 125.

[103] Daniel Bowen (2020) *Australia's Top Tram Routes* <https://www.danielbowen.com/2020/03/02/top-tram-routes/>.

[104] *Ibid.*

[105] See Michael Batty and Paul Longley (1994), *op. cit*.

[106] See e.g. Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*, pp. 58-59.

more than 0.6.[107] It is not self-evident, however, that the Melbourne City Loop was or is really that great. It took from 1971 to 1985 to build and its cost escalated from the £35 million initially estimated in 1965 to $500 million in 1985 - a lot of money back then.[108] It only delivered three new underground stations and added only a few kilometres of track to the network. According to many, its cost deprived the network of other improvements for a generation - including rail lines to places such as Monash University, La Trobe University, Doncaster and VFL Park. In hindsight, it might have been a better engineering solution to have spread the coverage of the lines over a wider area and coupled some line groups in an end-to-end configuration. The project probably should have eliminated the unattractive elevated viaduct between Flinders Street and Spencer Street by putting rail lines in that section underground. But instead it doubled down, duplicating the ugly pre-existing viaduct. Passengers find it frustrating and time-wasting to travel in a direction at first that is opposite to their intended direction of travel. No other world city has since sought to emulate the arrangement of terminating lines in loops stacked underground in a double-decker formation at the city's core. That type of configuration has generally become discredited as an engineering solution in favour of end-to-end lines.

3.6 Misleading Treatment of 'Polycentrism'

One of the tenets of *Plan Melbourne* embraced by the SRLA is that, in being heavily centralized around the CBD, Melbourne is highly 'monocentric'. To continue solid economic growth, however, the argument goes, the city ought to develop satellites to become more 'polycentric'. In support of polycentricity, the *Strategic Assessment* cites three cities: London, Singapore, and Manhattan.[109] It further cites the Canary Wharf district of London and the North York district of Toronto as examples of satellites in cities that it claims have 'developed polycentrism'.[110]

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[107] *Ibid*.

[108] Marion Terrill (2017) *What Price Value Capture?* Grattan Institute Report No. 2017-05, p. 14.

[109] London, Singapore and Manhattan respectively have population densities of 6,400km^{-2}, 11,000km^{-2} and 40,000km^{-2} compared to Melbourne's mere 1,873km^{-2}!

[110] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*, p. 53.

These examples are misleading, bizarre and clueless. Singapore is an extremely densely populated island, city, and nation, with no hinterland, and the same government responsible for everything from UN representation to garbage disposal. Its urban environment is hardly comparable to that of Melbourne in any way. Ninety percent of the land there is government-owned. Due to exorbitant fees and taxes that get added to the price, the cheapest compact cars in Singapore cost more than $A150,000.[111] Manhattan is not a city so much as the central borough of a vast metropolitan area that includes three large islands in addition to the mainland, and also spans three states. In the case of Manhattan, the *Strategic Assessment* is probably referring to the separation between the Downtown and Midtown business districts. That separation is about 3km, about as far as Fisherman's Bend is from the Melbourne CBD. In the case of London, Canary Wharf is 4km away from the City of London, about as far as Prahran. In the case of Toronto, North York is 5km away from central Toronto, about as far as St Kilda. Despite pertaining to bigger and denser cities, the cited cases do not generally support the proposition that the polycentric satellites should be as far away or far apart as the stations of the SRL - that is to say, as far as 16 kilometres to 20 kilometres from the CBD, especially for a city like Melbourne whose growth is not particularly constrained by its geography.[112]

The most proximate example of a big city with polycentric satellites further away than a few kilometres from its CBD is Sydney. Chatswood and Parramatta, for example, are both about 20km away from the CBD. North Sydney, Macquarie Park and North Ryde also qualify as satellites. As it is bounded by national parks, mountains and waterways, Sydney's growth, however, is exceptionally constrained by its geography. Much of Sydney's CBD is bounded on three sides by water, and forms part of a central zone that is itself bounded on three sides by water: the Sydney CBD is more or less a peninsula off a peninsula. If Sydney is to continue to grow impressively in future decades, much of its growth must be achieved in places that are distant and disagglomerated away from its CBD: it has little choice.

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[111]<valuechampion.sg/costs-car-ownership-singapore>.

[112] On the other hand, Parramatta and Chatswood are about 20km away from the Sydney CBD. But that is hardly a relevant comparison as Sydney is so constrained by its geography. The *La Défense* commercial district of Paris is also about 20km away from central Paris. The latter is so because of the desire to keep the historic core of Paris intact for heritage reasons.

For cities like Melbourne that are not so constrained by unusual geographies, however, the case studies support the proposition that polycentric satellites should be sited closer to the CBD so as not to surrender *too* much agglomerative advantage, or throw the agglomeration baby out with the congestion bathwater. The benefits of agglomeration are, after all, why cities exist in the first place. Unlike the satellites promoted by other state government agencies (e.g. the 'priority precincts' of Docklands, North Melbourne and Fisherman's Bend) the relatively distant proposed satellites of the SRL therefore are not only not buttressed by the government's cherry-picked case studies, but also they also raise concerns that by embracing the SRLA's vision of polycentricity Melbourne may be sacrificing an advantage that it enjoys over its main competitor city of Sydney, namely, its ability to agglomerate a greater urban critical mass closer to its core because of its relatively unconstrained geography.

3.7 Fails to Respect The Fractal Geometry of City Growth

Is the government's simplistic and dualistic polycentrism-is-good/ monocentrism-is-bad assumption even the right one? Canberra's polycentric satellites, such as Belconnen, Woden and Tuggeranong, are hardly considered by Canberrans to be planning success stories. There is probably no more monocentric city in the western world than New York City and no more polycentric city than Los Angeles. Yet these two cities, despite not having the status of national or even state capitals, are in the top three in the world as measured by gross metropolitan product.[113] It is not obvious that the Victorian Planning Authority's and the SRLA's views about good urban form and how cities should grow really hit the nail on the head.

The growth of cities and towns has been subject to much study over many decades. Cities do not grow in a random or arbitrary fashion, or as stipulated by government. This notion was pioneered by Third Reich-era German geographer Walter Christaller in the 1930s.[114] Christaller developed a 'theory of place' about how cities and towns

[113] IHS Global Insight </ /https:ihsmarkit.com>.

[114] Paul Krugman (1996) 'Confronting the Mystery of Urban Hierarchy', *Journal of the Japanese and International Economies*, 10, 399-418, p. 405.

evolve with a natural geometry and a hierarchical order of settlement.

Since then it has been confirmed that city and town growth follows profound mathematical principles. City size, for instance, is invariably distributed by a power law with an index that proves to be the same regardless of decade or country. Nobel laureate Paul Krugman has described this principle as 'one of the most overwhelming empirical regularities in economics'.[115]

The development of chaos theory in the 1980s gave rise to fractal geometry.[116] Since then, it has generally been understood that the growth of cities and the networks of transport arteries that serve them invariably follows a fractal pattern, like a tree in plan view, and that cities exhibit fractal properties such as scalability and self-similarity.[117] Such properties, according to Krugman, arise from the 'self-organizing' nature of cities, which in turn are spawned by the self-organizing nature of the economies that they serve.[118]

Moreover, when governments of an interventionist disposition have sought to dictate how cities should grow or have sought to induce demand without respect for natural fractal geometry, they have generally failed. The Whitlam government in the 1970s aimed to develop Albury-Wodonga into a very large city as a relief valve for growth in Melbourne and Sydney. South Australian Premier Don Dunstan sought likewise for his state in the form of the Monarto precinct. Both failed. The only demographic relief valve that Monarto could ultimately provide was demographic relief for giraffes, cheetahs, hyenas and the like: the place is now an open plains zoo.[119]

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[115] Paul Krugman, *op. cit.*, p. 417.

[116] Benoit Mandelbrot (1982) *The Fractal Geomitetry of Nature*, WH Freeman & Co, New York.

[117] *Ibid.*

[118] Paul Krugman, *op. cit.*

[119] The most extreme example of megaproject overcapitalization, however, is to be found in Bucharest, Romania, with the 'Palace of Parliament' building and associated redevelopment scheme in surrounding neighourhoods. This was orchestrated by a deranged socialist dictator, Nicolae Ceauşescu, in the 1980s.

3.8 Flawed Route Appraisal

Much like grafting a thick branch unconnected with its trunk along the extremities of a tree, the proposed route alignment of the SRL goes against natural fractal geometry. This fact in and of itself makes the SRL a much riskier venture than rail projects that seek to respond to or stimulate city growth in accordance with natural patterns, such as Sydney Metro and London Crossrail.

In the *Strategic Assessment*, three alternative rail routes arcing around the metropolitan area were discussed as options, from which one option was then chosen. The alternatives presented were as follows:[120]

- An 'inner' route at a radius of approximately 10km from the CBD. This route included Caulfield, Camberwell, Kew, Coburg, Essendon and Footscray.

- A 'middle' route at a radius of roughly 20km from the CBD. This route was the chosen option. It includes Cheltenham, Clayton, Burwood, Box Hill, La Trobe, Broadmeadows, Tullamarine, Sunshine and Werribee.

- An 'outer' route at a radius of roughly 30km from the CBD. This route included Frankston, Dandenong, Ringwood, Epping, Tullamarine and the outer west.

Plan Melbourne defines various types of precincts within Melbourne's urban geography. These include 'major activity centres' (MACs), 'national employment and innovation centres' (NEICs), 'health precincts', 'education precincts' and 'priority precincts'. To make its choice, the *Strategic Assessment* considered the numbers of precincts formally defined in *Plan Melbourne*, raw job numbers and raw population numbers within each ring region. It also assessed how the precincts within each ring region might be linked together. Its conclusion was that the middle ring had the strongest demand and most potential benefits, as that region contained the most jobs and precincts that could be linked. This was in essence using an impression-

[120] Suburban Rail Loop Authority (2018) *Suburban Rail Loop Strategic Assessment*, pp. 6-9.

istic proxy for benefits as the decision-making criterion. As was stated:[121]

> 'The middle corridor was identified as it provides the greatest opportunity to link NEICs and other major health, education and employment precincts. It also provides an efficient and integrated transport route which better connects all Victorians.'

The *Strategic Assessment* did not consider population density or job density in its evaluation, even though the three alternative regions are arbitrarily defined and have very different areas. The conventional metric to gauge travel demand is 'activity density', defined as the sum of job density and population density, and usually expressed on a per hectare basis. Activity density is a particularly helpful metric because it is a proxy for both patronage, which forms the basis of calculations of conventional economic benefits, and 'effective' job density, the basis of calculations of agglomeration benefits and wider economic benefits.

Nor did the *Strategic Assessment* take into account the extremely obvious fact that longer railways are more expensive than shorter railways. For circles or arcs, length is of course proportionate to radius.[122] So a railway that encircles a city at a radius of 5km should cost much less than a railway that encircles a city at a radius of 10km. As the three arcs that the *Strategic Assessment* compared had very different radii, they also had very different costs solely for reasons of basic geometry. But not even this was taken into account.

Furthermore, given the inner city's much greater activity density and much greater concentration of *Plan Melbourne* precincts (see below), it is not clear why an inner circle route at a radius of approximately 3km-5km from the CBD was not also appraised.[123] Even *with* the SRL, the government's own modelling shows that by 2036 it is the inner city precincts of North Melbourne and Fisherman's Bend that will have the greatest activity density outside the CBD.[124]

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[121] *Ibid*., p. 22.

[122] As per elementary geometry, circumference = 2πr.

[123] This issue is addressed in Appendix 2.

[124] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*, p. 200.

Leaving aside ergodicity considerations, it is also a well-established principle that the economically correct choice among competing project alternatives is the option that maximises net present value (NPV).[125] NPV equates to the discounted aggregate of 'net benefits' (that is, benefits less costs). Contrary to naïve intuition, the optimal choice is neither the alternative with the highest benefit-cost ratio (BCR), nor the option which produces the most benefits. The metric to be maximized, in other words, is the discounted sum of B-C, not B or B/C.[126] As Jenkins, Kuo and Harberger emphasize:[127]

> 'The net present value (NPV) of a project criterion is widely accepted by accountants, financial analysts, and economists as the one that yields the correct project choices in all circumstances. …'
>
> 'Among a set of mutually exclusive projects, the one with the highest net present value (NPV) should be chosen'

By making its selection criterion a subjective impression of benefits, without any regard for cost, or as if all route alternatives carried the same cost even though they had different lengths, the *Strategic Assessment* violated the principle that net present value ought to determine project choice. This was shockingly incompetent.

3.9 Rationale For Choice Of TBM-Bored Tunnels Does Not Stack Up

As noted at section 1.4, the government's rationale for choosing TBM-bored tunnels for the SRL ahead of elevated or at-grade alternatives (at a cost of at least $20 billon) is to 'minimise impacts'. By any measure, however, the 'impacts' associated with redeveloping and densifying land areas equivalent to more than 70 CBDs and across twelve precincts will be enormous. The 'impacts' associated with corridor construction, on the other hand, will pale by comparison. Accordingly, this justification does not make a whole lot of sense.

Furthermore, one of the great things about major projects is that they can be made 'Kaldor-Hicks efficient'. This is a state of affairs in which there may be *prima facie* winners and losers but there are no

[125] Glenn Jenkins, Chun-Yan Kuo and Arnold Harberger (2011) *Cost-Benefit Analysis for Investment Decisions*, manuscript, §4.1, §5.1.

[126] Where B = benefits and C = costs.

[127] Jenkins *et al*, *loc. cit*.

ultimate losers, at least in theory. On Kaldor-Hicks efficient projects stakeholders who are *prima facie* worse off are compensated so that they are not *ultimately* worse off.

3.10 Non-Existent Mode And Grade Options Appraisal

Aside from route, choices as to mode and grade also have to be made to design a transportation network. A large number of mode and grade choices were or are available to fulfil the design aims of the SRL. This is especially so because the route chosen coincides with suburbs that have been planned to accommodate motor vehicles from their inception. The suburbs are thus bisected by wide surface road corridors in a grid configuration. In the vicinity of most SRL precincts the main surface roads have at least four lanes and large nature strips and median strips.[128] Unlike the municipalities that are to or do play host to Sydney Metro, London Crossrail and Grand Paris Express stations, these suburbs do not suffer from a shortage of corridor space at grade.

Although the *Strategic Assessment* does canvass some route alternatives as mentioned above[129], it contains no discussion whatsoever of mode alternatives.[130]

Are the choices as to mode and grade that the government makes reasonable and optimal in the circumstances?

Capacity is an important metric to take into account when considering alternative modes. Conventional wisdom has it that when operating at peak capacity, a freeway lane or road lane can carry a maximum of about 2,500 people per hour in one direction.[131] Melbourne street 'trams' can typically carry about 5,000 people per hour in one direction; on Swanston Street that capacity is more like about 10,000 people per hour. Buses without dedicated way can move about 6,000 to 8,000 people per hour. Articulated light rail trams with dedicated

[128] See Appendix 1.

[129] See section 3.8.

[130] The mode choice may have well been underpinned by an unstated rationalisation that a TBM-bored tunnel is the way to go as it was used for the designs of Sydney Metro, Melbourne Metro Rail, Paris Grand Express and London Crossrail.

[131] Rail Futures Institute, *op. cit.*, pp. 44-45.

way can transport as many as about 15,000 people per hour.[132] The equivalent figure for a rail line is about 35,000 to 40,000 people per hour. Rail transportation, despite its expensiveness, is for this reason important in densely populated inner cities.

Geological conditions are also important to consider. Unfortunately Melbourne's geological strata do not lend themselves well to tunnelling. Melbourne has extremely hard basalt (known as 'bluestone') predominating in the western suburbs and in the western portion of the CBD. In the northern suburbs Silurian mudstone predominates. The mudstone is structurally weak, highly variegated, and full of faults. Around South Melbourne and the Yarra estuary, the strata known as Coode Island Silt and Fisherman's Bend Silt are to be found. These silts are also very weak structurally and sometimes contaminated. Large buildings in South Melbourne and Port Melbourne require deep and expensive foundations as a result. In the southeastern suburbs and eastern suburbs where the first stages of the SRL are to be constructed, the soil is very sandy (it is, after all, a region known as the 'sandbelt'). None of these strata are favourable to TBMs, and tunnelling progress in Melbourne is thus slower and more expensive than elsewhere.[133]

Twelve potential mode/grade alternatives, in order from cheapest to most expensive, are listed and described below. Option 10 was the option actually chosen for the project. Costs and benefits associated with these twelve choices are also roughly estimated at Table 2 and discussed at section 7.5.

3.10.1 Option 1: A Fleet Of Free Shuttle Buses Between Precincts

A fleet of free shuttle buses plying the surface roads between the precincts is one solution to address the stated aims of the SRL. 'Shuttle' in this case entails limited stops so as to provide a service that is much faster than existing bus services (including the orbital 'SmartBus' routes), and has its own

[132] On-street parking, on the other hand, gives a corridor capacity of precisely zero people per hour.

[133] Parenthetically, Sydney, London and Paris, by contrast, have geological strata that are highly favourable to tunnelling. In Sydney, sandstone predominates. In London and Paris, firm clay predominates.

stops.[134] According to Bus Australia, a public transport bus in Australia typically costs in the order of $1,000 per vehicle per day to maintain.[135] That sum is inclusive of all sundry expenses such as fuel costs, maintenance downtime, driver wages, insurance, cleaning costs and so on.[136] Although buses are inferior to trains on criteria such as speed and ride quality, they are orders of magnitude cheaper to run. They are cheap as chips. Making buses free maximizes their impact in terms of decongestion. Central Perth has free buses circulating on three circular routes. Even allowing for infrastructure requirements such as bus stops, the money earmarked for the SRL could probably fund a huge fleet of 100 free buses plying the route for the remainder of the millennium - until the year 3000 or thereabouts!

3.10.2 Option 2: Shuttle Buses With Dedicated Way

This option is as per (1) but with dedicated bus lanes, sometimes known as 'bus rapid transit' or BRT. Buses without dedicated way can generally move about 6,000 - 8,000 persons per hour. Buses with dedicated way can move almost double that number. On some surface roads, which run along alignments similar to the SRL, there already are dedicated bus lanes.[137] On other roads, bus lanes could be added without reducing the number of lanes available. On some, the number of road lanes available to private vehicles would need to be reduced. Contrary to popular intuition, because the corridor capacity of BRT lanes is superior to that of car lanes, such an arrangement would likely reduce rather than increase congestion.

3.10.3 Option 3: Trackless Trams At Grade, Existing Corridors

Trackless trams are a relatively new and very promising technology. They are used in some Chinese cities. Their pas-

[134] There are existing orbital bus routes traversing paths not dissimilar to that of the SRL: 902 and 903.

[135] *Discussion Board*, Bus Australia <www.busaustralia.com>.

[136] *Ibid.*

[137] See Appendix 1.

sage is guided by computer rather than rail tracks. This gives the vehicles a ride quality and smooth kinematic envelope similar to that of conventional trams. Roads on which trackless trams run are likely to require structural reinforcement, but overall infrastructure construction and maintenance requirements and expenses would be much less than those of trams that run on tracks.

3.10.4 Option 4: Trackless Trams At Grade, Existing Corridors, Priority Signalling

This option is as per (3) but with traffic lights and intersection signalling adjusted so that the trackless trams have priority and do not have to spend as much time waiting at intersections. But reprogramming the traffic light system in this manner would be no mean feat, and is easier said than done.

