Thinking Outside the Box

2023 Thought Pieces

The Institute of Transport and Logistics Studies (ITLS) at the University of Sydney Business School in 2015 started a commentary series, adding it to its portfolio of engagement with the broader community of interests in the space of Infrastructure, Transport, Logistics and Supply Chain Management.

While academic publications and reports are a very important outlet for high quality research including debates on themes with a rich policy and strategic value beyond theory, methods and evidence, there is room for a series of short pungent commentaries on themes that are of broad community interest. These are short pieces so they can be digested through the many social media platforms and focus on topics of currency that are also likely to be challenging and controversial – hence the titling of the series 'Thinking Outside the Box'. It has all the elements of critical thinking and the 'challenge of change'.

Each piece is published monthly since April 2015, but we thought it would be useful to bring all of the 2023 contributions together into a monograph that is freely available. We hope it will be useful to researchers, consultants, government and industry agencies and associations as well as in the classroom for debate and discussion.

David A. Hensher
Founding Director, ITLS

Thinking outside the Box Series

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Our research projects contribute to the design, improvement and optimisation of infrastructure, transport, logistics and supply chain initiatives around the world. Our experts are investigating a range of pertinent issues including the implications of Working from Home, Sustainable Transport Futures and MaaS. We are also regularly being called upon for media comments. You can view all this work and more on our **research projects page**.

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1. Taken for a ride: The real cost of Sydney's metro railways

9 January 2023

Christopher Day and Dick Day question the value of the large investments made in Sydney's metro system and its proposed developments.

Sydney is in the throes of a massive wave of **investment** in automated, stand-alone high-capacity metro railways. These technologies are tried and tested in very large and densely settled **cities** such as Hong Kong, Shanghai, Beijing and Taipei. Unfortunately, metro expenditure in Sydney is failing to relieve congestion on the existing rail system. Post COVID-19, changes in workplace **commuting** call into question the continued heavy expenditure on additional metro projects.

Metro implementation in Sydney has had bipartisan support. This ultimately metamorphosed into a government decision to construct the new railway line from Epping to Rouse Hill as an automated metro, as opposed to the initial plan to build it as an extension of the existing, conventional rail system. Simultaneously, the new line between Epping and Chatswood, then less than 10 years old, was converted to metro operation. From the outset it was proposed to extend the automated metro line through the CBD and, by conversion of an existing heavy rail link from Sydenham, onwards to a terminus at Bankstown, in the south-western suburbs. A proposed bifurcation from Sydenham to Hurstville was quickly abandoned when it was appreciated that the specialised metro operating requirements were incompatible with freight trains that shared the route. Subsequently metros have been adopted both to provide a circumferential **link** from the far western suburbs at St Mary's to the site of Sydney's second airport and to link the metropolitan area's second CBD at Parramatta directly to the Sydney CBD. In both cases there has been an unprecedented **rush** by the government to lock in the construction of these projects despite a very poor understanding of their costs and benefits. This has taken place at a time when commuting patterns have shifted **considerably** following COVID-19, and the development industry is under intense resource pressure leading to very rapid price escalation.

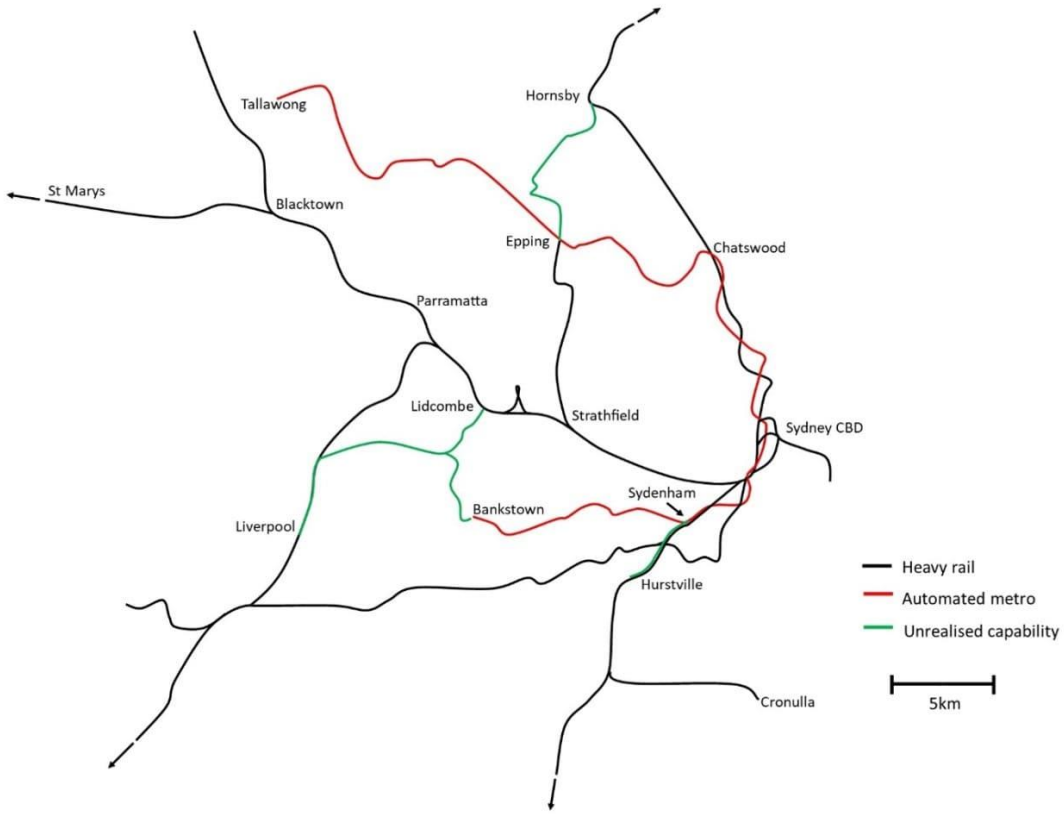
This article questions the value of the current splurge on metro construction.

Sydney's first metro: Tallawong to Bankstown

The new metro from Tallawong, in north-west Sydney provides a much-needed rail link to a broad range of destinations. However, the choice of an alternative technology has led to significant cost increases and passenger inconvenience which are less well documented.

Additional costs were incurred in four ways. Firstly, there was conversion of the recently completed existing line between Epping and Chatswood which involved considerable resignalling, major modifications to the overhead and electrical supply systems and platform modifications to suit the new metro trains. Secondly, there were significant costs in adapting the northern part of the existing North Shore Line to accommodate the extra trains needed to carry passengers alighting from the Metro at Chatswood and proceeding towards the city. This involved a difficult and expensive upgrade at Hornsby which will cease to be required when the metro extension to the CBD is completed. Thirdly, additional trains were required due to the forced change at Chatswood compared to conventional direct trains from the north-west sector to the CBD. Finally, there was a significant increase in rail congestion caused by rerouting Hornsby trains traveling via Epping onto their traditional and congested route via Strathfield.

A map of the Sydney rail network, including the North-West, City and South-West Metro is as follows.



Source: Authors

The extension of the metro line through the CBD provides a much-needed increase in central area capacity. The Metro's fundamental deficiency becomes apparent south of Sydenham and results in its inability to operate at more than half its achievable capacity, whilst limiting relief to the rest of the rail system. Unlike the Eastern Suburbs Railway extension of 50 years earlier, through which train diversion benefitted the entire rail network, the new Metro only gives effective congestion relief to trains operating from Bankstown, East Hills and Campbelltown. In order to achieve this more modest uplift the Bankstown Line requires extensive modification to cope with driverless metro trains. Furthermore, some stations beyond Bankstown lose their through service entirely whilst others will be forced onto the alternative and congested route to the city via Lidcombe and Strathfield making services from the Liverpool/Fairfield area of the city even slower than today.

Adoption of the original Metro plan, which incorporated additional services to Hurstville, would have afforded significantly greater benefit by relieving congestion on the Illawarra Line from Sutherland, Cronulla and the South Coast. It would also have taken up a significant amount of the endemic spare capacity caused by having only a single southerly connection from the Bankstown Line which, by any stretch of the imagination, is unlikely to ever produce more than 16,000 passengers in a peak one hour, even after massive, and perhaps unwanted, construction of additional high-rise apartments.

Underutilisation of the new CBD metro tunnel also applies to services from the north. The Metro indeed has the much-vaunted capacity to move at least 30,000 people per hour in each direction. Unfortunately, the entire north-west sector is unlikely to generate more than 16,000 boardings per hour in the foreseeable future.

Metro mania

With Sydney's first metro far from complete, and at a time when COVID-19 has dramatically increased the rate of change away from traditional full-time CBD office employment, one might

surmise that further metro adventurism would be firmly on **hold**. Instead, there has been a rush to commit to vast additional projects for which there is little rationale.

The proposed Western Sydney Metro is a north-south circumferential line with six stations connecting a relatively small suburban station in Western Sydney to the new Western Sydney Airport and putative third CBD, currently an undeveloped area to the south of the airport site. The cost is estimated at $11 billion!

The most basic understanding of mobility requirements makes it apparent that trips to the future airport and adjacent centre will come from a variety of directions and, initially at least, will be primarily by car. In these circumstances public transport access is best served by a network of express **bus** services linking both the airport and future city centre directly to the surrounding major nodes of Campbelltown, Camden, Liverpool, Parramatta, Blacktown and Penrith. Whilst **reservation** of fixed transit corridors is laudable, enormous expenditure on an isolated metro system that will see quite limited use is a gross misuse of public funds. Indeed, the Commonwealth infrastructure agency has **questioned** the decision, but to no apparent avail.

Undeterred the NSW Government is also pressing ahead with another **metro** line from Westmead and Parramatta eastwards to the centre of the Sydney CBD. Superficially this seems a worthwhile investment to ease congestion on Sydney's busiest rail artery. However, even an initial examination makes it apparent that this will not be the case. The vast majority of rail passengers heading towards central Sydney from Parramatta have boarded their trains at the numerous stations further west and will not interchange onto the new metro which is projected to serve only one location in the Sydney CBD compared with six on the existing line between Redfern and North Sydney. The existing railway already boasts a three-minute service frequency in the peak period compared with the much touted four minute turn up and go frequency of the proposed metro! Whilst the West Metro will provide enhanced accessibility for a few areas around Olympic Park and Five Dock any benefit is dwarfed by the huge, but poorly articulated cost of the project, estimated at **$26.6 billion**. The only proposed station in the heart of the Sydney CBD will create enormous disruption in order to create a new rail link between the two CBDs of Parramatta and Sydney that in most cases will be less convenient as well as no quicker than the existing line.

In conclusion

Sydney's metro mania comes with a lot of hype. In reality, it is destined to be an extremely expensive and poorly thought through experiment found wanting as a cost-effective means of enhancing the metropolitan area's public transport network. Compare it with **London**, Melbourne or **Brisbane** where new railway tunnels through the heart of each city will accommodate existing train services at improved frequencies and provide relief for all of their existing networks.

Overall, the cost of creating Sydney's deliberately non-compatible metro rail system, let alone the **cost** of imposing it onto existing trackage such as the Bankstown line, substantially outweighs any imagined benefits from removing train drivers, privatising by stealth or marginally reducing tunnel bore size through the core of the CBD. Sydney will be increasingly vulnerable to service disruptions where train services can no longer be diverted onto alternative routes. Worst of all our first metro lacks the feeder routes that would provide enhanced congestion relief to the rest of the network and is limited to a ridership which is no more than half that which such a high-capacity system could readily sustain. The Parramatta to Sydney metro is poised to repeat this failure.

We are at what may be a watershed moment in central area employment, with CBD **workforces** and most employers showing no desire to return to pre-COVID levels of **occupancy**. Whilst it would be naïve to assume that central area office employment will not trend back up through time, it is apposite to recall that the Sydney CBD was managing the pre-pandemic commuter task with no rail enhancements. Even in its constrained configuration the metro will provide the equivalent of at least a 15% increase in usable capacity. Given the very real possibility that peak CBD rail commuting will never return to pre-pandemic levels, it appears

reckless at this time to commit vast sums of money on additional, and relatively ineffectual, enhancements.

How did the current situation come about and what can be done, if anything, to ameliorate it?

The last 15 years has seen a steady concentration of transport decision-making in the NSW Department of Transport, accompanied by a general deskilling of the specialised workforce previously responsible for managing the operation and development of the railway. There is a paramount need for comprehensive and informed analysis and discussion prior to critical, multi-billion dollar infrastructure investment decisions being made and a need to separate them from a largely unaccountable political environment. Unfortunately, there is little public pressure to embark on such comprehensive reforms.

Regarding the future of Sydney's metro railways, the western Sydney airport link is clearly premature. There is also no immediate need for a west metro from Sydney to Parramatta. At the least it must be made interoperable with the existing railway west of Parramatta as this would enable significant capacity enhancements for the whole western corridor. With regard to Sydney's first automated metro, the original concept of converting two of the tracks to Hurstville still has considerable merit. Unfortunately, adaptations that might permit through running from Hurstville are highly unlikely to prove contractually or financially acceptable.

2. Counting the full costs of transport choices

6 February 2023

John Rose is the Neil Smith Chair in Sustainable Transport Futures. Here, he discusses how calculating the environmental impact of transport involves more than simply calculating CO2 emissions.

Consumers in general are often very poor at understanding the full implications of their choices, particularly with respect to things they cannot directly observe themselves. When purchasing a cup of coffee for example, most consumers will be aware of the potential impact single use plastic lids have on the environment. Very few however will take the time to understand the origin of the coffee beans used to make their coffee, determine the potential environmental effects the production process may have at these locations (e.g., issues with possible deforestation, soil erosion and water contamination), or seek information as to whether or not modern-day slavery was employed anywhere along the supply chain. Unfortunately, the consequences affecting other parties arising from the industrial and commercial activities involved in delivering a coffee to the end consumer, are not likely to be reflected in market price of the coffee paid by the consumer. Economists have a word for such impacts: externalities.

When it comes to transportation choices, the general public are far more likely to believe that they have a better understanding of the consequences their decisions have on others, particularly with respect to the impact their choices have on the environment. In part, this is due to the fact that transportation as a sector tends to attract a disproportionately high level of media attention, as well as government intervention. For example, news coverage concerning electric vehicles has increased substantially over the past four to five years, whilst the government mandated that all new petrol vehicles sold since 1986 use unleaded petrol before implementing a nationwide ban on the sale of leaded petrol in 2002. Independent of one's belief as to whether or not climate change is real, or caused by human activities, it is highly unlikely that any given traveller would fail to understand that vehicles relying on internal combustion engine technology as the primary power source generate emissions, particularly in the form of CO_2 gases.

However, the ecological advantages of so called environmentally friendly vehicles, particularly electric vehicles, over internal combustion engine vehicles may not be as clear cut as many travellers believe. Considerable debate exists as to what, if any externalities are associated with electric vehicle manufacturing and use. Whilst consumers may be aware that the electricity used to charge batteries may come from unsustainable energy generation sources such as coal, there is growing consensus that other lesser-known externalities arise from simple use of vehicles on the road. One study conducted in London for example, monitored air pollution levels along 65 roads over a ten-year period and found that across many routes, air quality improvements resulting from the use of lower emission vehicles were outweighed by increases in particulate matter arising from wear on tires vehicle brakes, and roads in general (Font and Fuller 2016).

Consider the very act of braking. Most braking mechanisms involve some form of friction system that converts the kinetic energy of the vehicle into friction heat. Wear and tear of brake pads and brake rotors in such systems is unavoidable, resulting in material deposits along the roadway as well as airborne particulate matter (Lyu et al. 2020). Such particles largely consist of transition metals which **have been shown to be highly toxic**. Aside from environmental impacts, air pollutants from vehicle braking and road and tyre wear have been shown to increase cardiovascular diseases, and may also contribute to increases in Alzheimer's disease, asthma, acute respiratory infections, cancer, as well as a whole raft of other medical conditions.

Unfortunately, some estimates suggest that particles derived from braking and tyre wear may be up to 1,000 times the acceptable pollution limits set by the EU and contribute up to 20 percent of all traffic emissions (Grigoratos and Martini 2015). Worse yet, moves towards greater electric vehicle uptake may exacerbate the issue. This is because one of the major causes of

brake and tyre wear is vehicle weight, and unfortunately, electric vehicles tend to be far heavier than other types of vehicles on the road. As such, whilst adopting policies to promote electric vehicle uptake and use may on the surface appear to represent an environmentally responsible action, without understanding the full set of externalities of such technology adoption, it is possible we may be making things worse.

There currently are no policies related to controlling these types of emissions. What is known is that braking at speed from 50 km/hr results in almost twice as much particle emissions than braking from 30 km/hr, hence changing speed limits in urban settings may be one possibility. Developing new braking systems and adopting new tire technology may also provide some benefits. Of course, the most realistic possible solution is to reduce traffic volumes outright.

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3. It's called Frenchs Forest for a reason and why it is important to see the wood for the trees

8 March 2023

Rico Merkert and David Li look at the effectiveness and authenticity of carbon offsetting when looking at the true carbon footprint of proposals.