3.10.5 Option 5: Fast Light Rail, Existing Corridors, Priority Signalling

This option is as per (4) but with articulated light rail trams running with dedicated way at grade.

3.10.6 Option 6: Fast Light Rail, Existing Corridors, Priority Signalling, Some Grade Separation

This option is as per (5) but with some grade separation projects to ensure that the articulated light rail trams do not have to wait so much at intersections.

3.10.7 Option 7: Driverless Elevated Light Rail, Existing Corridors

There is no reason whatsoever why a rail route could not be developed through the SRL precincts on elevated viaducts. Wide surface roads provide plenty of corridor space to work with. Rubber wheeled vehicles and other noise attenuation technologies can ensure that noise impacts are no greater than that of automotive traffic.[138] Elevated rail has proven popular as an engineering solution for the Level Crossing Removals Program. The relevant corridors could hardly be

[138] See e.g. Vancouver 'Skytrain', Vancouver, Canada.

said to have too great a heritage or amenity value to sustain the intrusion of viaducts: Springvale and Clayton Roads are not exactly the Champs d'Elysées. The complete grade separation provided by viaducts would enable driverless technologies to be adopted, which increases capital costs but reduces operating costs. This option combined with the subsequent two options is similar to or the same as the mixed 'medium capacity transit' (MCT) option which the Rail Futures Institute recommends for these middle suburbs.[139] According to the Rail Futures Institute, the construction cost per kilometre of this type of option is only about 20% of the cost of the SRLA's chosen option, No 10.[140]

3.10.8 Option 8: Driverless Elevated Light Metro, Existing Corridors

This option is as per (7) but in a 'light metro' format, such as a four car metro train set, as distinct from a 'light rail' format such as a tram in three articulated sections. That means more capacity and faster speeds, but also longer station platforms and more expensive infrastructure. This option is also consistent with 'medium capacity transit' (MCT) recommendation of the Rail Futures Institute.[141] Elevated viaducts (however well designed) may deliver a slightly inferior outcome from the standpoint of urban amenity than tunnelled alternatives. But there is no reason why a viaduct solution could not coexist with most if not all of the precinct design initiatives that are planned for the TBM-bored solution. Noise impacts can be attenuated with the use of rubber-tyred rolling stock, as with Vancouver and some lines of the Paris Metro.

3.10.9 Option 9: Driverless Light Metro, Cut and Cover, Existing Corridors

Cut-and-cover tunnels, although far from cheap, are usually a much less expensive option for tunnelling than boring with tunnel boring machines (TBMs). Cut-and-cover is a tunnelling method that may be deployed where a tunnel is not too

[139] Rail Futures Institute, *loc. cit*.
[140] Clifford F. Bonnett (2nd edn, 2005) *Practical Rail Engineering*, Imperial College Press, London UK.
[141] *Ibid*.

deep and is to be aligned along an existing surface corridor. On the downside, cut-and-cover tunnels cause much more disruption on the surface during construction than bored tunnels. Melbourne's Domain Tunnel (not to be confused with the Burnley Tunnel) from the Melbourne City Link project is an example of a cut-and-cover tunnel. Many urban underground rail lines around the world have also been constructed in cut-and-cover tunnels. For this option to be feasible, the SRL lines would need to align with north-south and east-west road orientations, rather than zig-zagging around diagonally. This would make them longer. Because cut-and-cover tunnelling is not subject to the high upfront overheads of procuring a TBM, work fronts on cut-and-cover jobs can be duplicated more feasibly than on TBM jobs. This means that progress can be accelerated and the tunnelling can be completed more quickly if need be.

3.10.10 Option 10: Smaller Bore Driverless TBM Tunnelled Light Metro

This is the option that the SRLA is committed to. Tunnel boring machines are awesome pieces of machinery, with a level of sophistication somewhat akin to that of submarines. But generally speaking, tunnelling with TBMs is a phenomenally expensive enterprise. Very roughly, the cost is in the order of a few hundred million dollars per TBM, a few hundred million dollars per station, and a couple of hundred million dollars per bored kilometre. There are also considerable time-related overheads (or costs that accrue in proportion to project duration). Tunnelling progress is generally very slow: it is literally slower than a snail's pace. TBMs in London, Sydney and Paris often bore more than 20m in a day. In Melbourne's unfavourable geological conditions, by contrast, no more than about 12m-15m progress per day on average can be expected. The high upfront costs for each TBM, moreover, mean that accelerating progress by doubling the number of TBMs so that work on multiple tunnel sections can proceed in parallel is seldom feasible. Each underground station is also a major project and an engineering challenge in itself: building a vast watertight cavern under the ground that is easily accessible is no mean feat. The Rail Futures Institute claims that the per kilometre cost of this option is about five

times as great as those modes it describes as 'medium capacity transit' (MCT).[142]

3.10.11 Option 11: Smaller Bore Driverless TBM Tunnelled Metro

The chosen option (No 10) is a 'light metro' with four-car sets. The bore of the tunnel is also narrow. Seats are for the most part laid in two rows separated by the longitudinal aisle. The rows of seats are along the sidewalls and windows of cars such that seated passengers face one another across the aisle, perpendicular to the direction of travel.[143] The motion of the trains will make seated passengers sway from side to side rather than back and forth. This is similar to the Victoria Line on the London Underground, and other smaller bored tube lines on that network. The standard load for each train set is 820 passengers, with 118 seated. The crush load is 1136 passengers. There will only be seating for 14% of passengers under standard loading conditions and for 10% of passengers under crush load conditions. In other words, it will be fairly uncomfortable and a bit claustrophobic: it's not exactly the Orient Express. This option is as per (10) but extends the size of the train sets to six. This means that the system qualifies as a 'metro' rather than a light 'metro'. That means more capacity, but also more expensive stations, as the stations have to have wider platforms.

3.10.12 Option 12: Full Bore Driverless TBM Tunnelled Metro

This option is as per (11) but with a wider bore so that more passengers are seated.

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[142] Rail Futures Institute, *loc. cit.*

[143] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*: Appendix A: *SRL Stage 1 Rail Tunnel Alignment*.

No	Description	Costs and Benefits										Benefits ($ billions)	Costs ($ billions)	Net Benefits ($ billions)	Absolute Benefit Cost Ratio (ABCR)	Incremental Benefit Cost Ratio (IBCR)
		Public Transport User Benefits	Road User Benefits	Non-User Benefits	Option and Non-Use Value	Residual Value of Assets	Wider Economic Benefits	Urban Consolidation Benefits	Capital Cost	Recurrent Cost	Farebox Revenue					
0	Origin											0.0	0.0	0.0		
1	Free Shuttle Buses	4.8	2.0	1.1	0.3	0.0	2.5	0.8	0.7	0.8	0.0	11.5	0.3	11.2	0.03	38.33
2	Free Shuttle Buses with Dedicated Way	6.0	3.5	1.4	0.35	0.1	3.0	1.0	2.0	1.4	0.0	15.35	0.85	14.5	0.06	7.00
3	Trackless Trams At Grade, Existing Corridors	7.0	4.5	1.65	0.45	0.3	5.5	1.6	4.5	2.2	-1.5	21.0	2.0	19	0.10	4.91
4	Trackless Trams At Grade, Existing Corridors, Priority Signalling	7.5	5.2	1.7	0.5	0.4	6.0	2.2	5.1	2.8	-1.7	23.5	3.4	20.1	0.14	1.79
5	Fast Light Rail, Existing Corridors, Priority Signalling	8.0	7.5	1.8	0.65	0.5	6.7	2.6	7.2	3.6	-1.8	27.75	5.4	22.35	0.19	2.13
6	Fast Light Rail, Existing Corridors, Priority Signalling, Some Grade Separation	9.0	8.2	2.0	0.8	0.8	7.2	3.0	10.0	4.0	-2.0	31.0	8.0	23	0.26	1.25
7	Driverless Elevated Light Rail, Existing Corridors	12.6	9.0	2.3	0.9	2.5	7.8	3.4	17.0	5.8	-3.4	38.5	13.6	24.9	0.35	1.34
8	Driverless Elevated Light Metro, Existing Corridors	14.0	9.5	2.8	0.94	3.0	8.4	3.6	21.0	7.4	-3.7	42.24	17.3	24.94	0.41	1.01
9	Driverless Light Metro, Cut & Cover, Existing Corridors	15.8	10.0	3.2	0.95	3.5	9.0	3.8	29.0	7.9	-3.8	46.25	25.2	21.05	0.54	0.51
10	Smaller Bore Driverless TBM Tunnelled Light Metro	17.4	11.0	3.5	1.1	3.8	9.5	3.9	46.5	8.0	-4.0	50.2	42.5	7.7	0.85	0.23
11	Smaller Bore Driverless TBM Tunnelled Metro	19.0	12.0	3.7	1.2	4.3	10.0	4.2	62.0	8.2	-4.2	54.4	57.8	-3.4	1.06	0.27
12	Larger Bore Driverless TBM Tunnelled Metro	20.5	12.5	3.8	1.3	4.5	10.5	4.3	75.0	8.4	-4.3	57.4	70.7	-13.3	1.23	0.23

Table 2 – 'Guesstimates' of Costs and Benefits for Twelve Engineering Alternatives

Rough but comparable estimates of benefits, costs and calculations of net benefits and benefit-cost ratios for each of these twelve options are shown at Table 2. The figures in Table 2 are derived to some extent by extrapolating and interpolating from the cost and benefits calculation for the chosen option, No 10. They also to some extent draw on cost information provided by the Rail Futures Institute.[144] They are crude 'guesstimates'. They do not take into account demand dampening effects arising from value capture taxes.[145] The estimates in Table 2 might perhaps be described as a 'super rapid cost-benefit analysis' (or 'super rapid CBA').

3.11 Failure to Consider Viability Of Inner Circle Line Option

The economics of underground rail projects are at their best in areas of high population density and activity density. For this reason, it is worth putting on the table as an option for consideration a proposal for an underground line that circles around inner Melbourne at a distance of 3k to 5km from the centre of the CBD. An outline of one such suggestion, the 'Melbourne Inner Rail Loop' (MIRL) is shown at Appendix 2. MIRL in inner Melbourne can complement a cheaper, non-TBM version of the SRL such as that discussed in option (8) above.

3.12 Failure to Consider Viability Of A Super-Loop Option

Another alternative that ought to be up for consideration is a 'super-loop'. A sketch is outlined at Appendix 3. Such a line would combine together several rail projects into a single driverless broad gauge metro loop. This would resemble Sydney Metro in some ways.

3.13 Insufficient Recognition Of Risks Associated With Melbourne Metro 2

'Melbourne Metro Rail' (MMR) is currently under construction. Its underground section is a TBM-bored tunnel that runs southbound from North Melbourne and Parkville, through extensions of City

[144] Rail Futures Institute, *op. cit.*, pp. 113-129.

[145] See section 8.4.

Loop stations, and then south to the King's Domain area on St Kilda Road, then through to Caulfield.

After MMR is complete, the government plans to proceed with another TBM-bored underground rail tunnel project: Melbourne Metro Rail 2 (MMR2). The tunnelled section of MMR2 is to run from Newport in the inner western suburbs, underneath the Yarra estuary and then onto the Fisherman's Bend precinct. Then it will run underneath the Yarra again to Southern Cross Station. It will then bend northeast to intersect with Flagstaff Station on the City Loop, and then onto Fitzroy and Clifton Hill.

There appears to be a general consensus among experts that MMR2 is necessary for Melbourne's economic growth. It will enable the economically important Fisherman's Bend precinct to blossom and flourish. The SRL *Business and Investment Case* is predicated on the proposition that MMR2 will indeed proceed. Infrastructure Victoria includes MMR2 within its pipeline.

There is no reason to doubt that these assessments of the MMR2's importance are correct.

It is prudent, however, to note that there is a *very* high level of technical risk associated with MMR2, and that this high level of risk comes with a corresponding financial burden that the State of Victoria may have to shoulder.

In particular, the TBMs for MMR2 will need to bore though very challenging geological strata. This includes very hard basalt (colloquially known as 'bluestone'), and weak silts around Fisherman's Bend that are potentially contaminated with the industrial waste of yesteryear. The TBMs will also need to maintain a positive pressure head so as to provide watertightness for two river crossings. Normally TBMs are designed either to cut through hard rock or to neutralize the pressure around weak or permeable soils and the water table, but not both. Hybrid TBMs that can handle both environments are a relatively new technology, and are especially expensive. These will need

to be manufactured and deployed for MMR2. Because of this, there is plenty of associated risk.[146]

Such circumstances will probably make tunnelling for MMR2 one of the most technically challenging TBM jobs ever attempted in the history of the world. There is a great deal that could potentially go wrong. If a TBM fails, resultant delays and salvage operations can end up adding a billion dollars or so to the bottom line.

Accordingly, the appetite that the state has for risk in relation to the SRL needs to be reconciled with the risks it is assuming in light of MMR2.

3.14 Conclusion

The conceptual design of the SRL is flawed. Alternative options for route, mode and grade were not assessed with due rigour. The *Strategic Assessment* is the document that was presented to the public before the 2018 election and which sets out conceptual design decisions. The document forms the basis of the government's claimed political mandate for proceeding with the project. It is misleading, deeply flawed and sophomoric. The public did not have much time to scrutinize it. Accordingly, the government's claim that it has an electoral mandate to proceed with the project lacks legitimacy.

[146] According to *Demographia* (if not the *Australian Bureau of Statistics*), Melbourne recently overtook Sydney to become Australia's most populous metropolis. See Demographia (2022) *World Urban Areas Report* <www.demographia.com>.

4. Demand Modelling

4.1 Model Inputs Appear Tainted by Optimism Bias and the 'Planning Fallacy'

As mentioned at section 1.5, the *Demand Modelling Report* reported that by 2056 the SRL would have a patronage of about 435,000 passenger journeys on weekdays.[147]

Where does the demand come from? An examination of the inputs into the VLUTI model helps answer this question. The forecasts of future residential capacity and job capacity of each precinct are entered into the model. These inputs are derived from 'SALUP', the 'small area and land use predictions' database prepared by the Victorian Planning Authority, a government agency.[148] VLUTI modelling then determines the extent to which that job capacity or job demand translates into actual increases in residences and job numbers, or the extent to which transport networks and land uses successfully allow that capacity to be filled. So whereas the job and housing capacities are exogenous variables that are input by users (via SALUP, as dictated by the Victorian Planning Authority), the actual numbers of jobs and residents are endogenous variables that are calculated by the model.[149]

As of 2018, SALUP shows 36,500 current jobs in the Monash precinct (excluding Clayton).[150] These jobs have developed since Monash University was founded and the surrounding area was converted from farmland to urban and suburban use from the late 1950s and early 1960s. The VLUTI base case (i.e. if SRL is not built) for 2056 is that there will be 75,000 jobs in the Monash precinct. The program case (i.e. if SRL is built) for 2056 is that there will be no fewer than 162,500 jobs in the Monash precinct.[151] As Figure 1 shows, when the overlapping Monash and Clayton precincts are taken in combination,

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[147] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case: Appendix C.1: Demand Modelling Report* (by KPMG), p. A90.

[148] *Ibid.*, pp. 26-29.

[149] *Ibid.*

[150] *Ibid.*, p. B36.

[151] *Ibid.*, pp. B36-B47.

the program case suggests that the SRL will enable nearly 100,000 more jobs in the area than for the base case.[152]

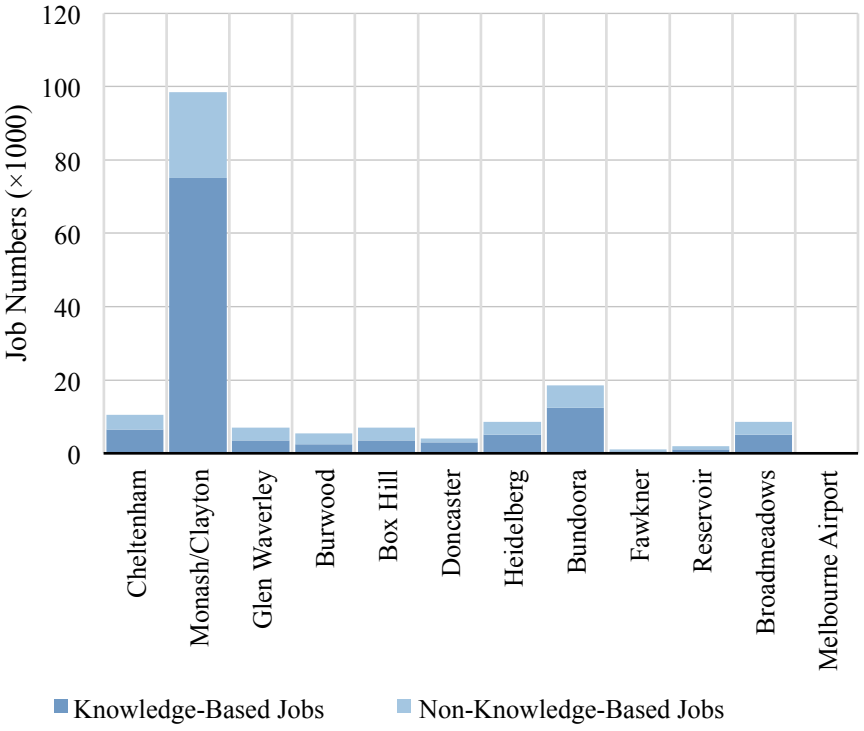

Figure 1 – Additional Jobs in 2056 for Program Case Relative to Base Case

This extraordinarily high capacity for new jobs within a 1.6 km radius of Monash station is an important component of the SRL's high forecast patronage levels and ultimately, its business case. No doubt the 162,500 workers in the Monash precinct in the program case, a large portion of whom might typically make two trips per person per working day, comprise a sizeable portion of the daily 435,000 passenger journeys and thus are major contributors to the economic benefits that arise therefrom and to the business case of the project itself.

As mentioned above, job capacity in Monash grew from zero to 36,500 in about 60 years, at a rate of about 600 jobs per year. How realistic is the Victorian Planning Authority's forecast that this will now grow from 36,500 to 162,500 jobs in the next 30 years, at a rate of about 3800 jobs per year?

[152] *Ibid.*, pp. 26-29.

Only the Victorian Planning Authority can answer this question fully. Nevertheless, like a struggling footy team's 'plan' to win the next premiership, this input has all the hallmarks of aspirations or target plans that are based on wishful thinking rather than an objectively grounded reference class forecast.[153] After all, as a tech hub, the Monash precinct is in stiff competition against the Fisherman's Bend precinct. Fisherman's Bend will play host to MMR2 stations and will be anchored by the engineering faculty of the University of Melbourne, the southern hemisphere's best university. It also faces burgeoning interstate competition, including the 'Silicon Hills' initiative in Sydney championed by scruffy start-up billionaires, Mike Cannon-Brooks and Scott Farquhar, and similar initiatives in Perth championed by Andrew 'Twiggy' Forrest. The outcomes of competitions in market economies are not predictable. It is exceedingly likely that this and other SALUP-derived inputs into the VLUTI model are tainted by optimism bias and the 'planning fallacy'. This would have an exaggerating effect in turn on the travel demand derived by VLUTI, the benefits associated with the project, its benefit-cost ratio, and ultimately, the strength of the SRL's whole business case.