The recent record-breaking floods and the not-so-distant memories of 2019 bushfires still haunt many of us. Today, most have accepted the scientific consensus that we are at the dawn of a climate emergency. Amongst the many challenges surrounding us, controlling carbon emissions has proven to be the hardest job our modern society has ever witnessed. Living in the 'Lucky Country', it's easy for us to shift the attention away and blame others. Sadly, as our governments may often have us believe that we are doing everything we can to catch up, Australia is amongst the most carbon-intense economies in the world, at 15 tonnes per person per year (Figure 1), well ahead of most other advanced economies in the world. Yes, you heard it right. An average Australian emits more CO2 than an average American.

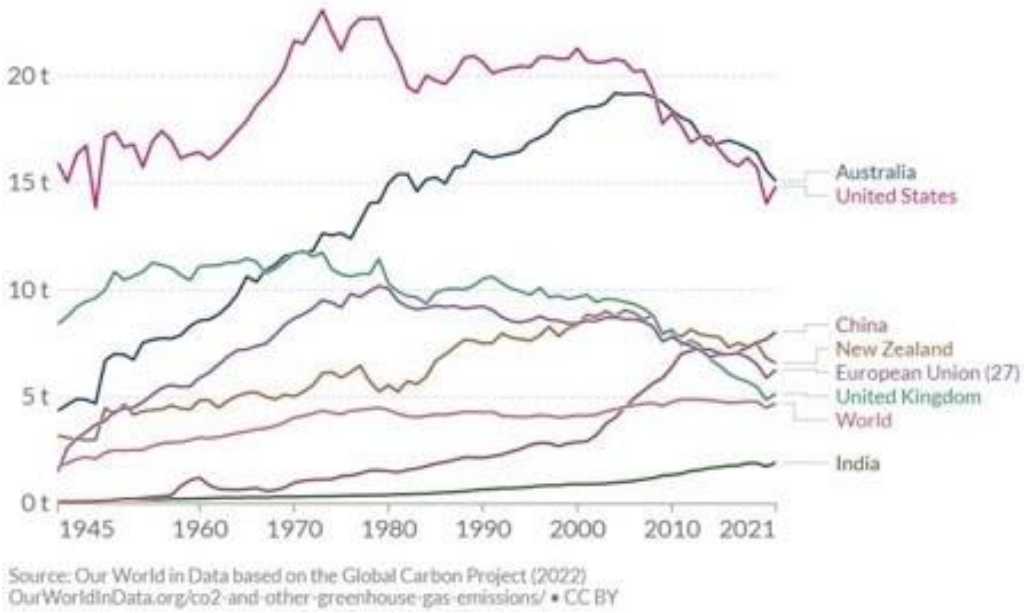

Figure 1. Per capita CO2 emissions by country; Source: Our World Data

Having the will is far from enough and we would be fooling ourselves to expect no changes to our way of life. Many sectors are starting to realise how entrenched we are in this fossil-fuel-powered modern life and how much hard work, investment, and compromise it's going to take to move the needle. The new federal government has recently announced to reduce Australia's emissions by 43% by 2030[1]. In the coming years, significant and swift changes will be necessary in areas such as where we live, work, and find entertainment, how we power our homes, what we eat, and how we move around our communities, commute to work, and travel the world. We can also expect more severe weather events to serve as a reminder of the urgency of these changes.

All these changes are geared to achieve an outcome. From Canberra to community neighbourhoods, from corporate boardrooms to local school classrooms, we are in the era of decarbonisation.

And this has brought us to the inconvenient truth in the recent MLALC development proposal at Lizard Rock, Morgan Road, Belrose. Despite a comprehensive list of benefits that are "consistent with the planning guideline", this proposal comes at a cost of 51.1 hectares of deforestation, in an area covered with mature *Bloodwood-scribbly gum, Narrow-leaved scribbly gum, Angophora woodland, coastal Banksia-Teatree scrub and Narrabeen Escarpment scrubs*[2].

Whilst we are not arguing against the potential economic and social benefits, such as additional housing, and indigenous cultural preservation this proposal seeks to achieve, we simply want to bring the attention of our community and politicians to the cost of deforestation, which is 'conveniently' not explicitly covered in the proposal reports.

It is hard to believe that in 2023, as the Australian society are moving mountains to take carbon (emissions) out of our life without inducing harsh impacts, we could be considering the option to build new housing at the cost of deforestation. Yes, trees are nice, but this is not an argument about the importance of preserving a native bush surrounding to our beautiful Sydney. We are simply arguing against the proposal from a carbon-economic standpoint, and the benefits of letting the bush be (say for biodiversity or recreational benefits).

Without any corporate jargon, we want to help our community understand the negative carbon impact of the Belrose project. We do this by calculating the carbon offset cost and material cost, two common measures used in the science community.

First, let's look at the numbers. The proposal report stated *a total area of 710 thousand square metres* of native bush, of which *511 thousand square metres (72%)* to be removed (Table 1). Figure 2 illustrates the area of concern.

Table 1. Lizard Rock proposal deforestation; Source: (GYDE, 2022)[3]

Total area (sqm)	**710,007**
Conservation under proposal (sqm)	198,802 (28%)
Estimated deforestation (sqm)	511,205 (72%)

Figure 2. Aerial view of site, outlined in white; Source: (GYDE, 2022)

We then plug the figures into the standard deforestation carbon conversion matrix (Table 2).

Table 2. Deforestation carbon conversion; Source: (IPCC, 2018)[4]

Area of concern (hectares)	**IPCC classification**	**CO2 emission per hectare of deforestation (tonnes)**	**Average CO2 emissions in area of concern (tonnes)**
51.1	Temperate forest	100-150	**6,390**

This gives us an estimation of 6,390 tonnes of CO2 emission. Whilst deforestation can be complex, we can interpret the result as such: the deforestation brought by the Belrose proposal would result in a surplus of 6,390 tonnes of CO2 being released into the atmosphere.

So, what does this mean? First, let's interpret this from a carbon offset standpoint. Suppose we ask a rural NSW landowner to plant trees on a farm in order to store carbon, and as a reward, be compensated with carbon credits at market price (this is what's happening in the carbon offset market today). At a cost of $37 per tonne[5], a rural landowner can offset the Belrose proposal carbon surplus at a cost of $236,432.

Let's also look at the material decarbonisation costs. For instance, one of the options we have today is to remove internal combustion engine cars from the roads. At an average petrol consumption of 7.5 litres per 100 km and an annual milage of 10,000 kms, we'd need to remove 3,630[6] cars from the roads for an entire year to offset the additional carbon induced by the Belrose proposal. Another option to decarbonise today is to reduce beef consumption. At an average level, each kilogram of beef consumed would generate 1 kilogram of emissions (CO2 equivalent)[7]. So, in order to reduce the emissions brought by Lizard Rock proposal, communities in the local area would need to reduce beef consumption by 6,390 tonnes. At an annual consumption level of 89.6 kg[8], all 13,473 residents in the Frenchs Forest area would need to remove beef from their menu for 5.3 years.

It is further worth noting that Lizard Rock is part of a wider proposal affecting six sites and hence a total area of 227.3 hectares. The remaining five sites require further investigation. Future land uses could include residential, industrial, employment and environmental conservation. These sites could have planning proposals or DAs submitted in the next 2-5 years or in other word potentially a lot more years of no beef on the plates of Frenchs Forest people.

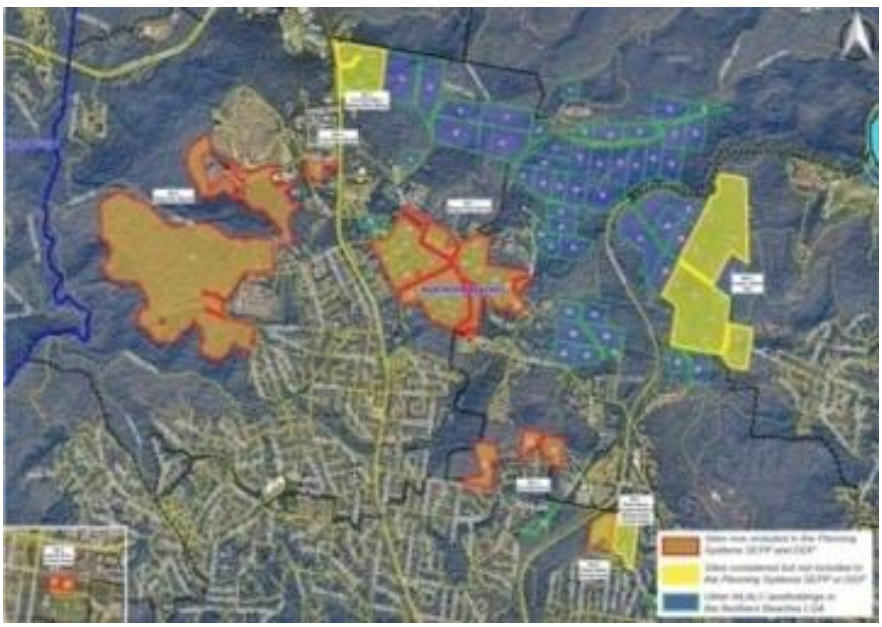

Figure 3. The six sites being threatened by deforestation; Source: (NSW Government, 2022)[9]

As more individuals begin to challenge the effectiveness and authenticity of carbon offsetting, it is important to note that the true carbon footprint of the Lizard Rock/Belrose proposal would greatly exceed the offset cost. Unfortunately, this crucial information is not made explicit in the proposal and should not be ignored by the community and decision-makers. In fact, the local community and community groups made 1,132 submissions objecting to this DDP.