4.2 Probability Spread of Job and Housing Capacity Forecasts Has Not Been Modelled

The SRL's business case is presented in the form of a Monte Carlo analysis, which purports to present results in the form of a spread of benefits and costs across the ensemble of future probabilities. But the job and housing capacities in each precinct have not been 'Monte Carlo-ized' or expressed as a probability spread. Only single point inputs are entered for job and housing capacities in each precinct. In effect, KPMG and the SRLA have the aforementioned figure of 162,500 jobs in the Monash precinct in 2056 down as the best-case scenario, the worst-case scenario, the most likely scenario, the expected value and the centrality estimate.

This is a mistake and produces a spread of probabilistic results for benefits that are much narrower than they should be.[154]

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[153] See Bent Flyvbjerg (2009) 'Survival of the Unfittest: Why the Worst Infrastructure Gets Built - and What We Can Do About It', *Oxford Review of Economic Policy* 25(3):344-67, pp. 353-358.

[154] This is discussed further at section 7.1.

4.3 Funnels People Off Footpaths and Bike Paths

Presumably, the most efficient way to cater for the high numbers of employees planned for the Monash/Clayton area would be to provide a corresponding quantity of high-density housing in the same precinct. Although commuting to work by public transport may be more sustainable than commuting to work by automobile, it is not more sustainable than walking or cycling to work. Taking people off the roads and putting them onto railways is a good thing, but taking people off footpaths or bike paths and funnelling them onto railways is not. But, as Figure 2 below shows, the dominance of the Monash/Clayton precinct when it comes to jobs is not matched by equivalent numbers of planned high-density housing. The plans mean that many Monash/Clayton workers will live in distant precincts, and then will then have to commute to work via the SRL. Their commute will entail: (1) walking to the station, (2) descending into the underground station, (3) waiting for the train, (4) travelling on the train, (5) ascending to ground level and (6) walking to work. If corresponding numbers of dwellings were provided in the Monash/Clayton precinct, an equivalent commute would entail only a single step: walking (or cycling, e-biking or e-scootering). They would not need the SRL to funnel them between their homes and their workplaces.

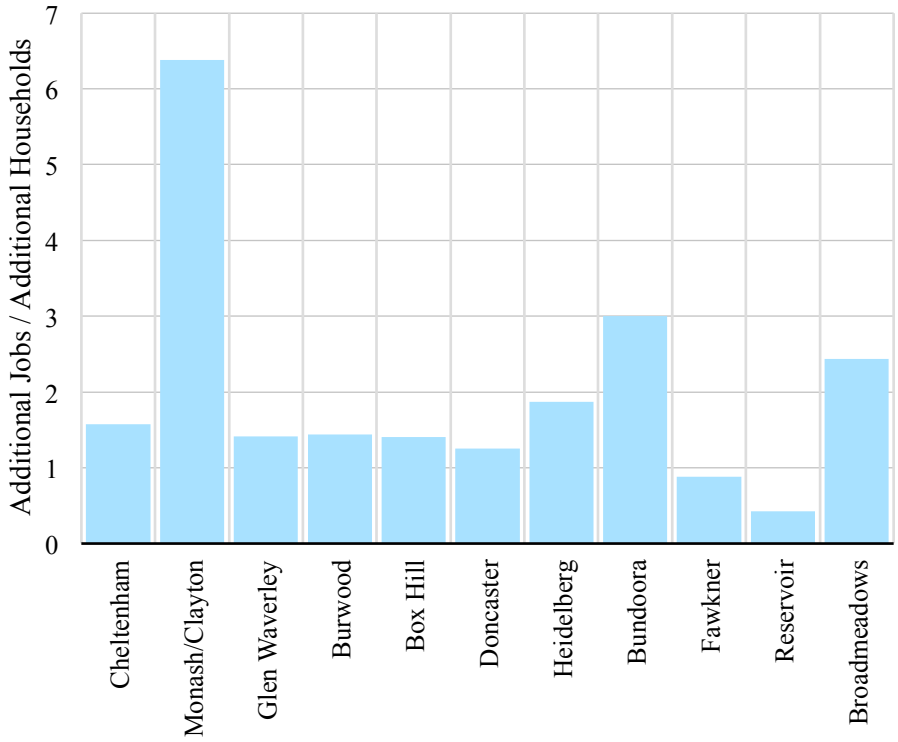

Figure 2 - Ratio of New Jobs to New Households by 2056 by Precinct

4.4 Separability Information Withheld

Delivery of SRL East is planned in a single stage. Delivery of SRL North is planned in two stages, from either side of Reservoir. What are the benefits and costs of these stages if they are taken on their own? What would be the economic result if future governments decided not to proceed with future stages? This information is not provided by the SRLA. It ought to be.

4.5 Modelled Car Ownership Levels Seem Optimistic

Car ownership levels strongly influence demand for public transport. The VLUTI models[155] require inputs about the levels of car owner-

[155] This is the 'Victorian Land Use and Transport Integrated' model (VLUTI), which includes two sub-models that interact with each other, the 'Victorian Integrated Transport Model' (VITM) and 'KPMG CityPlan'. See Infrastructure Victoria (2021) *Victorian Land Use and Transport Integration (VLUTI) Model Architecture Report: Overview of the Victorian Land Use & Transport Integration Model*.

ship in each precinct where such levels differ from those of the present day or base case scenario. KPMG derives its input assumptions for car ownership levels by an approach it describes as 'benchmarking' against comparable precincts as they exist today.

For instance, KPMG assumes that by 2036, residents of the 'inner' zone of Box Hill[156] will have the same car ownership levels as residents of South Yarra in the present day. By 2056, KPMG assumes that residents of the 'outer' zone of Box Hill will have the same car ownership levels as residents of South Yarra in the present day, and residents of the inner zone of Box Hill have the same car ownership levels as those of the Melbourne CBD in the present day.[157]

Current Melbourne CBD residents have very high parking fees with which to contend and extremely congested local roads. On the other hand, they enjoy free local public transport via the tram network. They live at the hub of extensive tram, train and bus networks that radiate out in every direction. They can hail taxis on demand from their local streets without any pre-booking. They have easy access to walk-up, pay-as-you-go car, e-bike and e-scooter rentals. They live within walking distance to world-class shopping, commercial, entertainment, leisure, sporting, cultural and arts precincts, as well as numerous parks and gardens. For many CBD residents, owning a car is more trouble than it is worth.

Even for a time as far away as 2056, the assumption that car ownership in Box Hill will decline to resemble car ownership patterns in the CBD today seems on the optimistic side.

Best practice would be to ensure this parameter is subjected to a sensitivity analysis.

[156] The 'inner' zone of a precinct is defined as the zone within a circle bounded by an 800m radius around the station (about 2 km^2). The 'outer' zone is defined as the zone bounded by the inner zone and a 1.6km radius around the station (about 6 km^2).

[157] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case: Appendix C.1: Demand Modelling Report* (by KPMG), pp. A61-A62.

4.6 Inadequate Scenario Modelling

We also believe that the following three scenarios ought to have been modelled within the multi-scenario analysis.

4.6.1 Smaller Personal Transportation Devices Scenario

Increases in the popularity and adoption of electronic and autonomous vehicles, along with corresponding increases in ride sharing, are among the scenarios modelled and reported in the *Demand Modelling Report*.[158] As technologies, particularly battery technology, develop and improve over the next few decades, there exists also the possibility of a surge in popularity of smaller personal transportation devices including: e-scooters, e-bikes, Segways, electric skateboards, ride-on drones, jetpacks, microlight aircraft and as yet uninvented electronic or electric personal transportation devices.[159] There could also be a surge in the popularity of traditional bicycles, mopeds or motorcycles. Such scenarios would reduce demand for SRL trips.

4.6.2 Working From Home Scenario

There is also a prospect that working from home ('WFHing') will become much more prevalent and widespread in Melbourne than it has been, and not only in times of pandemic. WFHing becomes more feasible as more online teleconferencing technology, along with the bandwith to support it, develops and becomes further trusted, entrenched and accepted in society. Such a development affects the business models of both workplaces and universities which anchor SRL precincts. University students and academics may well attend campus less frequently, or only sporadically. According to some observers, this is already happening: university campuses are not the lively places that they once were; they

[158] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case: Appendix C.1: Demand Modelling Report* (by KPMG), p. A122.

[159] The 'hoverboards' that featured in the movie *Back to the Future II*, filmed in 1989 and set in 2012, still have not materialised, unfortunately. *Star Trek*-style teleporters may be another millennium or so away.

are more like ghost towns. The same may also be said for many workers, particularly knowledge workers. The scenario will also reduce demand for SRL trips and create a risk of a benefits shortfall.

4.6.3 RAILWAYS BECOME TECHNOLOGICALLY OBSOLETE

Self-propelled trains with flanged steel wheels running on steel tracks have been in existence since the opening of the Manchester-Liverpool railway in 1830, nearly 200 years ago. Named after a venerable restaurant in Manhattan, the 'Lindy effect' is a default rule-of-thumb used by futurists to provide a best guess of how much longer a technology will endure: the default best guess is that a technology will remain around about as long as it has already been existence.[160] If the Lindy effect is anything to go by, railway technology may not become obsolete this century. On the other hand, the emergence of 'trackless' tram technology suggests that it could well become more economical within a few decades for the passage of public transport vehicles to be guided by computer rather than by rails. In any event, this is another scenario that ought to be carefully considered.

These three scenarios have not been included in the sensitivity analysis. They should be.

4.7 Retracted Base Case Exaggerates Impact of Program Case

A 'base case' is the default scenario against which the merits of a scheme are measured and judged. Derivation of a base case entails the application of a 'but for' test. It may be equated to the scenario that would be most likely to unfold *but for* the project. For relatively small projects that are constructed within a few years and whose value is measured in millions rather than billions, contemplating the world as it would exist without the project is usually a straightforward exercise: it is a simple question of with versus without. For

[160] Nassim Nicholas Taleb (2018) *Skin in the Game: Hidden Asymmetries of Daily Life*, Random House, New York, pp. 141-152.

such projects the base case is usually either a 'do-nothing' or 'do-minimum' scenario.

For multi-billion dollar megaprojects that take many years to complete and have knock-on effects which resonate throughout the economy for decades to come, on the other hand, establishing a reasonable base case is more complicated and controversial. It requires a great deal of knowledge, insight, experience, imagination and even speculation to derive a credible account of most likely *but for* scenario.

The scenario to be used as a baseline for such exercises is not necessarily always clear-cut. What really is the status quo? In this context, the 'base case' probably means allowing Melbourne's suburban development to continue at a steady pace, but with a more reactive, incremental and piecemeal approach to transport and urban planning.

In the circumstances, transit-oriented developments (TODs) around stations and associated densification and re-zoning initiatives would probably still be allowed to develop. Developments would be approved via the regular planning system, subject to ministerial call-in powers and VCAT appeals, along with the processes of local and state politics. Developers rather than government agencies would typically take the initiative when they submit development applications, instead of doing so as part of one huge centrally administered scheme.

The base case that the SRLA uses assumes that there will be *no* major transport projects and *no* new suburban development initiatives between now and 2056 except for those already within Infrastructure Victoria's pipeline as of now.

Before the SRL was in the pipeline, however, there was a general consensus about the need for new light rail lines around the Monash and Clayton areas.

The principles of good transport engineering and modern urban design are not the exclusive province of the SRLA. The SRLA did not invent the ideas of agglomeration, grade separation, driverless running, skyscrapers, catalyst projects, TODs, light metro, value capture or hedonic multipliers. All of the most modern concepts of good urban planning and transport design would be available in the base case scenario, just as they are available to the program case. The state

would have plenty of option and non-use value from *not* having to construct TBM-bored underground tunnels in sparsely populated suburbs. It is also probable the tram and light rail network would be extended in the base case scenario, particularly around the Monash area.

It thus appears the base case is unrealistically retracted. This retraction has caused the benefits associated with the program case to be overstated and exaggerated. Some of these issues are also addressed by the use of an incremental approach rather than a one-shot approach, as is discussed in section 7.5.

4.8 Conclusion

There are several issues that arise from demand modelling. The VLUTI demand model predicts that by 2056, the SRL will not only have a patronage of about 435,000 passenger journeys per weekday but will be the busiest line on the Melbourne rail network. This is an extraordinarily high number of journeys. It is about the same as the total number of journeys that occurred on workdays across the *entire* network in 2018. Ambitious forecasts made by the Victorian Planning Authority about 'job capacity' and 'housing capacity' numbers in each precinct, especially the Monash precinct, are no doubt a primary driver of this high demand. But it appears that these forecasts are questionable, and made in a climate of optimism bias. Mistakenly, these forecasts have not been modelled probabilistically. The configuration of housing capacity and workplace capacity in each precinct appears as though it may be suboptimal. Assumptions about car ownership levels entered into the models appear optimistic. Scenarios of improvements in technology are inadequately modelled in the sensitivity analysis. Finally, it appears that an unrealistically retracted scenario has been used for the base case which exaggerates the effects caused by the program case.

5. Costs

5.1 Business Case Fails to Provide Transparency About Costs

A business case for a project draws upon estimates and forecasts of benefits on the one hand and costs on the other. The economic strength of the project is then measured by comparing benefits to costs. To provide the level of scrutiny that is appropriate for a publicly funded infrastructure project, a comprehensive business case should provide detailed particulars and descriptions of models and methods used to derive results on *both* sides of the cost-benefit ledger. In this instance, however, while the *Business and Investment Case* does indeed detail the derivation of benefits, very little detail is provided about costs. 'Costs' in this context decomposes to construction costs, precinct costs, other types of capital costs, future operational costs and future maintenance costs. It also typically includes farebox revenue as a negative cost or cost offset.[161] The proportion of the cost that is offset by farebox revenue can be an important signifier of the financial strength or otherwise of the scheme.

Delay and schedule risk should also be addressed separately, as delay is an important factor in cost overruns.

Cost overruns are a widespread and nearly universal problem on major projects. Costs are subject to 'regression to the tail' and fall under the purview of 'fat-tailed risk theory'.[162] That makes them particularly unpredictable. The importance of not only getting cost estimates right but also quantifying and managing the risks of cost overruns (as well as delays) cannot be overstated.

So in that sense the *Business and Investment Case* may be considered only *half* a business case, because while it enables scrutiny of benefits, it does not enable proper scrutiny of the costs side of the ledger.

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[161] Mayor of London, Department of Transport, Cross London Rail Link and Transport for London (2010) *Crossrail Business Case: Summary Report*.

[162] Benefits can can have a fat tail as well, and blow out, although cost blowouts are much more common. The Sydney Opera House is an example of a project that experienced *both* fat-tailed cost blowouts *and* fat-tailed serendipitous benefit blowouts.

6. Benefits

6.1 Reliance on Wider Economic Benefits (WEBs)

Of non-conventional benefits discussed at section 1.5, 'wider economic benefits' (WEBs) are stated to be in the range $7.5 billion to $13.9 billion.[163]

According to *ATAP*, estimations of wider economic benefits need to be treated cautiously. *ATAP* advises:[164]

> '[T]here are serious measurement difficulties, with the availability of Australian-specific data needed to calculated WEBs currently being sub-optimal. So much so that Infrastructure Australia recommends that cost-benefit analysis results… be presented first without WEBs, and then with WEBs, treating WEBs effectively as a sensitivity test.
>
> It is recognised that the calculation of these wider benefits is still in its infancy, both in Australia and internationally. …
>
> Therefore, WEBs should be treated separately to the traditional CBA.'

They need to be taken with a pinch of salt, in other words. Rather than respecting this recommendation, the SRLA and KPMG have instead treated WEBs in like manner to conventional economic benefits (CEBs).

6.2 Reliance on Urban Consolidation Benefits (UCBs)

Across both timing options (Option A and Option B), the unorthodox category of 'urban consolidation benefits' is stated to provide benefits in the range $3.2 billion to $5.3 billion.[165]

All the caveats about reliance on wider economic benefits (WEBs) as stated above apply *a fortiori* to urban consolidation benefits (UCBs). UCBs have not been even been recognized as legitimate by *ATAP*

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[163] *Ibid*.

[164] Commonwealth of Australia (2021) *Australian Transport Assessment and Planning Guidelines*, Vol. 'T3: Wider Economic Benefits', <www.atap.gov.au>.

[165] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*: — Appendix C.2: *Economic Appraisal Report* (by KPMG), *loc. cit*.

and as such, are an even flakier type of benefits than WEBs. They need to be taken with an even bigger pinch of salt than WEBs.

6.3 Doctored Productivity Elasticities (WEB1)

The calculation of agglomeration benefits (which is the first type of wider economic benefit, designated 'WEB1') depends on several parameters, including the productivity gains that arise from agglomerating. Because different industries observe different rates of productivity gain in this regard, *ATAP* provides productivity elasticity parameters that vary on an industry-by-industry basis.

ANZSIC Industry Code	Industry Group	Productivity Elasticity Recommended by *ATAP* (2021)	Productivity Elasticity Used by KPMG
ABCD	Agriculture, forestry and fishing; Mining; Manufacturing; Electricity, gas, water and waste services.	0.021	0.025
EFGHIPQRS	Construction; Wholesale trade; Retail trade; Accommodation and food services; Transport, postal and warehousing; Education and training; Health care and social assistance; Arts and recreation services; Other services.	0.024	0.025
O	Public administration and safety.	0.024	**0.08**
JKLMN	Information media and telecommunications; Finance and insurance services; Rental, hiring and real estate services; Professional, scientific and technical services; Administrative and support services.	0.083	0.08

Table 3 – Comparison of Productivity Elasticities

As Table 3 shows, KPMG and the SRLA appear to have used either incorrect or obsolete *ATAP* figures. This is especially so in relation to 'public administration and safety' workers. It is not obvious why KPMG and the SRLA believe that such workers as police officers, council workers, parking inspectors and security guards would achieve the same rate of productivity improvement from clustering together as say, accountants with bankers, or solicitors with barristers.

6.4 Agglomeration Benefits Could Do With Further Exploration

ATAP's perfunctory model (albeit with doctored inputs) is intended primarily for projects a couple of orders of magnitude smaller than the SRL. For a project as large as the SRL, the agglomeration benefits could do with a bespoke exploration and analysis. Agglomeration is profoundly important to how any city's economy develops or is organized.[166] It is relevant to consider how agglomeration benefits would accrue in the SRL precincts and to compare them to how agglomeration benefits accrue in central Melbourne.

In this regard, several SRL precincts are dominated either by shopping centres or university campuses. (Cynics might be forgiven for thinking that the SRL had been designed by academics and shopping centre executives). But retail and educational workers are *not* among those who achieve particularly high degrees of productivity uplift as a result of agglomeration, according to most sources.[167]

It is well known that knowledge spillover between 'town' and 'gown' can be a potent driver of economic success. Silicon Valley, along with tech hubs such as Austin in Texas, Cambridge in Massachusetts and Cambridge in England bear this out.[168] As Edward Thorp put it:[169]

> 'Economists have found that one factor has explained a nation's future economic growth and prosperity more than any other: its output of scientists and engineers.'

'Tech hubs', however, do not arise as a result of government decree. Furthermore, there is not necessarily a compelling case for linking together the campuses of three different universities. Academics or students tend to patronize one university or another, not several at once. Monash stakeholders may be more likely to appreciate ag-

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[166] Dave Aron, 'The Future of Talent Is in Clusters', *Harvard Business Review* (1 Feb 2013); Paul Krugman, *op. cit.*; Florent Le Néchet, Daniel Graham & Patricia Melo (2012) *Transportation-Induced Agglomeration Effects and Productivity of Firms in MegaCity Region of Paris Basin*, Journal of the Transportation Research Board, 2307 Transportation Research Record 21-30.

[167] Le Néchet *et al*, *op. cit.*; Commonwealth of Australia (2021) *Australian Transport Assessment and Planning Guidelines* <www.atap.gov.au>: 'T3 – Wider Economic Benefits'.

[168] Dave Aron, *op. cit.*, p. 2.

[169] Edward Thorp (2017) *A Man For All Markets*, Random House, New York, p. 159.

glomeration via Melbourne Metro Rail with the Monash Caulfield campus, or the huge medical precinct and rival university at Parkville (the University of Melbourne), rather than clustering with Deakin Burwood or La Trobe.

Similar arguments may be made in relation to the four indoor shopping centres and the airport. Most big shopping centres offer nearly identical combinations of chain stores. Shoppers do not generally feel the need to visit more than one shopping centre per day. Most retail workers staff only one store at a time. Nor is the case for agglomerating shopping malls to the airport so clear-cut:

> 'Never mind this heavy luggage and jet-lag, what I could really use right now is a round of shopping at The Glen'.

Said no one, ever.

The businesses that have accumulated in the middle suburbs tend to be those from lower-agglomeration industries, for this very reason. If they benefit significantly from clustering with similar or complementary businesses, they would probably not have located in such suburbs in the first place; they would for the most part be located closer to the CBD. In other words: the current demand for agglomerating this chain of locations together should not be overstated.

The 'nighttime economy' (and to some extent, the 'lunchtime economy') is also worthy of consideration. It makes central Melbourne more attractive than comparable suburban locations. The nighttime economy includes pubs, restaurants, bars, cafes, sporting events, cinemas, theatres, casinos, brothels, and other forms of nightlife. On weeknights particularly it relies partly on induced demand: many workers will visit pubs and restaurants after work, or participate in other nocturnal pursuits if they are already proximate to them, but they will not necessarily make a special trip to access them on if they are not. This is a section of the economy is buttressed by tourism, major events, conference attendees and business visitors.

Trams, parks, gardens, attractive views and associations with AFL teams add further to the hedonic attractiveness and cultural magnetism of inner Melbourne for many. If the SRL precincts are to succeed in their competition with inner Melbourne's precincts, they will need to overcome all of these advantages somehow.

6.5 Use of Discredited Method to Calculate WEB2b

According to the *Business and Investment Case*, $1.0 billion to $2.9 billion worth of wider economic benefits accrue due to the movement of labour to more productive jobs as a result of the SRL. This line item is designated 'WEB2b' or 'WB2b' in the *ATAP Guidelines*. An earlier edition (2018) of *ATAP* suggested a method for the calculation of this line item. By 2021, however, the method had become discredited. As the current (2021) edition puts it:[170]

> 'Johnson et al (2010) showed that the actual productivity differentials at a local authority level for all industries and occupations together are much smaller than average wage differentials and some cases differ in sign. So differences in earnings for within occupations and industries are not necessarily reliable guides to productivity differences.
>
> Until research is undertaken into productivity differences by location, occupation and industry, the *ATAP Guidelines is unable to offer a satisfactory methodology for WB2b estimation*. Unless the *proponents of business cases can reliably establish such a productivity index*, i*t is recommended that estimates not be reported in Australian CBAs*. If WB2b is considered to be likely to be significant for a transport initiative, a *narrative should be provided to support the case*. Estimates of numbers of jobs 'created 'and 'destroyed 'in different locations by industry, and if possible, by occupation can be reported and used to support the narrative.
>
> If WB2b is reported in a CBA, *it is recommended that it be treated as sensitivity test*. The estimation methodology should be described, and *the following issues addressed*:
>
> The source of the productivity differentials, for example, an econometric study or derived from agglomeration elasticities and effective densities.
>
> If output changes are estimated from wage data, possible divergences between wage and productivity differentials between zones
>
> Whether the WB2b estimate reflects other distortions in addition to income and payroll tax, in which case, the estimate represents more than WB2b. The ATAP Guidelines recommends that the tax wedge be for income and payroll tax only as for WB2a above.

[170] Commonwealth of Australia (2021) *Australian Transport Assessment and Planning Guidelines* <www.atap.gov.au>, Vol. T3: *Wider Economic Benefits*, p. 25. Emphasis added.

> The level of disaggregation at which the calculations have been undertaken in terms of zones, industries and occupations, and in particular, whether the productivity differentials between areas are assumed to be the same across industries and occupations as in the UK approach.
>
> The extent to which averaging across industries, occupations and zones may have biased results. The last three points will be particularly important where the WB2b estimate comes from a spatial equilibrium model.
>
> Note that even with knowledge of productivity differentials, *WB2b will be impossible to estimate where infrastructure investments radically transform the economic characteristics of zones*.'

The *Business and Investment Case*, on the other hand, states as follows:[171]

> 'SRL – Cheltenham to Airport includes transport network and precinct development initiatives to address this productivity and skills matching issue that is expected to worsen over time. Therefore, it is important WEB2b is quantified for the SRL – Cheltenham to Airport economic appraisal to fully understand its impact. Failing to do so would result in significant underestimation of the benefit associated with SRL – Cheltenham to Airport.'

The *Business and Investment Case* ignores *ATAP*'s misgivings and caveats about this line item. It presents as credible a figure derived from the discredited 2018 approach. It does not provide a derivation of appropriate productivity indices. It does not estimate numbers of jobs created and destroyed. It does not address the issues that which *ATAP* suggests should be addressed. It does not provide a sensitivity analysis.

Accordingly, the benefits cited for this line item seem dubious. We consider that at the very least the item ought to be subjected to a sensitivity analysis, in accordance with *ATAP*'s recommendations.

[171] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*: Appendix C.2: *Economic Appraisal Report* (by KPMG), p. 149.

6.6 Inconsistent Treatment of Output Increase in Imperfectly Competitive Markets (WEB3)

The *Business and Investment Case* states:[172]

> 'Any transport projects in developed countries, which are characterized by reasonable transport access, are unlikely to generate significant enough travel cost savings to have any material impact on competition, as is the case for SRL – Cheltenham to Airport. Consequently, the approach to estimating benefits from increased competition is not discussed in this economic appraisal.'

Similarly, the *Economic Appraisal* states as follows:[173]

> 'In an imperfectly competitive market, prices may exceed production costs and output may be less than optimal. 'Output change in imperfectly competitive markets '(WEB3) arises from a reduction in transport costs allowing for an increase in production or output of goods or services that use transport. …WEB3 is considered minimal in countries with a highly competitive market like Australia. Therefore, WEB3 is not included in this economic appraisal.'

Having proclaimed that this line item is not applicable and is not to be included in the appraisal, KPMG then bizarrely assigns $0.4 to $0.6 billion worth of benefits against this line item.[174]

This treatment is inconsistent.

6.7 Dubious Inclusion of Social Inclusion Benefits

Under the heading of 'urban consolidation benefits', the *Business and Investment Case* includes a line item of $1.0 billion to $1.9 billion worth of benefits for 'improved social quality and inclusion'. This sum is derived from a unit rate of $19.30 and the number of trips likely to be made by persons who are 'deemed to be at risk of social exclusion'.

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[172] *Ibid.*, p. 151.

[173] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*: Appendix C.2: *Economic Appraisal Report* (by KPMG), p. 62.

[174] *Ibid.*, p. 91.

Both the unit rate and the criteria for deciding the persons to whom the unit rate is to apply arise from an academic paper published in the *Journal of Transport Economics and Policy* in 2011 entitled 'Social Exclusion and the Value of Mobility'.[175] The paper's authors are John Stanley, David Hensher, Janet Stanley, Graham Currie, William H. Greene and Dianne Vella-Brodrick.[176] The first-named author is the same Professor John Stanley referred to at section 1.6 who has expressed misgivings about SRL's viability and who was also a leading light in the production of *Plan Melbourne*. The professor has fingers in many pies. The paper reports its central finding as follows:

> 'We find that people are less likely to be at risk of social exclusion if they have regular contact with significant others, have a sense of community, are not poor, are mobile and are open to new experiences which enable them to grow on a personal level. The value of an additional trip is estimated at [$A19.30].'

The paper adopts results from a study co-sponsored by the Brotherhood of St Laurence, Bus Australia and the Victorian Government. To determine the prevalence of persons who are 'at risk of social exclusion', it considered the results of a survey of 443 people in Melbourne in 2009 conducted via Monash University.[177] The survey queried such things as: (1) income levels; (2) 'community participation' (as measured by whether the respondent 'attended a library, sport or arts event' in the last month); (3) 'political participation' (as measured by whether the respondent 'participated in a political party, campaign, or action group to improve social/environmental conditions to a local community committee/group in the past 12 months'); (4) how frequently the respondent communicates with family and friends; and (5) the price that the respondent would be willing to pay for transport if his or her usual mode choice were unavailable.

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[175] John Stanley, David A. Hensher, Janet Stanley, Graham Currie, William H. Greene and Dianne Vella-Brodrick, *Social Exclusion and the Value of Mobility* (2011) 45 Journal of Transport Economics and Policy 197-222.

[176] These are academics based at, respectively: the University of Sydney, the University of Sydney, Monash University, Monash University, New York University and Monash University. John Stanley, David Hensher, Graham Currie and Janet Stanley are particularly well-known in the field of transport economics and transport studies in Australia and are much published. See also John Stanley and Anton Roux (eds, 2014) *Infrastructure for 21st Century Australian Cities: Papers from the ADC Forum National Infrastructure and Cities Summit*.

[177] Stanley *et al*, *loc. cit*.

They also sought to address psychological aspects of personality. For instance, they sought to measure where respondents stood on an introversion-extraversion scale, on the basis that introverts are likelier to suffer from social exclusion than extroverts, and likelier be unhappy as a result.

They also asked respondents:

1. How much do you trust people in your local community?
2. How willing are people to help out in your local community?
3. Do you think your neighbourhood is a good place for you to live?

They then sought to grade the responses using a seven point 'Likert scale'. They generated the following seven variables to quantify the survey results:

1. The person's sense of community;
2. Whether or not the person has contact with members of the close family more than once a year;
3. Whether the person never has contact with members of extended family;
4. Whether the person does or does not trust people in general;
5. Household gross income per day squared;
6. Number of trips on travel day;
7. A 'personal growth' rating.

Survey responses were then converted to quantitative data points, with the help of an 'ordered polychotomous choice model'. They then used an econometric technique known as 'generalised ordered logit' modelling. 'Logit' stands for 'logistic unit' function, which means a 'sigmoid' or 'S-curve' function whose abscissae (or x-values) are unbounded but whose ordinates (or y-values) range between 0 and 1. In essence, the process was to create a mathematical model from the logit function and then calibrate it to explain the data points as closely as possible, minimizing error as determined by a regression coefficient. They addressed the concepts of 'unobserved hetero-

geneity', 'preference heterogeneity in the thresholds' and 'heteroskedasticity' to explain discrepancies between the survey results and their model. They surmised that there is a diminishing marginal return as income levels rise: the value of an additional trip is greater for poor people. They concluded that, based on a 'marginal rate of substitution' paradigm, the value of potential relief from social exclusion that the transport network gives to 'socially excluded' persons averages out to $19.30 per additional trip.

KPMG in the *Economic Appraisal Report* adopted the derived unit rate in its calculations to calculate the total benefits associated with this line item. In essence they input $19.30 as the amount that people who are statistically deemed to be at risk of social exclusion would be willing to pay to use the SRL in order to escape their social exclusion. If that $19.30 came out higher than the generalized cost of their travel (that is, ticket fares plus a valuation of their travel time) then the model makes them patrons of the SRL.

Since this paper was published in 2011, its approach and its $19.30 unit rate have *not* been formally adopted by *ATAP* or in the guidelines any other comparable jurisdiction. The study is mentioned in several places, however, including Infrastructure Australia's guidelines[178] and an appendix in Transport for NSW's guidelines[179], without incorporation into recommended methodology.

Although some might consider it cause for concern that the analysis departed a long way from pre-existing norms, the authors adopt a somewhat boastful tone in summarizing their findings:[180]

> 'This is about twice the value that would be implied by using generalised costs to infer values and over four times the value that results from using the generated traffic (50 per cent) rule.'

What conclusions should we draw?

On the one hand, the social benefits that transport networks confer are genuine. For instance, people who live in outer suburbs for rea-

[178] Infrastructure Australia (2021) *Assessment Framework*.

[179] Transport for NSW (2016) *Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives: Transport Economic Appraisal Guidelines*, p. 350.

[180] Stanley *et al*, *op. cit.*, p. 219.

sons of economic necessity rather than social choice are vulnerable to social isolation. A transport network can help them to relieve that social isolation by making their family and friends more accessible. The authors of the paper, furthermore, seem to pack an academic punch and the medium of publication is not completely undistinguished.

It is not clear, however, why this social (as distinct from economic) spin-off benefit should be quantified within the cost benefit analysis but not other social spin-off benefits such as, for instance, additional time spent with loved ones as a result of lower travel times by people who are *not* statistically deemed to suffer from social exclusion.

Furthermore, there are good reasons to question the legitimacy of the $19.30 unit rate and its derivation. The methodology has several layers of contrivance. Single surveys can be affected by biases, such as the 'anchoring' phenomenon, and the tendency for participants to tell their questioners what they think they want to hear.[181] Doubts can also be raised about the representativeness of the sampled population. The conversion of subjective survey responses into numerical variables adds a layer of artifice that may also be questioned. People who suffer from social exclusion are often depressed, sub-clinically if not clinically. Depressed people are not rational actors. They are not *homo economicus*.[182] Depression seems to be an unobserved heterogeneity in this context and may correlate better to social exclusion than notions of extraversion or introversion. New migrants to Australia, particularly those without good English skills, are also vulnerable to social exclusion and may amount to another unobserved heterogeneity. Further doubts can be raised generally about the contrivance of fitting a regression model to a explain a data set that contains a large amount of noise and randomness.

Psychological factors that affect incentives to travel are already catered for within the modelling framework by the use of 'alternative-specific constants' (ASCs). It is not clear that the inclusion of social inclusion benefits in this way is not double counting.

[181] Daniel Kahneman (2011) *Thinking Fast and Slow Penguin London* pp. 119-128.

[182] See e.g. Steven D. Levitt and John A. List (2008) '*Homo Economicus* Evolves', *Science* 319: 909–10.

While interesting, in our judgement the method used to calculate this type of benefit has yet to gain sufficient credence outside of the sandstone of Camperdown and concrete of Clayton to warrant its formal adoption by government or industry. Other types of benefits and the models used to derive them within the framework of the cost-benefit analysis have a much more solid foundation beneath them. The four-step transport network model, the spatial computable general equilibrium model and the activity and agent based model have all been legitimated by development and refinement around the world for several decades. Further deliberation and debate by both academics and practitioners is needed for this particular methodology. Endorsement within the *ATAP Guidelines* would be the best way to gain legitimacy.

In summary, we believe that this line item ought to be excluded from quantification and discussed qualitatively, in like manner to such benefits as 'civic pride', 'reduced roadway costs' and 'improved neighbourhood amenity'.

6.8 Conclusion

A significant portion of the benefits calculations that underpin the SRL's business case lack robustness, rely on dubiously exaggerated imputs and make questionable assumptions.

7. Cost-Benefit Analysis

7.1 Probability Distribution for Benefit-Cost Ratio Is Misleading

The *Business and Investment Case* presents its results as costs, benefits and net present values in ranges that it terms '95% confidence intervals'. These output ranges are derived from a Monte Carlo analysis. A 95% confidence interval means a range bounded by 'P-values' close to the 'tails' of the distribution, namely P2.5 and P97.5. For a Gaussian or 'thin-tailed' distribution, or a classical symmetrical bell curve, a 95% confidence interval means a range of about two standard deviations either side of the mean.[183] Results for P-values other than P2.5 and P97.5 are not presented.[184]

This is unhelpful. As was discussed in section 2.6, ninety-five percent confidence intervals only make sense in the context of 'thin-tailed' distributions. Thin-tailed distributions are probability distributions that are or resemble a Gaussian distribution, with a symmetrical bell-curve shape. The probability patterns that arise from project costs, however, are notoriously 'fat-tailed'.[185]

Because of the different and unpredictable properties of the upper fat-tail, the P97.5 data point and the 95% confidence interval of which it forms the upper bound are likely to be considerably understated. P97.5 is thus a poor choice to represent the distribution. Ninety-five percent confidence intervals, framed by P2.5 and P97.5, are seldom used as the basis for presenting the overall results of project assessments, partly for this reason. The London Crossrail business case, for instance, presented a 'centrality estimate' (P50) and a 'sensitivity estimate' (P90). P50[186], P75, P80 and P90 are much more helpful and

[183] See e.g. Nassim Nicholas Taleb (2001) *Fooled by Randomness*, Texere, New York, p. 86; Nassim Nicholas Taleb (2nd edition, 2010) *Black Swan: The Impact of the Highly Improbable*, Random House, New York, pp. 229-252.

[184] The Premier, Hon. Daniel Andrews, made this even more misleading by citing the P2.5 BCR as if it were the centrality (P50) BCR. See Hon. Daniel Andrews MP (12 May 2022) *Questions Without Notice and Minister's Statements: Suburban Rail Loop*, Hansard (Assembly), Parliament of Victoria.

[185] See section 2.6.

[186] Mayor of London, Department of Transport, Cross London Rail Link and Transport for London (2010) *Crossrail Business Case: Summary Report*.

valid P-values than P97.5.[187] P97.5 is not really worth the paper it is written on.

7.2 Benefit-Cost Ratio Range Is Too Narrow To Be Realistic

The *Business and Investment Case* presents the benefit-cost ratio (BCR) for the SCL for Option A in a range from a P2.5 value (which may be termed a worst-case scenario) of 1.1 to a P97.5 value of 1.7 (which may be termed a best-case scenario). It does not provide a centrality value (P50), but it can be supposed without too much difficulty that this is around 1.4.

The following question can now be asked. In circumstances where the costs overrun and the benefits fall short by the same percentage, what percentage departure from the centrality value (P50) will be enough to bring about the worst-case scenario?

In other words: for what value of n will the centrality value (r_c) multiplied by $(1-n)/(1+n)$ equal the worst case scenario (r_w)?

Formally, this can be expressed as the following equation:

$$r_c\left(\frac{1-n}{1+n}\right) = r_w$$

Equation 1 - BCR Range Test Equation

We can now solve for n where $r_c = 1.4$ and $r_w = 1.1$. Using high school algebra methods, the solution is as follows:

$$n = \frac{r_c - r_w}{r_c + r_w} = \frac{1.4 - 1.1}{1.4 + 1.1} = \frac{0.3}{2.5} = 0.12$$

Equation 2 – Solution to BCR Range Test Equation

In other words, the SRLA and KPMG believe that the *worst-case* scenario for a simultaneous cost blowout and benefits shortfall by the same percentage amount in tandem is only about 12%.