Today, as Australians budget billions on solar, home battery and electric vehicles, as we redesign our diet, as investors (including most of us with a superannuation account) compromise on returns to decarbonise, and as we debate what more we must give up to break free from our carbon ties, cutting down 51.1 hectares of natural bush by the Ku-ring-gai National Park in the 21st century, in one of the wealthiest lands in the world to accommodate a 20th century lifestyle just doesn't make sense.

And if you're still not concerned, ask the children about their biggest concerns for their future, and how they would envision living in their future community, and the answer should not surprise you. Afterall, it's called Frenchs Forest for a reason, and it is that forest which will preserve our future.

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4. Reversing the carrot and stick: Incentivising Better Driving Behaviour

11 April 2023

In the lead up to the NSW election both parties were proposing to incentivise driver behaviour. Professor Stephen Greaves looks further into the issue.

The pre-election promises of opposition Labor and the Coalition to reward 'safe' drivers in response to a tenfold increase in speeding fines following removal of speed warning signs in 2020, has been met with scepticism by many in the industry claiming this does little to advance road safety and is simply a cheap vote-grabber before the upcoming state elections[1].

Under Labor's proposal, motorists who commit a 'low-level' infringement but retain a clean driving record for a year would be able to win back a precious demerit point. Under the Coalition, motorists with a clean record, would be able to argue their way out of fines for infringements including low-range speeding, disobeying signs and driving in a bus lane.

While both proposals potentially underscore the seriousness of 'low-level' infringements and in the case of the Coalition, some might argue, condone risky behaviour - 'I can get away with it that one time' – the focus on incentivising better behaviour as opposed to penalising poor behaviour is nothing new. Experiments conducted in the Netherlands[2] and Australia[3] over a decade ago, demonstrated the potential for using rewards to improve driving behaviour.

In the Netherlands Beloniter speed trials of 2005, speeding was reduced by 20% by rewarding 0.04 Euros for every 15 seconds spent not speeding. In the Australian trials of 2010, three-quarters of motorists reduced their speeding following the introduction of an incentive scheme paying a few cents/km for every km spent under the speed limit.

While government efforts to incentivise better driving behaviour will likely continue to be met with scepticism due to their overtly political undertones, insurance companies competing for market share face no such constraints. Incentive-based products, where motorists can earn rebates back on their premiums, based on demonstrating 'good' driving captured through an in-vehicle tracking device are widely available overseas.

These products have typically targeted 18-25 year-olds, who constitute the highest risk, highest premium, most under-insured group. Despite the overseas experiences, no such offerings are available in Australia, with reductions only based on kilometres driven. Perhaps government could step in and be more proactive in this space, particularly through the mechanism offered through the mandatory CTP Green Slip program.

Sceptics claiming incentive-based programs are ineffective at achieving safety goals will continue to beat their drum arguing for higher fines, harsher penalties and more bone-jarring speed bumps to physically slow drivers down. The harsh reality is that no manner of penalties or obstacles will stop the 10-15% of habitual offenders who continue to deliberately flout road rules – the only option here is to take the car keys or the car itself away.

In-vehicle technology solutions aimed at actively or passively slowing drivers down were heralded as the silver bullet decades ago, but the reality is the typical car on today's road is still largely at the mercy of the driver with 'Autonomous Vehicles' largely confined to controlled environments and academic research.

While we might question the timing and motivation for the announcement of these two policies, let's not dismiss the thinking that putting a carrot out there for improving driving behaviour may reduce the need for continually wielding the stick.

Stephen Greaves, Professor of Transport Management, ITLS.

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5. Private Assets as a Service (PAaaS) with reference to the Private Car as a Service (PCaaS)

1 May 2023

It is increasingly recognised that a role for the car will have to be factored in more carefully if MaaS is to grow in value. In this piece, Professor David Hensher looks at the idea of a Private Car as a Service (PCaaS)[1].

It is popular to label many new initiatives with a title and acronym that includes '…as a service (…aaS)'. Mobility as a service, or MaaS, is the most cited idea (Hensher et al. 2020). MaaS however, despite its intuitive appeal, is struggling to develop a future, with the business case and indeed the commercial case yet to be proven. While a growing number of App developers are parading their digital capability as delivering a MaaS capability, in the main we see little more than another trip planning app, which while it may have merit in some markets (especially global tourism where knowledge of local services is limited), it struggles to attract significant market interest in many markets where there is a dominant amount of habitual mobility behaviour or behaviour change that is typically from one mode to another and which does not need a trip planning App, or need a pay as you go or subscription plan under a multi-modal MaaS offering, even with generous financial incentives.

Sadly, MaaS appears to be in trouble, and the recent announcement that the pioneering MaaS Global (linked to Whim) is running out of money and has let its staff go, with a request to interested organisations to step in to help keep the agenda alive[2], speaks volumes for what is happening in this fragile market. Despite this, the enthusiasm for MaaS without a business model continues unabated. Time will tell whether MaaS, as typically promoted, has long term legs (Hensher 2022)[3].

What we do know after at least five years of seeing how MaaS might progress as a relevant societal-focussed contributor, is that unless it can change travel behaviour in a behaviourally meaningful way aligned with broad-based societal objectives, which includes reducing private car use in metropolitan contexts, and improving well-being and reducing social exclusion in rural and regional settings, then one questions why MaaS should be pursued (Hensher and Mulley 2021, Hensher et al. 2021).

It is increasingly recognised that a role for the car will have to be factored in more carefully if MaaS is to grow in value and indeed deliver on societal sustainability objectives. Hensher, Nelson and Mulley (2022) discussed this in an urban setting with the idea of electric car sharing as a service (ECSaaS), with a focus on a corporate commitment to investing in the vehicles that is accessible through a MaaS subscription offer.

Another idea[4] which may, initially at least, have great appeal, especially in a rural context is what I am calling 'Private Car as a Service (PCaaS)' or more generally "Private Assets as a Service (PAaaS)". The idea is based on a critical need to provide mobility services to residents of regional towns and rural hinterlands who have a need to visit medical specialists who are located many kilometres away, often over 200 or more kilometres, and where they are likely to have to stay overnight. An increasing number of aging individuals (often frail), require a carer or friend to accompany them and typically do not have access to a car, and local community transport (CT) services typically do not service such long-distance mobility requirements. Where CT does service them, it often involves transporting several individuals (in a small combi van) who then have to either wait to see a specialist if they arrive too early to accommodate other people or have to wait around to return home until the last person has seen a specialist. In addition, they may have to stay overnight if the timing of the meeting creates a problem in returning home on the same day. Alternatively, the CT service may transport the client part of

the way (e.g., to a rail interchange) which may not be very suitable for someone with special requirements.

One potentially attractive way of resolving this is to match a private car trip with a person in need (recognising that they may need to be accompanied) who has to get to the same or close by destination. To ensure that there is safety and security including quality of vehicles in this process, we propose a community membership club (CMC)[5]. There is no fee to join the CMC, but when a person requests a lift to a specific destination, there will be a small fee in the way of a donation which will be dispersed to the owner of the CMC and the driver of the private car. The apportion and sum can be decided on a case-by-case basis with some guidance on what might be deemed a fair and acceptable allocation by all parties (for example, a 50:50 split of $20). In addition, the CMC may coordinate with accommodation services to offer discounted overnight stay where that is necessary.

What this does is speak to the need for much needed services for regional and rural residents who are at the high end of the spectrum of social exclusion and low levels of well-being. Community led initiatives like this will need some kick-start financial support which seems to be a sensible way for governments to invest in a commitment to improve social exclusion and well-being through mobility enhancements that are much more flexible and with greater spatial coverage than can ever being achieved with regular public transport, on-demand bus services, community transport and commercial ride share.

This may be an attractive feature aligned with the aspirations of MaaS but developed initially as a uni-modal offering through a CMC. It not only opens up new mobility offerings but also grows new friendships and a feeling of belonging that has to be a positive contribution to the sharing economy. In this way, the preserve of maintaining the private car (even when electric and autonomous) can be reinforced by an alignment with societal sustainability objectives, something that appears to have eluded MaaS in metropolitan settings.

1. Suggestions by John Nelson are appreciated.
2. **https://www.mobility-payments.com/2022/09/02/pioneering-maas-start-up-seeks-buyer-new-investors-as-cash-crunch-worsens/**
3. Corinne Mulley in a personal communication (14 October 2022) has made the following comment: "Bundles are difficult to sell unless they are targeted at segments and then only if it is cheaper than what customers would normally spend (unless there is a subsidy). People don't seem to be prepared to pay for the app (which is to me unsurprising). I have always maintained that unless one can make the package cheaper – even if it is through cross subsidy, why should people pay for it. Business models are tortuous with the mix of subsidised and market priced modes. Maybe it will be rural MaaS that takes off where tailoring trips with an app might find favour and where additional modes not readily understood/available become more apparent on the app."
4. The idea evolved out a discussion with Lee-Ann Breger, Programs Director, iMOVE CRC. **https://imoveaustralia.com/**
5. This club could be linked to CT but could be a stand-alone citizen supported not-for-profit business. The CMC could also be organised by local government or set up as a social enterprise entity.

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6. Ship Recycling at the Port of Newcastle and the promotion of green steel?

5 June 2023

Veronica Schulz and Michael Bell look at possible opportunities for a ship recycling industry in Australia given the coincidence of recent developments in regulations and environmental concerns around the world.

The shipping industry is a major driver for the global economy and shipbuilding is a pathway for economic growth and development. After 25 to 35 years of service at sea, every ship comes to the end of its first life and issues of recycling, repurposing or disposal arise. The current ship recycling industry is built on unsustainable foundations for both society and the natural environment. About 90% of ships (in gross tonnage) are recycled in just three countries, Bangladesh, India and Pakistan, where labour is cheap, working conditions are often unsafe, and environmental pollution is generally excessive (United Nations UNCTAD, 2021). Recycling ships at facilities in these countries is, however, attractive to shipowners despite the unsustainable and unsafe conditions because they receive more for their ships.

Some attempts have been made to regulate the ship recycling industry. The Basel convention of 2004 classified end-of-life ships as 'waste' and required ships flagged in OECD states to be recycled in OECD states. The Hong Kong Convention for the Safe and Environmentally Sound Recycling of Ships, adopted 2009, extended this principle to all ratifying states along with conditions to improve the safety and sustainability of recycling (International Maritime Organisation, 2022b). However, it is now more than a decade later and the convention is still not in force as 40 per cent of the world fleet is yet to be flagged (registered) in states that have ratified the convention. Consequently, some states feel compelled to act leading to the European Union (EU) Ship Recycling Regulation of 2013, which stipulates that all EU-flagged ships must be recycled at an approved facility (Directorate-General for Environment, 2022). Facilities from any country can join the list provided the safety and environmental conditions are met. There is some anecdotal evidence that suggests some ship owners switch ships away from EU flags just prior to recycling to circumvent the EU regulation (Gourdon, 2019).

The increasingly strict regulation of ship recycling is coinciding with an anticipated rush of ships for recycling, either because they are surplus to requirements in the post-pandemic global economy or because IMO environmental regulations starting in 2023 will lead to the scrapping of substandard ships (Ford, 2022). From 2023, ships above a certain size and engaged in international trade will need to meet new efficiency and carbon intensity standards. Ships that have an Energy Efficiency Existing Ship Index (EEXI) that exceeds a threshold will need an enhanced Ship Energy Efficiency Management Plan (SEEMP) that lays out energy efficiency improvement steps. Furthermore, each ship will be rated on a scale A to E with respect to a Carbon Intensity Indicator (CII). Ships with an unacceptable rating will not be allowed to operate by states that have ratified the latest incarnation of the MARPOL convention (International Maritime Organisation, 2022a). Furthermore, there is evidence that the CII rating is affecting the value of ships (Chambers, 2023).

This coincidence of developments in ship recycling could create an opportunity for the industry to develop in Australia if a way can be found to reduce labour costs and the environmental impact. Ship recycling is typically done using one of four methods: Dry docking, pier breaking, landing, and beaching (Gourdon, 2019). There are benefits and drawbacks to each method. Dry docking reduces environmental pollution but still requires manual labour and is relatively expensive due to dock maintenance requirements. Pier breaking and landing involves less manual labour. However, both of these methods have high rates of pollution. While the beaching method typically has the lowest costs, highest labour intensity and high pollution rates are problematic.

With higher labour costs in Australia, and more stringent safety and environmental conditions, the ship recycling method needs to be reconsidered. One way to minimise health, safety and environment issues is to automate the ship dismantling process. Major technological advantages are occurring in the automation space. One start-up, Circular Marine Technologies (CMT), is developing a fully automated ship recycling process. CMT's process involves bringing ships ashore to be cleaned using recycled wastewater and then slicing the ship into sections "like a loaf of bread" (Bartlett, 2022). Breaking down ships into smaller sections allows for easier automated handling with minimal manual labour requirements. The CMT concept also suggests that the methane captured from organic matter on the ship could be converted into cleaner fuels like LNG or hydrogen to power the ship recycling precinct. Whether enough organic matter can be recovered from the ships to power the entire facility is unclear. Overall, CMT argues that automating the process will allow them to price match south Asian facilities (Bartlett, 2022).

The main resource that is recovered from recycling ships is scrap steel which can be recycled without losing any structural integrity (unlike recycled concrete which loses structural strength) (Planet Ark, 2020). With the steel making process being so energy intensive, the demand for scrap steel, which on average uses 75% less energy than virgin steel, is relatively high (Planet Ark, 2020). Indeed, steel is one of the most recycled materials and about 30% of the global steel production originates from scrap steel (Berlin et al., 2022). In most ships there are leftover equipment and materials such as radios or furniture. In many beaching facilities, these items are scavenged and further sold in second-hand markets. Recovering scrap steel from the ships would require some pre-processing and building this step into the automated process would further increase its 'circularity'. Overall, there are prospects for both exporting scrap steel through the Port of Newcastle or using it locally for steel products.

Introducing an automated ship recycling facility at the Port of Newcastle could be beneficial for their continuing efforts to diversify away from coal exports. The availability of plentiful vacant space in the port precinct dating back to the closure of the BHP steel works in 1999, deep water access, and a skilled workforce of engineers would favour such a development. The prospect for the automated ship recycling facility is just one circular economy ecosystem that could be located at the port with the potential to accelerate New South Wales's decarbonisation strategy. In fact, the possibility of locating a ship recycling facility at the Port of Newcastle could be a major driver of industrial development at the port and in the Hunter region by creating a supply of recycled material, in particular scrap steel. With higher safety and environmental regulations, a facility at the Port of Newcastle could be compliant with OECD, Hong Kong Convention, EU and US conditions for ship recycling. Development of a compliant Australian ship recycling industry would assist the growing logjam of end-of-life ships to be recycled in a safe and sustainable way.

The challenge with automated ship recycling is reducing the costs to compete with beaching in south Asia. The capital investment required to construct the automated recycling facility would most likely increase costs despite potential labour savings. The availability of carbon credits could, however, lead to the commercial success of the project. The Australian carbon market operates by using Australian Carbon Credit Units (ACCUs), which are tradeable permits that projects can receive if they avoid, reduce, or remove carbon (or equivalent) from the atmosphere (Clean Energy Regulator, 2020). ACCUs can be traded to companies with unavoidable carbon emissions. By claiming ACCUs for the recycled steel, there is an additional revenue stream for the ship recycling facility, which may make the process more attractive.

There are, however, some problems with Australia's carbon credit market. There is no mandatory involvement for companies emitting carbon, and this consequently leads to low and often volatile prices for ACCUs. Legislative changes would improve the success and efficacy of the scheme, and therefore likely to eventuate at some point. In the meantime, it would be worth estimating at what price for an ACCU a ship recycling facility at the Port of Newcastle could compete with beaching in south Asia.

With the development of an ambitious 'Green Hydrogen Hub' at the Port of Newcastle, there is also the prospect of making green steel (Port of Newcastle, 2020). Research developments in Australia are accelerating the potential for green steel manufacturing. In traditional steel making, coking coal is used as an ingredient to heat the furnaces. The green steel making process

uses green hydrogen produced by electrolysis using renewably generated electricity and water and carbon sourced eventually from the atmosphere. Thus, the carbon footprint of green steel is substantially lower than traditional steel. The prospect of steel making returning to Newcastle, on the back of ship recycling would indeed be a remarkable turnaround to the once former 'steel city', particularly if it is green steel.

The development of a ship recycling facility at the Port of Newcastle would require both private sector involvement and policy support from government. However, increasing ESG and SDG pressures on companies to comply with OECD, IMO and EU recycling regulations combined with ACCUs could make ship recycling commercially viable in Australia and eventually lead to Australia becoming a major player in this sector as well as the green steel industry.