[187] See e.g. Marion Terrill (2016) *Roads to Riches: Cost Overruns in Transport Infrastructure,* Grattan Institute Report No. 2016-13, pp. 70-75. See also Infrastructure Australia (2021) *Assessment Framework,* Stage 4, p. 29, which requires P50 and P90 values.

What utter bullshit!

7.3 Benefit-Cost Ratio Lacks Resilience

A method similar to that above can also be used to derive the percentage of simultaneous cost blowout and benefits shortfall that the BCR can supposedly withstand without making the project uneconomic. Here, we substitute the worst case BCR mentioned above with 1.0 and solve for n :

$$n = \frac{1.4 - 1.0}{1.4 + 1.0} = \frac{0.4}{2.4} = \frac{1}{6} = 0.167$$

Equation 3 – Solution to BCR Resilience Test Equation

In other words, even if all the assumptions and methods in the *Business and Investment Case* are taken as correct, the BCR is only robust enough to withstand a simultaneous cost blowout and benefits shortfall of 16.7% before the project is deemed uneconomic. As a percentage figure, 16.7% is a long way from the 45% and 50% that Flyvbjerg considers to be typical on a megaproject such as this.[188]

7.4 Assumes Rather Than Derives Discount Rate

The standard formula for calculating the net present value within a cost-benefit analysis is as follows:[189]

$$NPV = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+r)^t}$$

Equation 4– Net Present Value

Where:

NPV = net present value;

t = time unit (year);

[188] See section 2.2.

[189] See e.g. Jenkins *et al*, §4.2.3.

B_t = benefits for time unit t;

C_t = costs for time unit t;

r = discount rate;

Which ratio should be used for the discount rate? This has long been a difficult and problematic issue. As one economist put it:[190]

> '[I]t would be difficult to mount a decisive case for or against any rate of discount governments might choose over a range of 3 percent to 20 or even 25 percent'.

Since 1989, federal government agencies have stipulated that cost benefit analyses for Australian infrastructure projects should use a discount rate of 7%.[191] That was in line with the 1989 10-year Commonwealth bond yield of 6.8%, that rate being the usual proxy for borrowing costs and risk free returns on investment in Australia.[192] Since the late 1980s, borrowing costs have lowered dramatically, but the 7% discount rate has remained standard. By 2007, for instance, the 10-year Commonwealth bond yield had lowered to 0.8%. As Terrill and Batrouney of the Grattan Institute put it:[193]

> 'The discount rate is the tool that puts costs and benefits occurring at different points in time onto a comparable footing. It expresses how much we value costs and benefits in the future relative to costs and benefits occurring today. …
>
> The discount rate is a core element of cost-benefit analysis, used to assess the merits of different proposals for projects and policies. …
>
> There are many views about what the discount rate should be, and what factors should affect it. It is one of the most controversial aspects of cost-benefit analysis. Yet despite this controversy and disagreement, almost all Australian jurisdictions have opted, since at least 1989, to use a discount rate of 7 per cent for most transport and other infrastructure projects, irrespective of project risk and real interest.

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[190] Robert J Brent (2018) *Applied Cost–Benefit Analysis* (2nd Edition) Edward Elgar Publishing Limited UK, p. 365.

[191] Marion Terrill and Hugh Batrouney (2018) *Unfreezing Discount Rates: Transport Infrastructure for Tomorrow*, Grattan Institute Report No 2018-03.

[192] *Ibid*.

[193] *Ibid*.

> In the private sector and in many agencies that regulate non-transport infrastructure, it is standard practice to vary the discount rate according to the level of risk entailed in a project. There is no rationale, aside from the difficulty of agreeing how to do it in practice, for not taking the same approach when doing cost-benefit analysis for transport projects.'

Terrill and Batrouney argue that discount rates for infrastructure projects ought to be lowered, particularly to match investment opportunities with the same level of risk. As Australian cities rarely decline in population and people need infrastructure in both good times and bad, urban infrastructure projects, moreover, are usually very low risk investments. Lowering discount rates shows more empathy for the future generations of a nation whose future population will be much greater. Accordingly, Terrill and Batrouney argue, it is reasonable to conclude that Canberra's inflexible insistence on a 7% rate over the years has been a mistake. Too-high discount rates are particularly discriminatory against long-term projects whose benefits take multiple decades to accrue. Because of something as mundane as an accounting convention, Australia has arguably suffered from a serious underinvestment in infrastructure over the last few decades.

Although Terrill and Batrouney argue in favour of a bespoke 'evidence-based' approach to setting discount rates for each project, they also at the same time suggest the following template:

- For projects with a 'very low' level of systematic risk such as buses, roads and urban passenger rail, 3.5%.

- For projects with a 'somewhat low' level of systematic risk such as ferries and freight rail, 5%.

Some experts have argued that a decaying exponential function with a constant index is the wrong type of mathematical function to use for discounting and that a hyperbolic discount rate where the rate of decay itself decays so as to take into account the unbounded nature of time would be preferable.[194] People do not want their great-

[194] Alexander Adamou, Yonatan Berman, Diomides Mavroyiannis and Ole Peters (2020) 'Microfoundations of Discounting', *Economics Review*, EconrXiv:1910.02137v3, p. 3. This paper makes it apparent that the question of which discount rate to apply is closely connected to ergodicity economics.

grandchildren to be living in poverty *that* much less than they do not want their grandchildren to be living in poverty.[195] A hyperbolic function that diffuses into an exponential function could be the way to go, others have suggested.[196]

The predicament of other developed countries in relation to discount rates has been similar to that of Australia, at least until recently. The *Business and Investment Case* notes that London Crossrail was appraised with a discount rate of 3.5% for the first 30 years and 3% thereafter.[197] Sydney Metro, Grand Paris Express and Australia's Inland Rail project also used a 4% discount rate.[198] The lower long-term rate of economic growth of European jurisdictions by comparison to Australia may or may not be a relevant consideration in this regard.

It is in this context that the SRLA states its chosen discount rate for the SRL business case: four percent. This is a rate, it states, that has been 'endorsed by the government'.[199]

Because cost-benefit calculations are so sensitive to discount rates, both the Grattan Institute and Infrastructure Australia recommend that the results of alternative discount rates of plus and minus two percent be modelled and reported in addition to the headline discount rate.[200] Unlike the business case prepared for the aborted eastern stage of the East-West Link project, the *Business and Investment Case* fails to do this.[201] Discounting with a wholly or partly hyperbolic function should also be included as a sensitivity scenario.

The arguments for lower discount rates have not been met with universal approbation, however. In a study commissioned by the federal government, Harrison concluded:[202]

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[195] Robert J. Brent, *loc. cit.*

[196] Alexander Adamou *et al*, *op. cit*.

[197] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case,* p. 293.

[198] *Ibid*.

[199] *Ibid.*

[200] Marion Terrill and Hugh Batrouney (2018) *Unfreezing Discount Rates: Transport Infrastructure for Tomorrow*, Grattan Institute Report No 2018-03, pp. 20-24.

[201] State of Victoria (2013) *East West Link Business Case*, p. 194.

[202] Mark Harrison (2010) *Valuing the Future: The Social Discount Rate in Cost-Benefit Analysis* Commonwealth of Australia Productivity Commission, Visiting Researcher Paper, p. VIII.

> 'Market rates reflect the opportunity cost of investing in public projects, and there is no case for allocating resources to low return investments when higher returns are available. Using an artificially low discount rate for project evaluation can make future generations worse off. Ethical arguments for a low discount rate are more a reason to increase savings and investment.'

Jenkins, Kuo and Harberger also take a dim view of the idea that discount rates should be lowered:[203]

> 'The use of a lower [discount rate] would create an incentive for the project managers to use production techniques that are too capital intensive. The choice of an excessively capital-intensive technology would lead to economic inefficiency because the value of the marginal product of capital in this activity is below the economic cost of capital to the country.'

In relation to the SRL, we believe that two key conclusions may be drawn about discount rates.

The first conclusion is that discount rates are generally used as proxies for at least two separate things. These are: (1) the generalized opportunity cost of capital and (2) the social time-preference value of money. The higher discount rate suggested by Infrastructure Australia makes sense if (1) is the dominant paradigm. The lower discount rate used by the SRLA makes sense if (2) is the dominant paradigm. The second paradigm represents a more subjective choice about the extent to which welfare that accrues sooner is valued over welfare that accrues later, be it the welfare of the future selves of persons alive today or the welfare of future generations. From this standpoint, a higher discount rate is more selfish and a lower discount rate is more empathic towards future generations. The discount rate implied by (1) would nearly always be higher than that implied by (2).

Logically, an analysis whose discount rate is based on the generalized opportunity cost of capital should not necessarily require a baseline comparison against specific alternative schemes or alternative investments (i.e. a 'real options analysis'): opportunity cost is already

[203] Jenkins, Glenn, Chun-Yan Kuo and Arnold Harberger (2011) *Cost-Benefit Analysis for Investment Decisions*, §8.1.

implicitly accounted for. In other words, if a proposal discounted by paradigm (1) attains an benefit-cost ratio above unity (i.e. BCR>1.0), it delivers net benefits in excess of the generalized rate of growth of capital. It may for this reason alone be deemed a sound capital investment that is worthy of a green light.[204]

The second paradigm loosens or discards the association with the generalized opportunity cost of capital in favour of an approach that is more empathic to future generations. Under this paradigm, the proposition that an analysis that yields BCR>1.0 represents a sounder investment than available alternatives weakens. It is logical to conclude that proposals which adopt such lower discount rates ought to be supplemented or baselined against with a 'real options analysis' that takes the real opportunity cost of alternative investments into account. If the proposed project is not shown to beat the generic rate of capital growth, it needs to be shown to beat actual alternative investment proposals on the table. Only if a scheme discounted using this approach comes out ahead of actual alternatives can it be regarded as a sound capital investment worthy of a green light.

One way or another, even if the lower discount rate paradigm is accepted, it may be argued that four percent seems on the low side. This is because the SRL is fundamentally riskier than comparable urban rail projects. While London Crossrail and Sydney Metro react to relieve congestion along those cities' natural fractal arteries, the SRL is more of a gamble on the government's ability to re-engineer Melbourne's urban growth patterns and establish transport demand through precincts whose popularity has yet to be fully demonstrated. When such considerations are taken into account, a rate of 4.5% or 4.75%, maybe 5%, might be more appropriate.

Finally, all relevant authorities suggest that the discount rate used ought to be subjected to a sensitivity analysis. The SRLA has not done this. Furthermore, the possibility that long-term interest rates and corresponding investment returns may actually increase in the next few decades should not be overlooked. The era of low interest rates may well be over.

[204] Ignoring safety margin considerations.

7.5 Improperly Adopts A 'One-Shot' Acceptance Criterion

Not all proposed infrastructure schemes have cheaper realistic conceptual alternatives in either scale, route or mode. Half a tunnel or half a bridge across a body of water is not realistic. Indeed, it is hard to conceive of a cheaper realistic option for either London Crossrail or Stage 2 of Sydney Metro. But as has been described above, this is not the case for the SRL. The SRL has a large number of realistic options (or 'optionality') available to satisfy its conceptual objectives.[205]

In light of the SRL's extensive optionality, the acceptance criterion that the SRLA relies on to derive a headline benefit-cost ratio is impossible to justify. In particular, the SRLA incorrectly adopts an *absolute* benefit-cost ratio (ABCR) criterion (ABCR > 1.0) without consideration of an *incremental* benefit-cost ratio (IBCR) criterion (IBCR > 1.0).[206] This is known as a 'one shot' approach.

Formulaically:

$$ABCR = \frac{B}{C}$$

where:

$ABCR$ = absolute benefit-cost ratio

B = benefits;

C = costs;

Equation 5 - Absolute Benefit Cost Ratio (ABCR)

$$IBCR = \frac{\Delta B}{\Delta C}$$

where:

$IBCR$ = incremental benefit-cost ratio

[205] See section 3.9.

[206] Where there is optionality.

ΔB = change in benefits relative to next cheapest alternative;

ΔC = change in costs relative to next cheapest realistic alternative;

Equation 6 - Incremental Benefit Cost Ratio (IBCR)

The incremental approach characterizes a proposed scheme with optionality as a series of potential investments, each of which upgrades the solution to a more beneficial but also more expensive alternative. As Jenkins, Kuo and Harberger put it:[207]

> '[A] project's net present value (NPV) is the most important criterion for the financial and the economic evaluation. . … [W]e should strive to maximize the NPV of *incremental* net cash flows or net economic benefits.

Jenkins *et al* make a similar comment in relation to choosing the best scale for a project:[208]

> 'The most important principle for selection of the best scale of a project … is to treat each *incremental* change in its size as a project in itself. … Using the present value of the *incremental benefits* and the present value of the *incremental costs*, the change in net present value, stemming from changing scales of the project, can be derived.'

Although the *ATAP* guidelines are vaguer, the *Economic Evaluation Manual* of the New Zealand Transport Agency underscores the importance of this approach, *viz*: [209]

> 'Where project alternatives and options are mutually exclusive… *incremental* cost-benefit analysis of the alternatives and options shall be used to identify the optimal economic solution.
>
> The *incremental BCR* indicates whether the *incremental* cost of higher-cost project alternatives and options is justified by the *incremental* benefits gained (all other factors being equal).'

---

[207] Jenkins *et al*, *loc. cit.*

[208] Jenkins *et al*, *loc. cit.* Emphasis added.

[209] New Zealand Transport Agency (2018, 1st edition) *Economic Evaluation Manual* (Amendment 2), pp. 5-511 - 5-513. Emphasis added.

The *ATAP Guidelines* refer to the concept of 'gold plating'.[210] Axiomatically, a project with IBCR < 1.0 can be considered to be 'gold plated', even if ABCR ≥ 1.0. While any project with ABCR < 1.0 is definitely uneconomic, the converse is not true; it does not automatically follow that a project with ABCR ≥ 1.0 will be definitely be economic. But where a project option is the only option or the cheapest option, there is nothing to increment. IBCR does not exist in such circumstances so, ignoring margin of safety considerations, the appropriate acceptance criterion will indeed be ABCR ≥ 1.0.[211]

To explain this concept another way, consider a worker on a medium salary seeking to purchase a car. Ignoring margin of safety considerations, if a Porsche is the only option available, the worker may well find that $B_P/C_P \geq 1.0$.[212] But if a Toyota sedan is also available the worker should only purchase the Porsche in the (unlikely) event that $(B_P-B_T)/(C_P-C_T) \geq 1.0$ or, to put it more compendiously, $\Delta B/\Delta C \geq 1.0$. If the worker purchases the Porsche because $B_P/C_P \geq 1.0$ even though $\Delta B/\Delta C < 1.0$, the purchase can be said to be 'gold-plated' to the extent of C_P-C_T.

As illustrated in Figure 3 below using admittedly very rough guesstimates of the costs and benefits of each option canvassed in section 3.9 above, NPV of benefits (B) may be plotted on the *y*-axis of a cartesian plot against NPV of costs (C) on the *x*-axis. In accordance with the microeconomic principle known as the diminishing marginal productivity of capital, these alternatives form a curve with an upward sloping convex shape and a declining gradient. The ABCR for a given data point is represented by the gradient between the origin (0, 0) and the data point, whereas the IBCR for a data point is represented by the local gradient: the gradient between data point and the adjacent less expensive data point.

Figure 3 below suggests that the cheapest alternatives to the SRL (such as shuttle buses) have a high ABCR (= B/C) and get great bang

[210] Commonwealth of Australia (2021) 'F3 Options Generation and Assessment', *Australian Transport Assessment and Planning Guidelines* <www.atap.gov.au>.

[211] See margin of safety discussion at section 2.13.

[212] Where the capital letters B and C refer to benefits and costs, respectively, and the subscripts P and T refer to Porsche and Toyota, respectively.

for the buck, but are not optimal because they fall a long way short of maximum net benefits (B-C) or NPV.

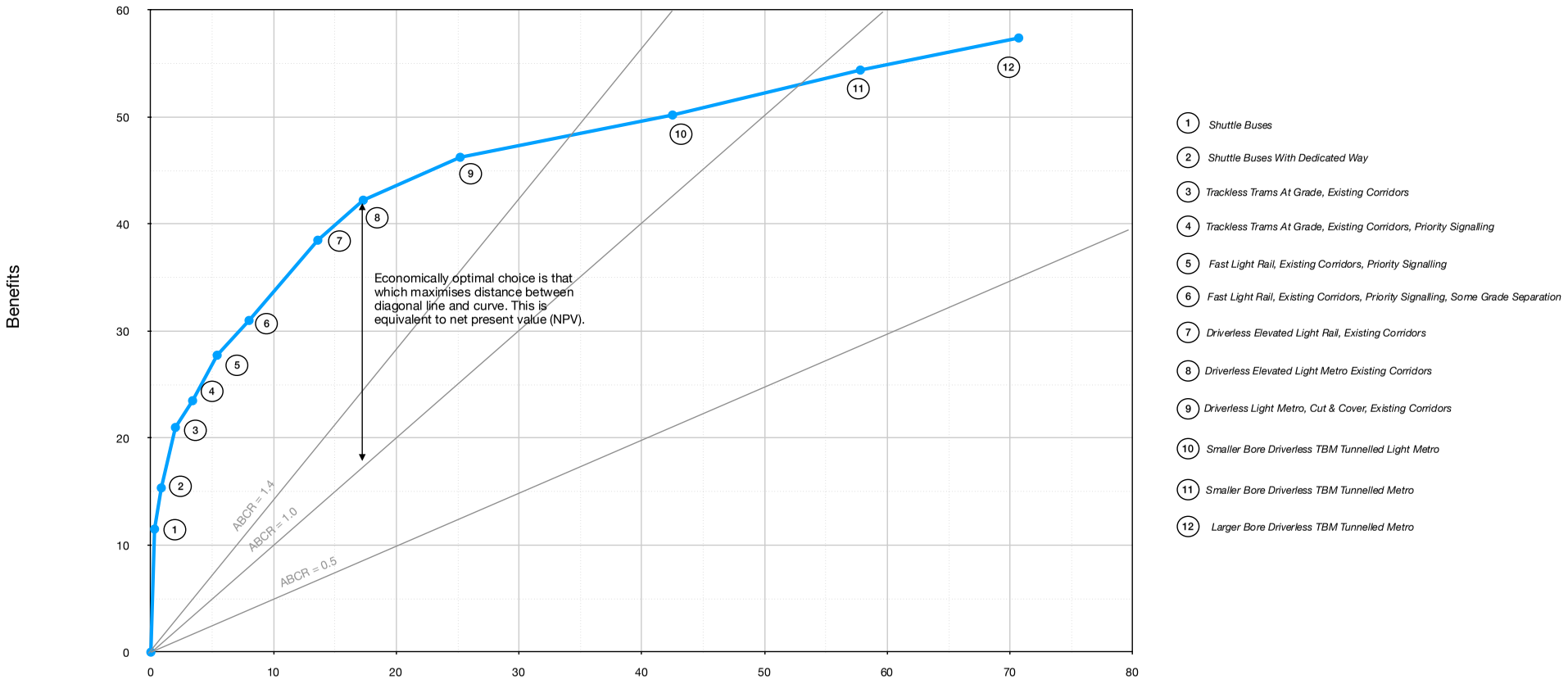

Figure 3– 'Guesstimated' Costs v. Benefits of Twelve Engineering Alternatives

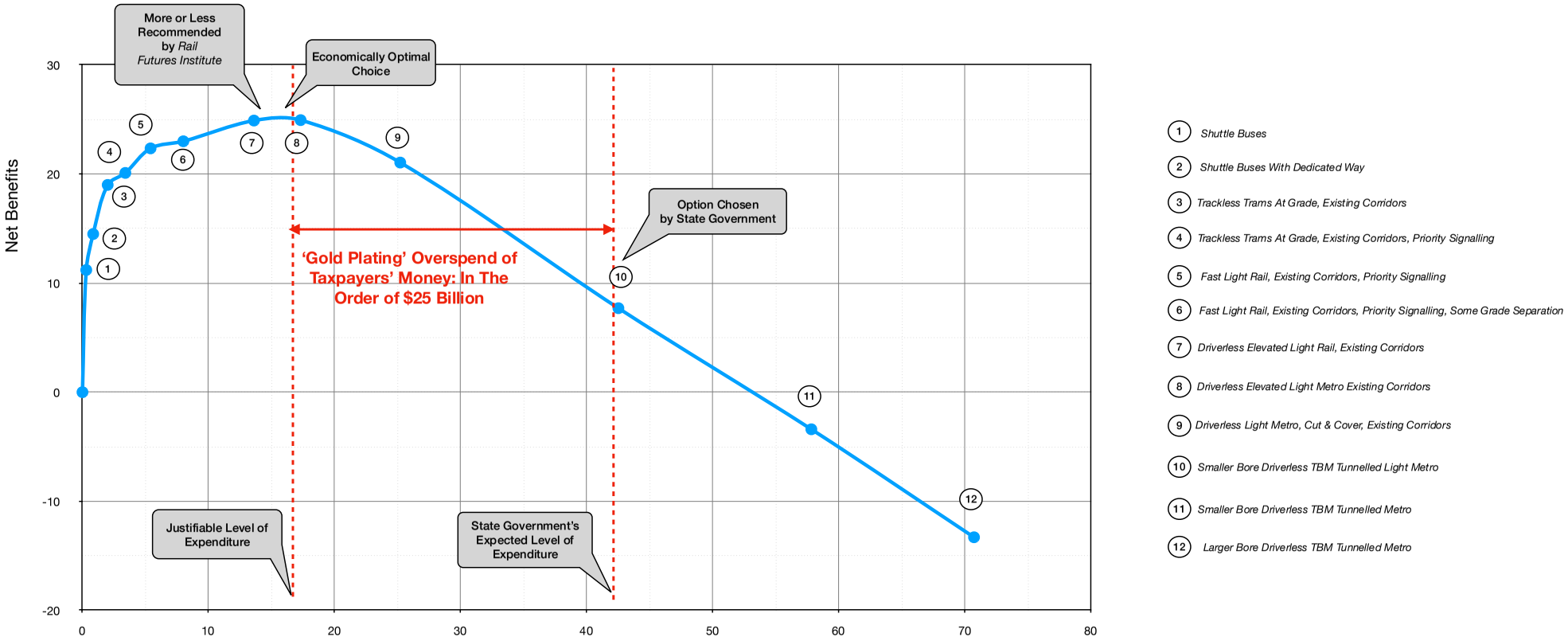

Figure 4 – 'Guesstimated' Costs v. Net Benefits of Twelve Engineering Alternatives

The 'curve' in Figure 3 can be thought of as a 'money tap'. It is rational to turn off the money tap when the gradient $\Delta B/\Delta C$ (i.e. the IBCR) dips below unity or a 45° angle, even though it remains above the ABCR gradient of 45° with respect to the origin. Given that ΔB-$\Delta C = 0$ when $\Delta B/\Delta C = 1$, when ΔB-ΔC falls below zero, NPV (or B-C) will have passed its maximum and started falling. Therefore, and as Figure 4 shows, turning off the $\Delta B/\Delta C$ money tap immediately before it falls below unity is exactly the same thing as maximizing NPV, which corresponds to the optimal project choice.

The optimal option is that which maximizes net present value (i.e. the discounted aggregate of benefits less costs). By this admittedly rough assessment, it is Option 8 that satisfies this criterion while Option 7 comes close. If the Rail Futures Institute's prognostications are to be taken into account[213], engineering necessity might make a combination of Options 7, 8 and 9 the best design: a light metro elevated in viaducts through the station precincts, perhaps supplemented in places with some cut-and-cover tunnelling.

Conversely, the horizontal difference between the economically optimal choice and the SRLA's choice is about $25 billion. In other words, it appears that the proposed design overcapitalizes by at least $20 billion.

7.6 No Margin of Safety

As discussed at section 2.13, it is prudent to include a margin of safety within project benefit-cost ratio acceptance criteria so as to hedge against error in the cost-benefit analysis. In circumstances where there is optionality and the option under consideration is not the cheapest, the proper acceptance criterion may be expressed as follows:[214]

$$\{ABCR \geq 1.0 + m\} \wedge \{IBCR \geq 1.0\}$$

where:

[213] Rail Futures Institute, *op. cit.*, p. 41.

[214] In mathematics, the symbol '∧' means 'and'.

$ABCR$ = absolute benefit-cost ratio;

$IBCR$ = incremental benefit-cost ratio;

m = margin of safety ;

Equation 7 – Best Practice Acceptance Criterion

Both Professor Bent Flyvbjerg's remark[215] that proponents need to take into account 'the risk of being very wrong' and Professor John Stanley's remark[216] that he is 'not comfortable' with the SRL's BCR may be interpreted to lend support to this proposition.

More specifically, based on Flyvbjerg's findings that rail megaprojects *on average* experience cost overruns of 45% and shortfalls in passenger forecasts (which are a proxy for benefits) of about 50%, it would not be unreasonable to apply a minimum margin of safety of ((1 + 0.45)/(1 - 0.5)) – 1, which equals about 2, to give an acceptance threshold of at least 3.0. That is to such say, such projects should not be given a green light unless their cost benefit analysis shows that benefits exceed costs by a factor of at least three. For a project of the SRL's magnitude and opaqueness, which runs the risk of damaging Victoria's economic growth if it fails, moreover, an absolute benefit-cost ratio acceptance threshold of 3.5 or even 4.0 would not be unreasonable.

7.7 Conclusion

The probability distributions derived by KPMG using the Monte Carlo method to represent the probabilistic spread of benefit-cost ratios on the SRL are too narrow to be realistic. Furthermore, the SRLA has adopted a 'one-shot' cost benefit analysis approach. This one-shot approach has averted a proper examination of the costs and benefits of alternative engineering solutions and other appraisals of optionality and opportunity cost. An incremental approach to the calculation of costs and benefits would be appropriate in the circumstances, but this has not been performed. A proper appraisal of alternatives is especially important because a lower discount rate has

[215] see section 2.2.

[216] see section 1.6.

been used that does not implicitly take into account the opportunity cost of capital. It is arguable that the SRLA's chosen discount rate of 4.0% should be a bit higher. An assessment of mode and grade choices suggests that the optimal choice for the route of the SRL would be a much cheaper conceptual solution, such as a light metro in elevated viaducts along existing corridors. The latter solution would come in at least $20 billion cheaper than the SRL. The chosen solution for the SRL therefore overcapitalizes by at least $20 billion. Finally, the margin of safety used for the absolute benefit-cost ratio decision threshold should not be less than 2.5. That implies that a project of the SRL's scale and risk levels should not be given the green light unless it has a conventionally derived absolute benefit-cost ratio of at least 3.5. The fact that the absolute benefit cost ratio cited by the SRLA and KPMG is supposedly the range defined by the 95% confidence interval of 1.1 to 1.7 raises serious alarm bells.

8. Value Capture Measures

8.1 Value Capture Mechanisms Are Unrealistic, Vague and Poorly Planned

The *Business and Investment Case* states that one-third of the cost of the SRL is to be raised by 'value capture'.[217] This means a raft of imposts on the scheme's users, customers and beneficiaries which[218] are labelled 'levies', 'charges', 'fees' and 'contributions' by the SRLA and less euphemistically termed 'value capture taxes' by the Grattan Institute.[219] The *Business and Investment Case* proposes three measures:[220]

> 'A *mechanism that captures a portion of the property value uplifts* attributable to SRL for those who choose to buy non-residential property within SRL Precincts… [I]t is proposed that this measure will be no more than 1% above the applicable land transfer duty rate on all non-residential property transactions within the SRL Precincts.'
>
> 'A SRL *Developer Contribution* will be payable by proponents of any development in a SRL East precinct.'
>
> 'An SRL East *Car Parking Levy* will be introduced. … It is expected to be an annual charge, payable by owners of commercial off-street paid car parks within the SRL East Precincts.'

These measures are evidently designed to be stealthy, not to hurt their targets too much and not to cause the government too much political damage: they apply only to those beneficiaries making significant gains and who are at arm's length from individual consumers. The *Business and Investment Case* emphasizes, however, that the arrangements have not yet been finalized. It states:[221]

> 'A final decision on the exact composition and timing of mechanisms that will be applied, and their respective rates, remains subject to detailed investigation. Factors to be considered include the mechanism

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[217] 'Value capture taxes' is the term used in Terrill, Marion (2017) *What Price Value Capture?* Grattan Institute Report No. 2017-05.

[218] See SGS Economics & Planning (2016) *Technical Paper on Value Capture: Final Report* <www.sgsep.com.au>.

[219] Marion Terrill, *op. cit*.

[220] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*, p. 359.

[221] *Ibid.*

> boundaries, rate setting, payment systems and processes, and any required exemption or concession arrangements.'

Attempts to fund major rail projects by 'value capture' are nothing new to Australia. As Terrill mentions, the original funding plan for the Melbourne City Loop in the 1970s proposed that 25% of the scheme would be funded by a local tax on City of Melbourne businesses known as a 'betterment levy'.[222] But in the end, that revenue source raised just 3% of the final outturn cost.[223] The Melbourne City Loop illustrates a major problem with value capture initiatives: when capital costs blow out, the value capture revenue stream does not follow suit.

Notwithstanding that the stated intention of *Plan Victoria* is to promote car-free urbanism, four of the precincts of SRL East (Cheltenham, Glen Waverley Box Hill and Doncaster) are anchored by very large indoor shopping centres ('Westfield Southland', 'The Glen', 'Box Hill Central' and 'Westfield Doncaster' respectively) whose business models depend not on car-free urbanism but on maintaining vast free car parks and ensuring that parking spaces never become scarce. As they are not generally 'paid', shopping centre car parks would not seem to qualify as the types of parking services contemplated by the suggested car parking levy. If this inference is correct, it seems doubtful that a car parking levy in these precincts would raise a huge amount of revenue. If anything the levy might funnel patrons into the shopping centre properties and inhibit the development of the retail sector outside the shopping centres but within the precincts.

8.2 Mode Choice Limits Value Capture Opportunities

The cost of building underground stations is a major component of the costs of constructing underground TBM-bored tunnels. Building a vast cavern under the ground that is accessible to the masses in often challenging geological conditions is no mean feat. Stations are major projects in their own right. The cost of building an underground station is usually measured in the hundreds of millions of

[222] Marion Terrill (2017) *What Price Value Capture?* Grattan Institute Report No. 2017-05.
[223] *Ibid*., p. 14.

dollars. For stations that have complicated interchange arrangements with other rail lines, that cost can run closer to a billion dollars. Because they are so expensive, the number of stations that can feasibly be built for a TBM-bored underground rail line is limited. That also limits precinct development and value capture opportunities.

8.3 False Assumption That the Funding Arrangements Of London Crossrail Can Be Emulated in Suburban Melbourne

The SRLA implies that the government will eventually implement value capture and funding arrangements that emulate those of impressive overseas projects, particularly London Crossrail and Grand Paris Express. The *Business and Investment Case* states as follows:[224]

> 'Lessons learned from global precedents
>
> Case studies provide an illustration of how [revenue raising] choices have been made by other jurisdictions and how important trade-offs in making those choices have been managed. Particular attention has been paid to the arrangements adopted for London Crossrail and the Grand Paris Express, among other more discrete examples, as benchmarks for successfully generating a material contribution to project costs through alternative new funding.
>
> …The [financing and funding] strategy builds on these observations from *successful* case studies.'

At the time of writing, construction is far from complete on Grand Paris Express and only just complete on London Crossrail, so it is premature for the SRLA to proclaim that they are 'successful' projects. France and the UK are in mild economic decline relative to Australia, as is Europe generally, and both nations now have a significantly lower GDP per capita than Australia.[225] The fact that has-been European nations have chosen to do something is not in and of itself conclusive evidence that the thing they are doing is worthwhile. The SRLA further states:[226]

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[224] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*, pp. 358-359. Emphasis added.

[225] <data.worldbank.org>.

[226] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*, *loc. cit.*

> 'Contemporary projects such as London Crossrail and the Grand Paris Express have adopted packages of three to five revenue mechanisms that have made significant contributions to overall project costs. In the case of Crossrail those charges have recovered around 30 per cent of costs.'

Buck, conversely, characterizes the level of value captured on Crossrail as 'very low':[227]

> 'A study commissioned by delivery company Crossrail Limited … estimated the uplift in land values within 1km of Crossrail stations between 2010 and 2020 …to be £5·5 billion. While this is a very positive reinforcement of the case for constructing Crossrail, the estimate illustrates the very low level of value captured (approximately 10% in this case) by the public sector – the remaining 90% accruing as windfall gains to the owners of the properties impacted.'

So what exactly are the funding and financing arrangements for Crossrail? And can the SRL emulate them? The following table provides a breakdown of funding and financing sources for Crossrail's project costs.[228]

	Funding/ Financing Source	**£** (millions)	
1	Funding from *Heathrow Airports Limited*	70	0.4%
2	'Voluntary' funding from London businesses	100	0.5%
3	*City of London Corporation* committed funding (ultimately paid by the corporate ratepayers of the Square Mile)	250	1.3%
4	Developer contributions	300	1.6%
5	Community infrastructure levy (set by Mayor, applied throughout London at different rates for different boroughs, rates decided by Mayor)	300	1.6%
6	Sale of surplus land and property (typically property compulsorily acquired for construction)	550	2.9%
7	*Department for Transport* Loan to *Transport for London* funded from future Crossrail revenues	750	4.0%

[227] Martin Buck (2017) 'Crossrail Project: Finance, Funding and Value Capture for London's Elizabeth Line', *Proceedings of the Institution of Civil Engineers* 17.00005. p. 6.

[228] Crossrail Ltd (2021) *Funding*, <www.crossrail.co.uk/about-us/funding#>.

	Funding/ Financing Source	£ (millions)	
8	*Network Rail* Funding (work financed by Network Rail on portions of scheme that coincide with NR's network, recovered from Crossrail via track access charges and ultimately funded from Crossrail farebox revenue)	2,900	15.5%
9	*Transport for London* Funding (direct funding which ultimately originates from TfL farebox revenues, including the London Underground farebox surplus).	2,050	11.0%
10	*Department for Transport* Loan to *Greater London Authority* funded from Business Rate Supplement and Mayoral Community Infrastructure Levy (broad-based local taxes)	2,125	11.4%
11	Funding from *Greater London Authority* (the upper tier of local government)	100	0.5%
12	Business Rate Supplement Borrowing and Direct Contributions (a 2% addition to municipal rates payable by businesses with premises that have a rateable value over £50k throughout London, and legislatively hypothecated to Crossrail).	4,100	21.9%
13	*Department for Transport* Funding (UK government)	5,110	27.3%
	Total External Funding and Financing	**18705**	**100%**

Table 4 - Breakdown of External Funding and Financing Sources for London Crossrail

As Table 4 shows, Crossrail's funding and financing is cleverly drawn together from a range of widely dispersed and different sources. In particular:

- Farebox revenue in London is a huge cash cow. Items 7, 8 and 9 in Table 4 account for about 30% of project costs and are ultimately funded via farebox revenue. This is *excess* farebox revenue that is left over after operating and maintenance costs have been paid. Melbourne cannot emulate this: farebox revenue in Melbourne is small by comparison. On Melbourne's existing train network, for instance, the farebox recovery rate is only 30% of operating and maintenance costs.[229] That compares to 134% for the London Underground.[230] So while in London the farebox provides a surplus that can help to pay for capital works (or to repay the financiers of capital works), in Melbourne, the farebox needs topping up if the trains are to run. The *Business and Investment Case* lacks trans-

[229] <www.bitre.gov.au>, as cited by 'Farebox recovery ratio' article in Wikipedia.

[230] Transport for London *Business Plan*, as cited by 'Farebox recovery ratio' article in Wikipedia.

parency when it comes to farebox revenue. Farebox revenue is not cited by the SRLA as a source of funding for the SRL so presumably it is not expected to provide a surplus in excess of operating and maintenance expenses. That said, the farebox recovery ratio for the SRL should be greater than that for the rest of Melbourne's network on average as the line does not have the complications that arise from sharing track with other systems and, because the SRL is driverless, there would be no driver wages or expenses to pay.

- The 'Business Rate Supplement' is a two percent uplift on the municipal rates payable by all London businesses to the Greater London Authority on properties with a rateable value of more than £50,000.[231] It is hypothecated by Parliamentary legislation to pay for Crossrail. This impost was agreed across party lines in an otherwise fractious political environment because London has a massive congestion problem and it was widely recognized that all of London would benefit from the reduction in congestion that Crossrail would deliver. The 'Community Infrastructure Levy', not dissimilarly, is a top-up on municipal rates for all Londoners but is set by the Mayor of London at different levels for different boroughs, at the Mayor's discretion.[232] These are metropolitan-wide levies. They are not imposts on Crossrail station precincts specifically. Nothing similar is contemplated for Melbourne; it would probably be untenable politically. Together, these London-wide levies (or 'broad-based local taxes') fund another 30% of the capital costs.

- Item 13 equates to funding from the national government, amounting to about 27% of project costs. The Australian federal government so far has only promised $2.2 billion worth of funding for the SRL, about 5% of initially forecast project costs. Because the federal government's funding commitment is a lump sum rather than a percentage, the percentage share of cost that it represents will diminish if costs blow out.

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[231] Greater London Authority (2021) *Intention to Levy a Business Rate Supplement to Finance the Greater London Authority's Contribution to the Crossrail project: Final Prospectus*.

[232] *Ibid.*

- Classification of some of Crossrail's funding and financing sources may be debated, so care needs to be taken with cross-jurisdictional comparisons. For instance, it is debatable whether the City of London Corporation line item counts as a local government contribution or a value capture contribution from the corporate sector. The City of London Corporation is the municipal authority for the historic City of London, which is now a specialized business district with very few local residents. It is also debatable whether the Mayoral Community Infrastructure Levy counts as a second city-wide levy or as a precinct-specific value capture initiative - it is probably best characterized as a bit of each.

One way or another, despite the SRLA's claim that 30% of Crossrail's project costs have been funded by 'value capture' initiatives, most of that figure is from broad-based local taxes of a type not contemplated by the government, which are unlikely to be politically tenable in Victoria and, even if they were tenable, would not raise anything like the amounts of money that are raised in London. Only about 5% is from the precinct-specific or *ad hoc* initiatives of the type contemplated by or available to the SRL. Nevertheless, the SRLA insists, no less than *one-third* of the SRL's costs will be funded by value capture. To the extent that 'value capture' conflates two different things: broad-based local taxes and precinct-specific or *ad hoc* measures, it is an unhelpful term.