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7. Using Artificial Intelligence to Mitigate Supply Chain Risks

3 July 2023

Professor Ben Fahimnia looks at how AI-driven analytics can help our essential supply chains to build resilience capabilities through systematic detection of mitigation strategies.

From COVID-19 to the war in Ukraine, the world has scarcely felt more chaotic – and the disruption to our fragile supply chains has been universal. But what if there was a way to predict and prepare for such random disruptive events? This science fiction could become science fact through harnessing the power of artificial intelligence (AI).

There is no real end in sight to the disrupted global supply chains. Continuing geopolitical instability, labour shortages, severe weather, and lingering inflation threaten to keep supply chains unsettled for the foreseeable future. Our essential industries must find effective ways to live with disruptions by systematic detection, evaluation, and implementation of mitigation strategies.

Australia is particularly vulnerable to trade disruptions in the global marketplace because most of our supply chains heavily rely on overseas supply with limited tolerance for disruption. Risk mitigation is even more crucial for the supply of essential goods and services (i.e., food, water, health, and shelter) as their continued supply during disruptions plays a critical role in Australia's economic functioning, the wellbeing of its people, and our national security.

"Predictive analytics" use probability theories to determine what is likely to happen based on patterns and trends revealed from analysing large historical and real-time data. Such tools are able to predict the impact of future disruptions on our essential supply chains.

Predictive analytics have been around for decades, but only recently they started to become mainstream thanks to AI methods capable of analysing large amount of unstructured data. For example, machine learning methods can now use historical disruption data as well as real-time operational data to provide an early warning of future supply chain failures. Many companies in the semiconductor industry have learned since Covid-19 how to utilise such AI tools to predict potential failures across the supply chains.

"Prescriptive analytics" use the results provided by predictive analytics to take a step further and determine the best action plans to reach a desired outcome. Such tools use advanced optimisation models and decision logic rules to find out the best mitigation strategies for the essential industries to capitalise on.

Predictive and prescriptive analytics can also assist with federal and state policy decisions on supporting risk management initiatives. For example, the use of predictive analytics will reveal whether resilience-building initiatives by certain industries are hampered by regulations. Prescriptive analytics can help policymakers take informed actions to provide special services to companies involved in the supply of critical products, or to take direct ownership of the risk management of certain products.

As impressive as AI tools are, their implementation is easier said than done. The most important challenge in Australia is data restrictions. AI tools require large amounts of precise digital data in order to train algorithms and produce reliable results (ChatGPT was trained on a corpus of over 570 GB of text data). In the past few years, most organisations have generated more data

than ever before. However, effective data management systems need to be established by these organisations to deal with data clustering, availability, and security constraints. The second challenge is the initial capital investment for design and deployment of such AI models and acquisition of the AI-specific hardware that the models need to work with cloud-based systems.

We know that the frequency and magnitude of disruptive events will continue to rise, so will their significant impact on our supply chains. AI innovations can make such disruptions a thing of the past. AI-driven analytics can help our essential supply chains to build resilience capabilities through systematic detection of mitigation strategies to capitalise on. Australian industries and research organisations must urgently increase research and development in AI-driven analytics to empower our essential industries to build future-ready supply chains.

8. Population growth and the economy: A mixed blessing?

7 August 2023

Christopher Day discusses population policy as one of the big three economic levers.

Immigration is an Australian success story. One of the great things about jumping on a train in Sydney or Melbourne is that you can immediately tell where you are in the world by the simple fact that the individuals beside you are from a bewildering range of cultures. This is seldom seen outside of Australia.

Following two years of border restrictions throughout the COVID-19 pandemic, the Australian Government has rapidly returned Australia's immigration intake to above already high pre pandemic levels with the objective of "making up" for lost time. This has resulted in a goal to bring in close to 350,000 people this year (nearly 1.5 per cent growth)[1]. These moves have been heavily supported by business leaders who lament significant skill shortages caused by the pandemic hiatus on global mobility.

Although seldom discussed, population joins monetary and fiscal policy as one of the big three economic levers. Increasing population growth through immigration generates economic activity by bolstering aggregate demand and provides an effective avenue in which to plug strategic skills shortages. Australia is blessed in that its high standard of living makes it an attractive migration target, enabling the government to set population growth at any level it deems appropriate.

Economic growth, measured as a nation's gross domestic product or GDP, is baked into the national psyche. It is engrained within us that high levels of economic growth are good, and declines are bad, the latter embodied in dreaded terms such as "recession". One of Australia's great boasts until the COVID-19 pandemic was its near three decades of uninterrupted economic growth. Our insatiable appetite for economic growth is grounded in the view that a larger economy will make us all wealthier. What is generally missed is that this relationship only holds when the economy grows on a per capita or per person basis. This creates an interesting dichotomy regarding the benefits of rapid population growth between businesses and government on the one hand and individuals and households on the other.

Population growth creates additional demand in an economy for goods and services from housing through to washing machines and haircuts. Business and asset owners benefit immensely from this as it creates more customers and enables them to grow sales and profitability without needing to snatch customers from another business. Government too is a beneficiary of population growth as more people increases spending which in turn makes the economy bigger. Given the public views economic growth positively, delivering as much increases the probability of electoral success. As such, population growth creates "easy" or "lazy" business and economic growth.

Making growth readily achievable for businesses reduces competitive pressure, thereby limiting the incentive for firms to invest in productivity enhancing measures such as research and development. Instead, retained earnings can be returned to business owners or shareholders in the form of dividends. Profit distributions may be positively received by business owners, yet they take away funds which could have been invested in a businesses', and in extension the country's, capital stock and capability. This is critical to maintaining global competitiveness. The absence of investment is reflected in Australia's weak productivity growth which has plunged to a six-decade low. As the Productivity Commission has warned, it is the plateauing of productivity which has and will continue to undermine the living standards of all Australians.

Despite benefiting business and capital owners, rapid population growth is far from costless. Absorbing the equivalent of another City of Canberra in Australia every year places enormous pressure on existing infrastructure, services and resources used by the community. School places, hospital beds and housing stock each need to rise at a rapid pace to meet demand. Doing so requires absorption of green spaces around major centres, threatening biodiversity and amenity, whilst the net effect on economic activity generally fails to lift productivity. Housing construction and service delivery are labour intensive activities, making them ill suited to productivity growth whilst many goods purchased by a growing population are imported. Further, many of the migrants being brought in to fill labour shortages are simply creating more shortages in the absence of productivity growth as demand for housing, goods and services rises alongside the population.

A large share of uplift from rapid population growth channels into property prices. Evidence of this is observed in the "surprise" reversal of Sydney property prices in March 2023 (+1.4 per cent) despite the Reserve Bank of Australia's rapid tightening of monetary policy since May 2022.[2] With supply failing to keep pace with demand, rents have surged upwards of 20 per cent in the last year with the national vacancy rate under one per cent. At the same time property listings have fallen, placing upward pressure on already high property values despite diminished borrowing power amongst buyers. Fundamentally, property prices will continue appreciating if demand outstrips supply.[3]

Whilst a classical view of economic functioning suggests that supply will rise to meet demand, the opposite is taking place. Higher interest rates and the tighter credit market have restricted capital available to developers, many builders have suffered financial difficulties due to high inflation and fixed price contracts and the availability of land, labour and materials is severely constrained.[4] Planning controls, which exist for many good reasons, restrict the type and volume of properties which can be constructed in an area. Ironically, controls tend to be strongest in more desirable regions close to employment opportunities. As such, we have a situation when we like to see our houses become more valuable and the aggregate benefits of population growth such as bigger dividends, but many communities are opposed to further development in their local area due to concerns over stretched services and infrastructure. This suggests that population growth creates a cost for Australian communities which they seek to externalise. Nevertheless, any solution to the pressures created from a rising population ignore better demand management and instead emphasise the challenging and prolonged task of lifting supply.[5]

Another potential and seldom acknowledged cost of rapid population growth is its contribution to inflationary pressure. Inflation is generally triggered by an imbalance between supply and demand which causes prices to rise. Rapid population growth works in a similar manner to low interest rates, in that it stimulates demand for goods and services. This creates a challenging policy dichotomy between the Reserve Bank's desire to lower inflation by lifting the cash rate and the government's introduction of a demand "shock" through high levels of immigration. If population growth continues unabated at a high level, it ceases to be a short-term shock, making it increasingly difficult for supply to catch up. This is especially true in a cycle of monetary tightening when investment is subdued. The end result will be inflationary pressure, particularly in the housing/rental market. Redirecting a greater share of the nation's resources into housing stock is inherently inefficient and starves capital from productive investment opportunities which will actually lift living standards.

In summary, immigration has transformed Australia into the successful multicultural society it is today. Rapid population growth has made our houses more valuable and enabled our businesses to make larger profits by creating a bigger market. Yet population growth incurs costs and has masked falling productivity growth alongside heightened pressure on key services and rapid inflation of property prices. This has undermined living standards and fuelled the current rental and housing crisis. Supply cannot readily keep pace with Australia's current population trajectory. Interestingly enough, it was the period of low immigration during COVID-19 that finally enabled wage growth to pick-up, rents to fall and unemployment to hit record lows![6]

We need to bring population policy to the forefront of policy debate and understand that it is not a limitless panacea for economic prosperity but a policy tool which must be carefully managed in the interests of the population at large.

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9. Value Creation through physical and virtual agglomeration

4 September 2023

David A. Hensher, Glen Weisbrod (EBP USA) and Ian Christensen (iMove CRC) discuss how the value creation perspective seems to have merit across physical and virtual agglomeration and why we need research to identify the probability that physical or virtual agglomeration can deliver on value creation for specific activities.

The COVID-19 pandemic has changed the landscape in which many individuals made decisions on whether to participate in activities face to face (physical interaction) or via a digital connection (virtual interaction). As the pandemic has subsided (but not completely resolved), there has been a concerted effort to identify the circumstances under which a hybrid model of activity participation might be the preferred future for work and play. While we would suggest that there is now plenty of evidence that working from home can offer flexibility in terms of a work-leisure-family balance and does not, in most cases, reduce productivity (the key reason for employer support for a hybrid model), some amount of time back at the office is a healthy outcome where social interaction appears to be a dominant reason for doing so (in contrast to work).

The rethink of the future of the location of activities and what it might mean for a new interpretation of agglomeration is necessary if we are to account for changes in the mix of physical and virtual activity interaction. In a recent paper, Weisbrod and Hensher (2023) discussed the relationship between the location of business activities and their spatial access characteristics. They suggest that the present relationships are likely to be changing in the future as information technologies are enabling both more remote work in lieu of in-person commuting and greater ease of doing business anywhere. Growing reliance on digital information connectivity reduces the benefits of physical density as well as spatial proximity benefits for office-oriented industries such as finance, insurance, and other producer services. There is a growing body of research on virtual agglomeration (e.g., see Liu et al 2020, Chen et al 2021).

The COVID pandemic accelerated adoption of an already emergent technology enabling remote working. Even with post-COVID readjustment, there is a long-term trend of increasing remote working (Vincenzi 2022), especially for computer-based office activities (McKinsey 2021). Ramani and Bloom (2021) measured associated changes in migration patterns and real estate markets within and across US cities. They found that within large US cities, evidence of a consistent shift in household, business, and real estate location demand from dense central business districts towards lower density suburban districts.

Digital agglomeration effects have also been observed in studies with supporting evidence from employers that productivity has increased because of increased working from home (Hensher et al 2022). Perceived productivity has a strong correlated link to economic productivity as shown by Barro et al. (2021), who found that data on employer plans and the relative productivity of working from home implied a 5 percent productivity boost in the post-pandemic economy due to re-optimized working arrangements. Only one-fifth of this productivity gain will show up in conventional productivity measures, because they do not capture the time savings from less commuting. At the same time, digital agglomeration is driving the growth of e-commerce, increasing goods deliveries to dispersed residential along with economies of scale for distribution industries (Australia Post 2022).

This line of research is important in showing that scale economies may come not only from physical agglomeration, but also from connectivity to transportation and information networks. It also suggests that in the future, the physical agglomeration and transportation connectivity benefits underlying "effective density" are likely to become even further dependent on the coexistence of "virtual agglomeration" via employee connectivity to high-speed information networks at a

region-wide level. By recognizing these conditional relationships, further priority may be given to projects that improve the speed and capacity of both regional internet and regional delivery facilities. Conversely, by failing to recognise these factors, transportation investment decisions may be unintentionally skewed away from projects that facilitate future economic growth in industries that depend on both information technology and goods movement.

Another way of thinking about the future role of physical versus virtual interaction and what it means for agglomeration is to recognise that there is significant heterogeneity in the extent to which each approach will be required and indeed supported. There is heterogeneity arising from the different interaction requirements of different types of work, and there is heterogeneity in elements of most business models at the level of the individual firm. What COVID has done is to create greater choice, that is recognised as not only feasible options, but ones supported by the main stakeholders. If the object of the firm is to maximise the creation of economic value, you would expect it would exhibit behaviours and activities that deliver high productivity and high levels of value creation. Ergo, we used to spend eight hours per day in close proximity with one another (the office) engaging in interactions with high informatic intensity (face to face meetings). But the COVID experience and the parallel improvement in telecommunications capacity has led to a refinement of the firm level operating model in which firms now deliberately segment their activity into high, medium, and low intensity informatic exchanges. In this way they can improve their economic efficiency by limiting their investment in 'time expensive' high intensity exchanges (face to face) to those situations that demand it and satisfy the remainder of their informatic exchange requirements with 'cheaper' forms of interaction. Thus, hybrid working has become established. The catch is that the understanding at the firm level of which activities need to be (or would benefit from being) done under high intensity exchange processes (face to face) and which can be adequately done by video conference or email, is poor.

If we approach this topic from a 'value creation' perspective, we might posit that information exchange in a physical meeting is higher (more intense) than occurs in a videoconference, and that is higher than occurs in a telephone conversation and that in turn is higher than occurs through a written exchange, and if we made a bold leap to assert that the 'value' of an interaction is proportional to the information exchange, then we might conclude that cities (which are our principle place (mechanism?) of physical agglomeration) will reconfigure themselves to focus on activities that require physical meeting and which simultaneously are value maximising. The best examples are in the entertainment, events, and fine dining restaurant sectors, all of which might be a hint and how we might grow public and shared transport.

Looking beyond a focus on a hybrid model for work to a wider set of activities, this would raise the importance of activities such as cultural events, conferences, special occasions, and restaurant dining (all of which implicitly involve physical interaction) both in the life of city and as loci for associated value creation/value capture transactions. That being so, there would be implications for the transportation services needed to maximise access to these physical agglomeration activities and so maximise the city's facilitation of value creation.

The value creation perspective seems to have merit across physical and virtual agglomeration; hence we need research to identify the probability that physical or virtual agglomeration can deliver on value creation for specific activities, be it at a firm level or more generally.

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10. Tolling and price setting

3 October 2023

In June 2023 the NSW Government invited submissions on the review of tolls and their structure across the toll network in Sydney. This short piece is the submission by Professor David Hensher.

1. My starting position is that the toll review should be positioned to be able to transition to a network-wide solution as part of a longer-term commitment to ensuring road use efficiency, accompanied by some equity (justice and fairness) rules to ensure that no one is worse off financially.

2. In discussing the tolls, we want to emphasise that we should set tolls at a level that delivers to users travel time savings benefits, given their value of travel time savings ($/person hour). We also recognise that the toll levels set are confounded by the need to raise revenue to fund the capital investment of a concessionaire (i.e., where tolls reflect the costs of, financing, constructing, designing, maintaining and operating the assets).

3. This hybrid set of pricing rules does not make it easy to identify an efficient price since economics suggests that capital investment recuperation should be seen through the lens of other ways of repaying the investment debt rather than imposed on users (given society as a whole obtains a benefit). However, the PPP structure depends heavily of revenue from patronage forecasts. Errors in patronage forecasts have been the main source of errors in revenue (linked to optimism bias and statistical misrepresentation). Experience over many years has resulted in the business case for equity providers discounting patronage forecasts to 60% of the forecasts offered up by models and consultants. I attach two papers we have written based on what we suggest is the experience with PPPs, and while they do not explicitly discuss specific toll prices, they place the pricing issue into a relevant broader setting, linked in part to the allocation of risk.

4. The current smorgasbord of toll settings in Sydney, set as part of a long-term concession for each tolled road, are adjusted based on an agreed indexation rule, which has created a distortion in the pricing of all roads, given the imposed baseline toll rate, which was often set politically. While the tolled infrastructure we have has been a net positive to users, the pricing of it has not helped the efficiency (and equity) of the entire network. We are stuck with it, with Transurban effectively controlling the Sydney Road network under current contracts.

5. At a previous parliamentary inquiry where I spoke, we got nowhere with new ideas, and the committee recommended staying with the existing pricing model under the concession agreements. To reproduce what I said, given the analysis undertaken in Hensher and Mulley (2014), we identified for all roads, a 5c/km distance-based charge (DBC) *in peak periods only* plus halving of registration fees [1], which made almost no user financially worse off and a slight gain to Treasury revenue, while close to a 6% improvement in peak hour traffic (approximately returning the busy periods to school holiday traffic levels in many locations):

   "Once buy in is secured and travel time savings demonstrated, the distance-based charge can be increased. For example if we increased it by 1c/km (to 6c/km) in the peak, this results in additional revenue of $4.2bn per annum, more than enough to remove the tolls on existing tolled routes and compensate the toll road operators over the duration of the concession, with part of the distance-based revenue raised on the tolled routes (and additional funding if required, although this is unlikely)."