Land laws in England are also very different from those in Victoria. England does not have the hotchpotch of strata title and small freehold estates that predominate in Australian cities. In most areas of England, tradeable real estate is mostly in the form of long leaseholds. Strata title, or 'commonhold' as it is known in England, is a very rare form of real property ownership that did not even exist until 2002.[233] Entire neighbourhoods of London often have a single freehold owner: a legacy of feudal times. Having few land owners in London at the freeholder level makes it relatively easy for the government to negotiate value capture arrangements.

[233] *Commonhold and Leasehold Reform Act* 2002 (UK).

Table 4 does not cover operations and maintenance costs which are internally funded by farebox revenue and have a net present value of about £3.5 billion.[234]

The folly of using Crossrail as a benchmark for the SRL's fundraising capacity is illustrated in Table 5, which highlights economic differences between Melbourne and the SRL on the one hand and London and Crossrail on the other.[235]

#	Point of Comparison	Melbourne/ SRL	London/ Crossrail
1	**Metropolitan Population** (millions)	4.6	11.1
2	**Metropolitan Population Density** (km^2)	1,820	6,389
3	**Population Density of the Densest Municipality Through Which the Scheme Passes** (km^2)	2,753	12,011
4	**Metropolitan Train Annual Patronage** (2017-18, millions)	242	1,548
5	**Metropolitan Bus Annual Patronage** (2017-18, millions)	118	2,247
6	**Metropolitan Tram/ Light Rail Annual Patronage** (2017-18, millions)	206	148
7	**Forecast Scheme Annual Patronage**	70k in 2036; Grows to 105 million by 2056	200 million
8	**Annual Patronage on Busiest Regional Inter-City Rail Line** (millions)	7	125
9	**Annual Airport Passenger Numbers** (2019, millions, multiple airports)	36	178
10	**Typical Train Multi-Zone Daily Fare** ($A)	$10	$20
11	**Farebox Recovery Ratio of Core Rail Network**	30%	134%
12	**Size of Train Sets for Scheme**	4	9

[234] Crossrail Ltd (2021) *Funding*, <www.crossrail.co.uk/about-us/funding#>.

[235] *Ibid.*; Transport for London (2021) *Caps and Travelcard Prices*, <www.tfl.gov.co.uk/fares>; Public Transport Victoria (2021) *Metropolitan Fares*, <ptv.vic.gov.au/tickets/fares>.

#	Point of Comparison	Melbourne/ SRL	London/ Crossrail
13	**Metropolitan Car Ownership Rate**	84%	56%
14	**Average Real Property Price per sqm in The Priciest Municipality Through Which The Scheme Passes** ($A)	$1,200	$30,764
15	**Metropolitan Population Living in Households Without a Car**	736000	4884000
16	**Cost of 1L of Unleaded Fuel** ($A, 2022)	$1.62	$3.20
17	**Has Congestion Charging Cordon**	no	yes
18	**Scheme Has Bipartisan Political Support**	no	yes
19	**Scheme Supported by Legislatively Hypothecated Broad-Based Local Taxes**	no	yes
20	**Approximate Cost of Project** ($A billions)	40	40

Table 5 – Relevant Points of Comparison Between Melbourne/SRL and London/Crossrail

Absent the ability to implement draconian Singapore-style arrangements[236], it seems unrealistic to expect that much more than a few percent of the SRL's project costs can be squeezed by value capture. Like most of Australia, post-Brexit London has three tiers of government. Both Crossrail and the SRL fall primarily under the jurisdiction of the middle tier of government, which are the Greater London Authority and the State of Victoria respectively. But while the Greater London Authority only has to fund 0.5% of the cost of Crossrail, the State of Victoria will probably need to fund at least 92% of the cost of the SRL if further federal funding is unforthcoming. Even in the best case scenario, where where there are no cost overruns and the SRLA's fantasy that the federal government will agree to pay for one-third of the project comes true, the State of Victoria will probably still need to fund at least 64% of the project.[237]

[236] In Singapore, remarkably, the government achieves 'value capture' by compulsorily acquiring a precinct it wishes to develop, and compensating landowners with a payment that matches the value of land legislatively backdated several years into the past.

[237] See section 9.5.

8.4 Modelling Fails to Take Into Account Demand Dampening From Value Capture Measures

Value capture taxes are by their very nature designed to be stealthy and not to hurt too much. Just as it would be naïve to suppose that value capture measures will go unnoticed by those who have to pay them, it would also be naïve to suppose that the costs of paying them will not be passed on down the supply chain to others. It would further be naïve to suppose that the measures, when they are passed down, would not have at least some disincentivizing effect on investment or exert at least some drag on precinct growth. Figure 5 below illustrates how these effects could not only dampen demand but also trigger negative feedback loops and vicious cycles. The SRL precincts are after all in competition with other growth precincts such as Docklands, Parkville, North Melbourne and Fisherman's Bend. There are plenty of other attractive suburbs that are ripe for development. Not by a long shot are the SRL precincts the only development or investment opportunities in town.

As the value capture measures have not been detailed, let alone agreed or legislated, it is a near certainty that they have not have been modelled in VLUTI or incorporated into the SRLA's calculations of costs and benefits. If the government tries to squeeze too much out of value capture, these vicious circles and negative feedback loops could become a reality and the already weak business case for the entire scheme will come crashing down like a house of cards.

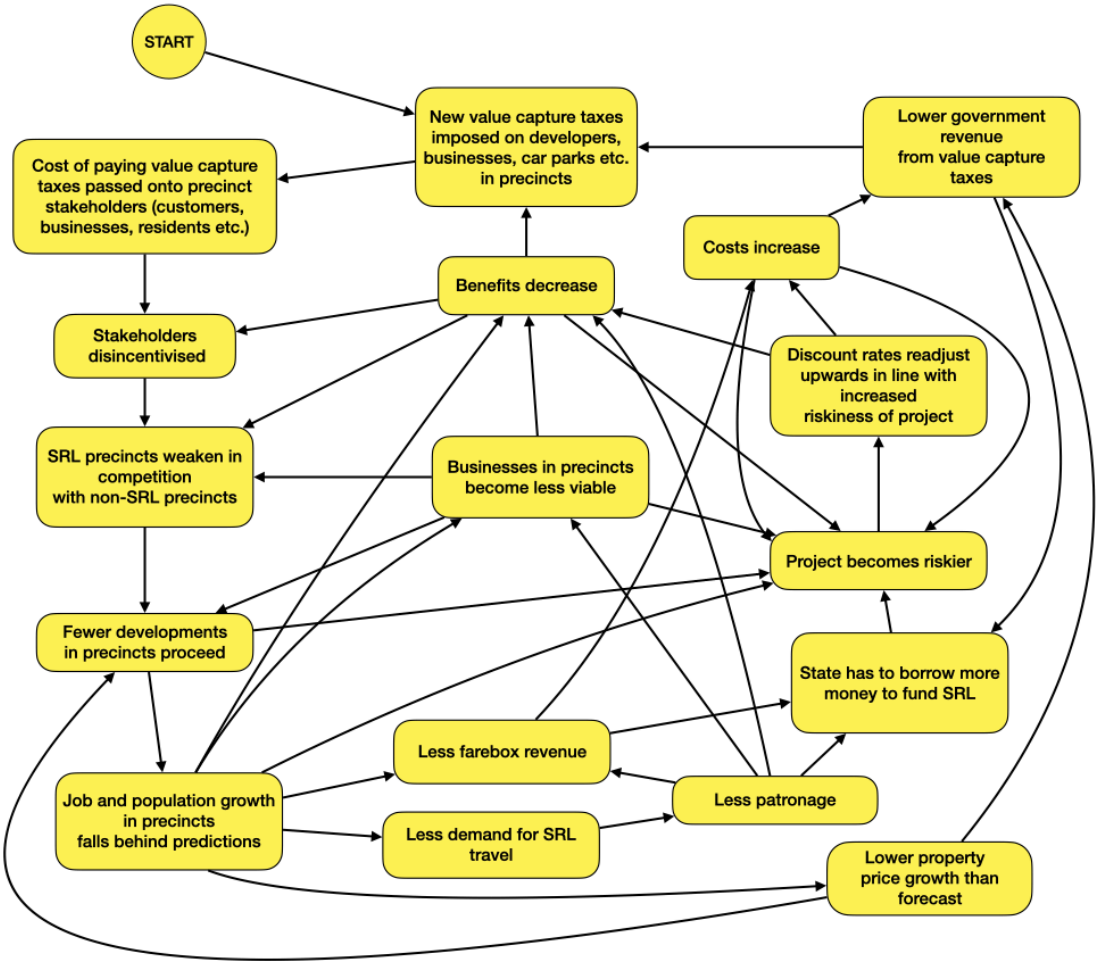

Figure 5 - Influence Diagram of Possible Effects of Value Capture Taxes

The state also bears the risk that future state governments may find it politically untenable to follow through with the imposition of planned value capture taxes, or that the value capture contribution falls short of the expected contribution to project funding.

8.5 Conclusion

Despite the government's claim that one-third of the cost of the SRL will be funded by 'value capture', it is difficult to see how the contribution to the project from value capture could amount to more than a few percent. The potential funding shortfall of at least thirty percent will need to be made up by the State of Victoria. Nor is ratcheting up the level of value capture taxes in precincts to pay for the project likely to work.

9. Other Funding and Financing Issues

9.1 Insufficient Private Sector Involvement

A remarkable aspect of the SRL, particularly given its risky nature, is the lack of private sector involvement in its financing and funding arrangements. The private sector, among other advantages, has the capacity to absorb some risk so as to reduce the exposure of taxpayers, to bring high levels of international expertise to the procurement process, to promote high standards of governance at arm's length from political interference, and to promote better transparency by exposing the business case to market signals and market competition. All of this is in the public interest. Professor Flyvbjerg recommends that on rail megaprojects, 'full public financing or financing with a sovereign guarantee ought to be avoided'.[238]

Flyvbjerg states:[239]

> The decision to go ahead with a project should, where at all possible, be made contingent on the willingness of private financiers to participate without a sovereign guarantee for at least one-third of the total capital needs. This should be required whether projects pass the market test or not, that is, whether projects are subsidised or not or provided for social justice reasons or not. Private lenders, shareholders and stock market analysts would produce their own forecasts or would critically monitor existing ones. If they were wrong about the forecasts, they and their organisations would be hurt. The result would be more realistic forecasts and reduced risk.

Furthermore:[240]

> Private capital is no panacea for the ills in major infrastructure project management, to be sure. …But private investors place their own funds at risk, as opposed to governments who place the taxpayer's money at risk. Capital funds and banks can therefore be observed not to automatically accept at face value the forecasts of project managers and promoters. Banks typically bring in their own advisers to do in-

[238] Bent Flyvbjerg, Nils Bruzelius and Werner Rothengatter, *op. cit.*

[239] *Ibid.*, pp. 139-140. See also Gerald Tucker in Patricia Galloway, Kris Nielsen and Jack Dignum (eds, 2013) *Managing Gigaprojects: Advice from Those Who've Been There, Done That*, ASCE Books, pp. 143 – 150.

[240] *Ibid.*, pp. 361-362.

> dependent forecasts, due diligence, and risk assessments, which is an important step in the right direction. The false assumption that one forecast or one business case (which is also a forecast) may contain the truth about a project is problematized. Instead project managers and promoters are getting used to the healthy fact that different stakeholders have different forecasts and that forecasts are not only products of objective science and engineering but of negotiation. Why is this more healthy? Because it is more honest about our future and our ability to predict the risks involved.'

9.2 Fails to Consider State Credit Rating Risk

Nowhere, in the financial section or elsewhere in the *Business and Investment Case*, is the risk of credit rating agencies lowering Victoria's credit rating as a result of borrowing requirements brought upon by the SRL discussed, considered or modelled. This is an omission.

9.3 Undiversified As an Investment

Diversification of risk is a hallmark of good investment practice, particularly for an investment worth as much as tens of billions of dollars.[241] From this standpoint, SRL is a poorly diversified investment choice for the people of Victoria. It is overweight in shopping malls, suburban university campuses, cheap suburban high-rise apartments and developments in a band of suburbs 16km to 20km out from the CBD. It is underweight in everything else.

9.4 Ratio of Increase in State Tax Receipts to State Interest Repayment Obligations is Less Than Unity

To judge the 'economic return on investment' of the SRL, KPMG derives four key performance indicators ('KPIs').[242] They are presented as ratios. As with benefit-cost ratios without safety margins, for such measures a score greater than 1.0 is presumptively a good thing and a score of less than 1.0 is presumptively a bad thing. At the time that KPMG's report was produced, Canberra had yet to commit any funds to the SRL. At the time of production of this report, the federal

[241] Burton Malkiel, *op. cit.*, pp. 197-204.

[242] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*: Appendix C.2: *Economic Appraisal Report* (by KPMG), pp.101-102.

government has committed a sum of $2.2 billion, or around five per-cent of the originally forecast project cost.[243] Notwithstanding that, KPMG's assessment assumes that one-third of the project will be financed by the state, one-third by value capture and the remaining one-third by the Commonwealth. As KPMG puts it:[244]

> 'This return on investment analysis assumes that the investment cost is borrowed and split one-third State Government funding, one-third Australian Government funding and the balance of one-third from value capture. Borrowing cost is based on the 10-year TCV bond rate and 10-year Commonwealth bond rate for the State and Australian Governments respectively. The KPIs have been calculated using total cost (capital expenditure and benchmark borrowing cost) and the real increase in GSP / GDP.'

The third of the four KPIs is the ratio of state tax receipts to the state's interest repayment obligations. It is essentially a measure of the state's ability to meet its financial obligations arising from the project or, to put it another way, the extent to which the project will be self-financing from the state government's point of view. The KPI comes out at 0.7, a 30% deficit for both staging scenarios.[245]

KPMG glibly dismisses this 30% deficit as a 'small shortfall'.[246] But is 30% on a project of this magnitude really so small?

One way or another, even *with* the assumption that the Commonwealth will provide a third of the funding, the project still falls a very long way short of being self-financing from the state government's point of view. This issue ought to have been considered in light of the state's credit rating risk.

9.5 Risk of Federal Government Not Providing Funding Not Addressed

As mentioned above, the *Business and Investment Case* assumes that one-third of the funding of the SRL is to be raised by mechanisms of 'value capture', one-third by state government borrowing, and one-

[243] What to Know About Anthony Albanese's $2.2 billion pledge for Victoria's Suburban Rail Loop'
[244] *Ibid*., p. 101.
[245] *Ibid*., p. 102.
[246] *Ibid*.

third by federal government contributions. As the *Economic Appraisal Report* states:[247]

> 'We assume that all investment is initially financed by the government through foreign borrowing. So government debt is increased by the total investment cost per year. Thus, during the construction phase the government debt rises above baseline levels reflecting the cost of implementing the rail project. Once the construction phase ends the government budget (as a ratio of GDP) is slowly reduced to baseline levels by 2079. This is achieved through higher income taxes raised by the Australian Government and paid to Victoria via higher intergovernmental grants. From 2080 to 2084 the Victorian Government pays back all borrowings used to finance their share of the investment cost (50 per cent). This is achieved via a broad-based consumption tax raised in Victoria. These assumptions ensure that the project build cost is *equally shared* by the Australian and Victorian Governments reflecting the financing arrangements of the project.'

The proposition that the federal government will match the state government's contribution is only an assumption. The federal government has so far only announced that it is committed to funding $2.2 billion, which amounts to about one-twentieth of the forecast project cost.[248] As this commitment is a lump sum rather than a percentage, the percentage share of project costs that it represents will diminish if the costs blow out and the State of Victoria will be required to make up the difference.

There is every possibility that no further funding from Canberra will materialize. How will that affect the financial viability of the overall scheme? Instead of going into a state of denial about this possibility, the SRLA ought to analyse and address this possibility and its consequences for the state within its multi-scenario modelling.

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[247] Suburban Rail Loop Authority (2021) *Suburban Rail Loop Business and Investment Case*: Appendix C.2: *Economic Appraisal Report* (by KPMG), pp. 182-183.

[248] Benita Kolovos, 'What to Know About Anthony Albanese's $2.2 billion pledge for Victoria's Suburban Rail Loop', *The Guardian*, Tuesday, May 10, 2022; <https://www.theguardian.com/australia/news/2022/may /10/what-to-know-about-anthony-albaneses-22bn-pledge-for-victorias-suburban-rail-loop.>

9.6 Conclusion

In addition to concerns over the value capture arrangements, the funding and financing arrangements for the SRL raise several alarm bells, the largest of which is in relation to federal funding. While the *Business and Investment Case* is based on the proposition that Canberra will pay for one-third of the project, there has so far only been a federal commitment of only $2.2 billion, or about 5% of the initially estimated cost of the project. The State of Victoria will need to make up any shortfall. As an investment for Victorian taxpayers, furthermore, the SRL is poorly diversified. Credit rating risk has not been addressed in the *Business and Investment Case*. The increase in state tax receipts that the project supposedly brings will not be enough to cover interest repayments.

10. Overall Conclusion

MELBOURNE is a large, prosperous and growing world city. According to at least one demographer, Melbourne recently overtook Sydney to become Australia's most populous metropolis.[249] Like most cities of its size, Melbourne's transport networks experience myriad congestion problems. It is not unreasonable for the Victorian State Government ('the government') to seek to invest in and develop metro-style rail networks in Melbourne.

In this regard, the case for improving public transport connectivity in the middle suburbs of Melbourne generally is strong, and this is particularly so for the Monash/Clayton area.

The multi-billion dollar megaproject that the government has proposed not only to tackle some of Melbourne's congestion problems but also to catalyse much of the future development of the city, the Suburban Rail Loop (SRL), is the subject of this report. Measured by its headline estimated cost of $35 billion for the first two stages and about $50 billion for all three stages, the SRL is the biggest project in Victoria's history. It is unprecedented.

Despite this promising background, and notwithstanding that the SRLA's purported benefit-cost ratio for the project is greater than unity, the SRL appears to overcapitalize on its design objectives to an enormous extent: that is to say, to the tune of at least $20 billion.

In other words, the SRL has the potential to be one of the biggest peacetime infrastructure boondoggles in modern world history. That this is so should be of a matter of grave concern to Melburnians, Victorians and Australians.

How has this happened?

Metaphorically speaking, red flags and warning signs abound. High-level conceptual design choices as to route, mode and grade appear to have been made without sufficient analysis or concern for the economic consequences and without adequate expertise in rail engineer-

[249] See Demographia (2022) *World Urban Areas Report* <www.demographia.com>.

ing, project risk or other relevant disciplines. The two documents that the government uses to justify its decision to proceed with the project, the *Strategic Assessment* and the *Business and Investment Case*, are both misleading and deeply flawed. The project bears many of the hallmarks that typify failed megaprojects: secrecy, optimism bias, the planning fallacy, lock-in, politicization, bureaucratic groupthink, the absence of peer review and the selective disclosure and non-disclosure of information. Procedural mistakes in the procurement process beget substantive mistakes in the conceptual design. The risks that the project faces and to which the state is exposed, furthermore, are poorly understood and poorly analysed by the government and the project's proponents.

The biggest reason why the project is uneconomic, however, is a simple one: the government's insistence that the rail line must be installed underground in tunnels bored by tunnel boring machine (TBM). This extremely expensive design choice is unnecessary. The 'economies' that make rail projects successful are economies of density, not economies of size. The suburbs that the SRL passes through simply do not have the activity density or population density to justify the expense of TBM-bored tunnels. This will remain the case even if the proposed precinct densification initiatives are as successful as planned.

Preliminary analysis suggests that the best grade and mode choice along the route of the SRL would be a light metro or light rail system in elevated viaducts along ample existing corridors such as Clayton Road and Springvale Road.

If more TBM-bored rail tunnels are to be added to Melbourne's rail network, they ought to be bored closer to central Melbourne where much better economies of density are to be found, in a manner similar to or the same as that suggested in Appendix 2.

There are four high-level risks that the Victorian public should understand that the SRL is exposing them to. These are: (1) the risk of a cost overrun; (2) the risk of a benefits shortfall; (3) the risk of a funding shortfall and (4) further risk compounded by the project's 'too big to fail' status.

Cost overruns are widely regarded as endemic on megaprojects generally and rail megaprojects in particular. For that reason alone, SRL exposes the state to considerable cost overrun risk. There is insuffi-

cient information within the *Business and Investment Case*, however, to allow for a detailed examination of cost data.

But cost overrun risk is far from the whole story. Projects are conventionally judged by the ratio of benefits to costs (or benefits divided by costs). So a 50% benefits shortfall (i.e. in the numerator) has the same deleterious impact on project viability as a 100% cost overrun (i.e. in the denominator). The State of Victoria is liable to the double whammy effect of a cost overrun and a benefits shortfall occurring simultaneously.

Economic benefits depend largely but not entirely on passenger demand. Unlike other rail megaprojects such as London Crossrail, Paris Grand Express and Sydney Metro, the pattern of travel demand across the SRL precincts is unestablished. The SRL's viability depends on the government's ability to fulfil its own plans for the large-scale densification of station precincts across twelve tracts of land whose collective area is equivalent to more than seventy CBDs. As the precincts are competitors in a market economy for property development opportunities across the country, it is no foregone conclusion they will succeed in the manner that the government plans. Many of the methods and inputs into calculations of economic benefits appear flawed and exaggerated, as is discussed within this report.

The third issue that the public need to be aware of is the risk of a funding shortfall. The SRL has been planned on the basis that one-third of the project is to be funded by the federal government, one-third by the State of Victoria and one-third by 'value capture' initiatives in like manner to overseas projects. So far, however, only $2.2 billion or about five percent of the estimated cost of the project has been pledged by Canberra. Even more alarmingly, it is difficult to see how value capture measures can successfully raise more than a few percent of project cost. That raises the very likely prospect that the Victorian government will be liable to pay not just its self-allocated portion of 33%, but at least 92% of the SRL's cost.

The fourth issue that the public need to be aware of is the project's 'too big to fail status'. The SRL is at least an order of magnitude larger than most of the other projects that are contemplated by standard guidelines. If the SRL fails economically, severely detrimental and irreversible consequences for the Victorian economy as a whole could follow. A project of the SRL's magnitude may be classed as 'strongly

non-ergodic' whereas the typical projects contemplated by standards and guidelines are 'weakly non-ergodic'. Strongly non-ergodic projects require a profoundly more prudent and conservative philosophy to risk management than more moderately sized projects. For this and for other reasons, Victorians should not be comfortable with an absolute benefit-cost ratio derived using orthodox methods for a project of this size of anything less than 3.5.

To posit a far from improbable scenario, if the SRL experiences a 100% cost overrun along with a 50% benefits shortfall, the State of Victoria will have wasted approximately $75 billion: it will have expended approximately $100 billion for a return of only $25 billion in benefits. That wastage will be equivalent to more than $10,000 for every Victorian. In the circumstances the state will probably also need to guarantee funding and financing to the tune of about $96 billion: about $79 billion more than it is currently forecasting.

It is better for the State of Victoria to face up to these issues now than decades later at a Royal Commission into why the state's economy went pear-shaped.

11. Recommended Action

First, the government needs to recognize that it has made a mistake and has a problem. Rather than launch a blitzkrieg of propaganda and spin to cover up the problem and mistake, it needs to take remedial action. It is important not to fall foul of the 'sunk costs' fallacy. In light of the findings of this report, the following actions are now suggested:

- That the government immediately cease all construction expenditure on the SRL, most especially expenditure on TBM tunnelling.

- That the government put out to competitive tender re-engineering the SRL corridor to a cheaper mode/grade choice, with a particular view to adopting mode/grade choice option (8) as described in section 3.10 of this report (driverless light metro elevated in viaducts along existing corridors) or perhaps, a combination of mode/grade choice options (7), (8) and (9), as described in section 3.10 of this report.

- That the government put out to competitive tender the design development of an inner city metro loop ('MIRL') as suggested in Appendix 1, or similar. This would enable the efforts of tunnelling sector to be redirected to the inner city where the economies of density are much superior.

- That the government put out to competitive tender a comparative real options analysis including the two prospective projects described above and, as an alternative, the 'super-loop' scheme suggested in Appendix 2. All prospective options should be run through VLUTI and appraised economically.

- That the government seek to renegotiate all SRL contracts as applicable, so as to redirect the efforts of the SRL contractors to a cheaper grade/mode choice and to redirect the efforts of the tunnelling sector to the MIRL scheme suggested in Appendix 1, or similar.

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— Appendix A: *SRL Stage 1 Rail Tunnel Alignment*

— Appendix B.1: *Precinct Location Options Assessment Summary*

— Appendix B.2: *Station Location Options Assessment Summary (SRL East)*

— Appendix B.3: Part A *Precinct Development Framework*

— Appendix B.3: Part B *Case Study Compendium*

— Appendix B.4: *Urban Design Framework*

— Appendix C.1: *Demand Modelling Report* (by KPMG)

— Appendix C.2: *Economic Appraisal Report* (by KPMG)

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Appendix 1 – Sample Photos of Surface Roads Between SRL Precincts

For the benefit of readers unfamiliar with the areas traversed by the SRL, the following photos are extracted from Google *StreetView*. The photos show typical views of some of the road surface corridors between SRL station precincts.

Judge it for yourself. Do you agree with the SRLA that these areas are so narrowly cramped that TBM-bored tunnels are a must?


41 Mahoneys Rd
Thomastown, Victoria
Google
Street View - May 2021
Mahoneys Rd
Google


32 Yarra Ave
Reservoir, Victoria
Google
Street View - Sep 2018
YARRA
SHOPS
Google


345 Station St
Box Hill South, Victoria
Google
Street View - Oct 2019
Station St
College
Google


345 Station St
Box Hill South, Victoria
Google
Street View - Oct 2019
Station St
College
Google


242 State Route 26
Burwood, Victoria
Google
Street View - Sep 2019
DEAKIN
Google


469 Springvale Rd
Glen Waverley, Victoria
Google
Street View - Oct 2019
State Rd
Google


179 Huntingdale Rd
Oakleigh East, Victoria
Google
Street View - Jan 2019
MOWERS HAIR STUDIO
Huntingdale
Google


225 Wellington Rd
Mulgrave, Victoria
Google
Street View - Nov 2018
Wellington
Google


Clayton, Victoria
Google
Street View - Feb 2019
Wellington Rd


207 Wellington Rd
Mulgrave, Victoria
Google
Street View - Nov 2018
Wellington Rd


388 State Route 18
Mulgrave, Victoria
Google
Street View - Mar 2020
Wellington Rd
Reserve
Waverley
Google


316 State Route 23
Clayton, Victoria
Google
Street View - Sep 2019
ORIENTAL DISCOUNT SHOP
Clayton Super Discount
State Route


227 State Route 23
Clayton, Victoria
Google
Street View - Mar 2020
State Route 23
Google


239 State Route 23
Clayton, Victoria
Google
Street View - Mar 2020
State Route 23
Google


632 Clayton Rd
Clayton South, Victoria
Google
Street View - Mar 2020
Lease
Footpath Works
Clayton Rd
Google


316 State Route 23
Clayton, Victoria
Google
Street View - Sep 2019
Clayton Super
State Route 23
Google


391 State Route 15
Moorabbin, Victoria
Google
Street View - Sep 2019
Google


86 Centre Dandenong Rd
Cheltenham, Victoria
Google
Street View - Oct 2019
Google

Appendix 2 – Opportunity Cost Study 1: Melbourne Inner Rail Loop (MIRL)

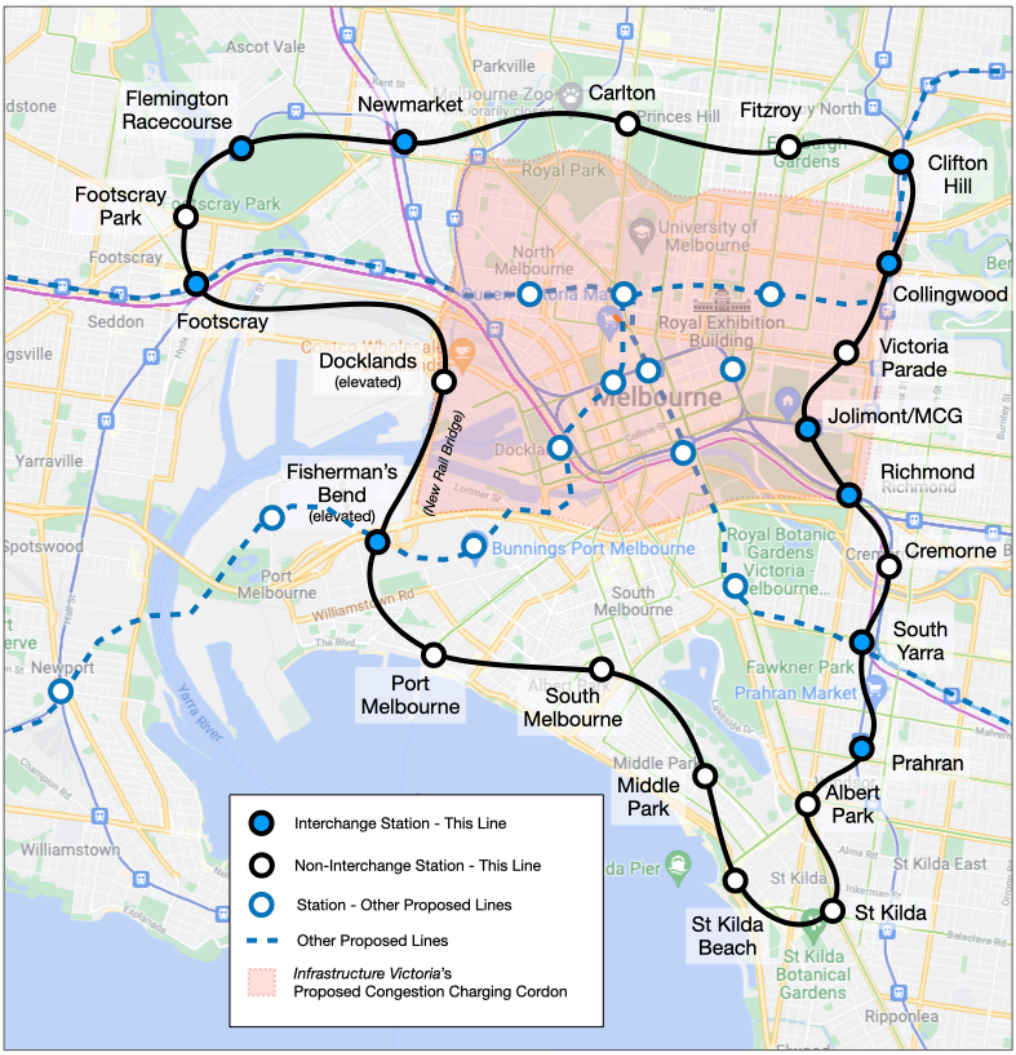

Figure 6- MIRL Map

Key Features and Advantages

1. MIRL interchanges with the Melbourne Metro Rail (MMR) extension at Footscray and proposes a second MMR interchange at South Yarra Station. It interchanges with MMR2 at Fisherman's Bend, Collingwood and Clifton Hill. It interchanges with the existing suburban rail network at Richmond, Footscray and Newport.

2. Infrastructure Victoria advocates that inner Melbourne adopt a road congestion charging cordon, like London. MIRL gels well with this objective.

3. *Connectivity with Plan Victoria precincts*. SRL links to two 'national education and innovation precincts' (NEICs) in its first two stages: Monash, La Trobe. In the third stage it links to another two NEICs: Sunshine and Werribee. SRL also links to two 'metropolitan activity precincts' (MAPs): Clayton and Heidelberg. MIRL on the other hand links three NEICs: Fisherman's Bend, Footscray and Parkville. Unlike SRL, MIRL connects with a 'priority precinct', Fisherman's Bend, and runs very near another 'priority precinct', North Melbourne. SRL also links with the MAP of Footscray and a 'transport gateway', the Port of Melbourne. SRL does not connect with any transport gateways. MIRL also links to no fewer than six 'health and education precincts' (HEPs).

4. Tourists, business visitors and convention delegates will love it as it allows them to traverse many of the more interesting parts of Melbourne without difficulty.

5. MIRL proposes an elevated rail bridge to run alongside the Bolte Bridge. This would provide spectacular views. Tourists would love it.

6. Traversing along St Kilda, Albert Park, South Melbourne and Port Melbourne makes beaches more accessible and fosters beachside development in those areas. This will help Melbourne develop a more beach-oriented culture, which may be aided by global warming.

7. Major events are an important part of Melbourne's economy. MIRL helps facilitate access and egress to major event venues including Flemington Racecourse, Albert Park, the MCG, and the large number of venues near the MCG including Rod Laver Arena, Margaret Court Arena, John Cain Arena, the Melbourne Park tennis complex, the rectangular soccer and rugby stadium and Olympic Park. Princes' Park in Carlton may be resurrected as a venue for major sporting events. MIRL also facilitates access to this venue.

8. MIRL provides a foundation for a future metro network that can then be extended by adding further lines in the future. This could be achieved by replacing congested tramlines with metro format, as has occurred in many European cities, converting suburban lines to metro format, as has happened in Sydney, or building new metro lines. Versatility and flexibility are key.

9. MIRL promotes the concept of the polycentric city by de-emphasising the Hoddle Grid and encouraging development further away. This is 'near' polycentrism rather than 'far' polycentrism, as with London and Toronto. It doesn't throw the agglomeration baby out with the congestion bathwater.

10. MIRL completes the circle, thereby providing a more efficient arrangement for transit than an arc.

11. MIRL links with the cruise terminal at Station Pier. This is a source of high-spending tourists.

12. MIRL is about 30km in length, which is similar to circle lines that have been proven to work well in other world cities, including London, Singapore, Berlin and Moscow.

13. Being only about 30km in length when complete, rather than 90km, means that MIRL will be much cheaper. The project is also likely to be completed in not much more than one-third of the time of the SRL.

14. MIRL follows corridors which have the possibility of employing cheaper tunnelling methods than boring with TBMs, such as cut-and-cover tunnels. This is particularly true along the Hoddle Street/ Punt Road corridor.

15. MIRL could make use of maintenance, repair and depot facilities at Newport.

16. Passing through a large number of interesting cultural and major event precincts will ensure that MIRL will enjoy high patronage at all hours, rather than just at the start and finish of working times.

17. MIRL will provide massive agglomeration benefits and do wonderful things for GSP and GDP. It will enable Melbourne to agglomerate to a greater urban critical mass in its centre and be more competitive against its main competitor city, Sydney.

18. MIRL accords with theories of optimal transit system design and the fractal geometry of the city.

19. MIRL enables a proper metro system, with six car sets, rather than a 'light metro' system with four car sets.

20. MIRL provides a diversified investment for taxpayers in Melbourne's and Victoria's future, rather than an investment overweight in shopping malls, suburban university campuses and cheap suburban apartments.

21. Areas relatively close to the CBD have better growth prospects and provide a surer return for investors than suburban developments. MIRL has little risk of becoming a boondoggle by overcapitalising too far away from the urban core.

22. MIRL provides numerous opportunities for value capture. Value uplift is much greater in the inner city than in the middle suburbs.

23. MIRL is fairer to regional Victorians and interstate taxpayers, who tend to visit central Melbourne much more frequently than the suburban sandbelt.

24. MIRL will improve Melbourne's liveability from the standpoint of high income earners who contribute the most to the economy and government revenue, as well as low income earners and students. Improving Melbourne's liveability from the standpoint of high income earners will make it a more attractive place for national and international businesses, which will induce numerous positive knock-on effects.

25. MIRL would take pressure off the problematic and congested Hoddle St/ Punt Rd corridor.

26. Sir Rod Eddington's 2006 report *Linking Melbourne* emphasized that the key to maintaining and growing Melbourne's future prosperity is unlocking and growing the economic potential of the western suburbs. That has not changed. With stations at Yarraville and Footscray, MIRL accords with Sir Rod's vision.

27. The western suburbs are among Melbourne's most disadvantaged suburbs, with which MIRL links. There are also concentrations of disadvantage at state housing complexes in Flemington, Prahran and South Melbourne. The Footscray campus at Victoria University, within the Footscray NEIC, is responsible for educating a large number of students with migrant backgrounds from the global south, indigenous Australians, refugees and asylum seekers. MIRL packs a great punch in helping the disadvantaged

to overcome inequality and fostering 'social equity' and 'social inclusion'.

This option should be appraised and run through VLUTI.

Appendix 3 –Opportunity Cost Study 2: The Super-Loop

Alternatively, consideration ought to be given to linking several 'metro' rail projects together to create a single long continuous driverless metro line that loops back on itself at each end. This could produce tremendous operational efficiencies. It would be awesome. On the map, it would form a back-to-front 'α' shape, with an elongated bottom strand stretching to Geelong. Except for the looping aspect, this option would bear some resemblance to Sydney Metro. Similarity to Sydney Metro could make for a compelling argument that it ought to receive federal funding in like manner to Sydney Metro. The sections are:

- Geelong Fast Rail (from Geelong to Newport).
- Melbourne Metro Rail 2 (from Newport to Clifton Hill).
- A linkage from Clifton Hill to Doncaster via Kew.
- The Doncaster-Monash section of SRL (but with a bigger gauge).
- A linkage from Monash to Caulfield via Chadstone.
- Melbourne Metro Rail (from Caulfield to North Melbourne).
- Melbourne Airport Rail Link (from North Melbourne to Melbourne Airport).

The route in outline:

> Geelong - Avalon Airport – Werribee – Newport = Fisherman's Bend = Southern Cross = Flagstaff = Fitzroy = Clifton Hill = Kew – Doncaster – Box Hill – Monash - Chadstone = Caulfield = South Yarra = Anzac = Town Hall = State Library = Parkville = North Melbourne – Sunshine – Melbourne Airport – Broadmeadows (possibly).

Where '=' represents and underground section and '–' represents an at grade or elevated section.

Or more succinctly: Geelong to Doncaster, Doncaster to Monash, and Monash to Broadmeadows.

This option should also be appraised and run through VLUTI.