Drawn from Hensher, D. A. & Mulley, C. (2014) Complementing distance-based charges with discounted registration fees in the reform of road user charges: the impact for motorists and government revenue. *Transportation,* 41 Number, 697–715.

6. Hence, my suggestion is a toll road repricing model that will move seamlessly, in the future, into a network wide solution. I like the idea of a peak, shoulder, off-peak distance-based charges that can be capped.

7. The DBC should vary by distance bands (and not arbitrary spatial zones), and I support some justice and fairness criteria to compensate those who are financially worse off, or adjust the amount outlaid (like a user side subsidy instead of a provider side subsidy).

8. The suggestion of an access charge is, in network terms, like a registration fee, to give access rights to the road network. We already have a discounted system for registration fees when the amount spent on tolls exceeds a stipulated sum. Instead of offering a discount on registration linked to toll outlays, I support converting this to an access charge (ultimately for all roads) that is used to cover the net costs of toll road operators when annual kms exceed an agreed quantum.

9. One also needs to distinguish discounts and/or caps according to who pays for the tolls, such as households or businesses, an issue that may be problematic when we have household-business registered vs other non-household business registered vehicles. This is an important issue in the context of equity (justice and fairness).

10. A question of great importance will be in setting a DBC that achieves multiple objectives, notably reflecting an efficiency outcome (distorted if only applied to tolled roads, but which can be resolved in time through a network-wide re-pricing), an equity outcome, and an outcome that accommodates the debt-repayment (and RoI) model of the toll road service provider (i.e., Transurban).

11. In recognising this, a starting position might be to identify the revenue per annum from tolls, the net debt recovery required per annum plus the acceptable profit margin (given risk profile) and the total annual kilometres of all vehicles (cars and trucks). This can be used to calculate a starting estimate of a crude average DBC:

    a. (Total revenue minus net debt recovery and other annual expenses)/total annual kilometres

    b. The resulting average can be increased for trucks and decreased for cars given the modal shares, to arrive at the same aggregate average DBC.

    c. The next challenge is to identify the trip length distribution (ideally with actual number of trips by mode) and to tailor the DBC to vary by kilometres driven, possibly blocks of 5 km. to ensure an average DBC aligned with the funding objectives. One assumes such data is with Transurban, and even TfNSW?

12. I attach a PDF of a slide presentation of what a network-wide road pricing reform model should consider, and a proposal to undertake a trial to test the ideas.

13. A serious challenge is the ability to remove fuel excise, which is collected Federally and have it replaced by a DBC, the latter one assumes will be collected by a state-based agency. Initially I assume the fuel excise with stay in place.

14. There will be complications as we transition to electric cars that will not pay the fossil-fuel excise, and my view is that a DBC should be aligned with travel time savings and not with the energy source of the vehicle. The latter might explicitly be a charge linked to emissions and it might be possible to combine into a DBC with a lower rate for lower emission cars (noting at present that there are still 30% emissions beyond the tailpipe of electric cars).

    See details in **https://ses.library.usyd.edu.au/bitstream/handle/2123/30276/ITLS-WP-23-06.pdf?sequence=1&isAllowed=y**

15. I offer some elasticities (Table 1) of the relationship between toll levels and traffic responses which may be useful for someone testing variations in tolls under a DBC and its link to changes in traffic levels and revenue.

Table 1. Elasticity of traffic level with respect to tolled routes

Wuestefeld and Regan (1981)	Roads between -0.03 and -0.31 Bridges between -0.15 and -0.31 Average value -0.21	Sixteen tolled infrastructures in the US (roads, bridges and tunnels)
White (1984), quoted in Oum et al. (1992)	Peak-hours between -0.21 and -0.36 Off-peak hours between -0.14 and - 0.29	Bridge in Southampton, UK.
Goodwin (1988), quoted in May (1992)	Average value -0.45	Literature review of a number of previous studies
Ribas, Raymond and Matas (1988)	Between -0.15 and -0.48	Three intercity motorways in Spain
Jones and Hervik (1992)	Oslo -0.22 Alesund -0.45	Toll ring schemes, Norway.
Harvey (1994)	Bridges between -0.05 and -0.15 Roads-0.10	Golden Gate Bridge, San Francisco Bay Bridge and Everett Turnpike in New Hampshire, US.
Hirschman, McNight, Pucher, Paaswell and Berechrnan (1995)	Between -0.09 and -0.50 Average value -0.25 (only significant values quoted)	Six bridges and two tunnels in New York City area, US.

Mauchan and Bonsall (1995)	Whole motorway network -0.40 Intercity motorways -0.25	Simulation model of motorway charging in West Yorkshire, UK
Gifford and Talkington (1996)	Own-elasticity of Friday-Saturday traffic -0.18 Cross-elasticity of Monday-Thursday traffic with respect to Friday toll -0.09	Golden Gate Bridge, San Francisco, US.
INRETS (1997), quoted in TRACE (1998)	Between -0.22 and -0.35	French motorways for trips longer than 100 kilometres
UTM (2000)	-0.20	New Jersey Turnpike, US.
Burris, and Pendyala Cain (2001)	Off-peak period elasticity with respect to off-peak toll discount between -0.03 and -0.36	Lee County, Florida, US.

16. Potential Price Plans, aligned with Mobility as a Service (MaaS), that might be worth considering within a DBC reform structure:

Casual off-peak (rare peak use)	Modest off-peak discount and peak surcharge
Frequent off-peak	Fixed monthly fee, free in off-peak, standard rate in peak
Frequent peak	Higher fixed monthly fee, free in off-peak, discounted rate in peak

Long-term committed / risk averse	Guaranteed toll rates over 10+ years (protect against price rises) for "customer investors" in "Warratah" bonds or toll-road equity. o Discounted tolls could be in place of dividends (investment risk reduced as the return is controlled by the customer's toll-road usage). o Investment could be via super funds (i.e., redirection of individuals' existing funds rather than requiring additional household investment).

Finally, some generic rules of good practice are offered. Schemes can be both economically viable for investors and politically actionable in the face of voter expectations if these general principles are adhered to:

1. There ultimately needs to be ***one mobility revenue scheme*** (or a fully interoperable series of schemes) for a region / province / conurbation that allows each resident access to all modes. With support from the OEMs and standards organisations like IEEE and SAE it is possible that through connected vehicles and apps universal mobility charging (PAYG) might even be achieved much as most mobile phones can now roam worldwide
2. All of the proceeds from the scheme need to go ***back into the transport network*** also across all modes, not just (as I suggest is often the case) back into roads, and definitely not back into the general treasury. A key component must that they must fund alternative mobility enhancements as a priority, effectively imposing both a "carrot" and a "stick" to get drivers out of personal vehicles.
3. ***Incentives*** need to be created for driving at certain routes or times that mitigate congestion including secondary / tertiary road usage or driving at nonpeak times.
4. ***Petrol taxes per se need to be eliminated,*** however incentives for LEV and ZEV usage and disincentives for ICE use can be provided selectively by a carbon tax or other environmental assessment. A question of semantics perhaps but politically very important.

Extra from Hensher et al. (2016)

Hensher, D.A., Ho, C. and Liu, W. (2016) How much is too much for tolled road users: toll saturation and the implications for car commuter value of travel time savings? *Transportation Research Part* A, 94, 604-21. (This paper has generated extensive media interest – newspapers, radio and TV).

Figure 6 shows the number of toll roads used for the journey to work (JTW) of the sampled workers. The Journey from work (JFW) is very similar. Of the commuters whose travel involved toll roads, the majority use one toll link with the most popular toll roads being the M5, followed by the SHB, M7, M2 and the Eastern Distributor (ED). However, it is not uncommon for the JTW to involve more than one tolled link. The most popular combination of toll roads are the M5 and M7 ($4,723 per annum), the SHB and LCT ($2,462 per annum), the ED and CCT ($4,046 per

annum), M7 and M2 ($6,739 per annum), and SHB, LCT and M2 ($5,539 per annum) with the number in parentheses being the annual toll outlay on commuting, assuming a 5-day working week and a 48-week working year (4 weeks vacation). The sample average annual gross personal income is $93,000 per annum (Table 2), which after tax is around $68,000. The range of toll outlays associated with the toll activity summarised above are from 2 to 9 percent of the after-tax income for toll users (although there are a number of users in excess of 9 percent). As indicated, the toll outlay for toll road commuters is substantial, and an addition of more tolled links may result in an increasing number of commuters not prepared to pay tolls to save travel time. Figure 7 shows the current level of toll saturation amongst toll road commuters. One in five toll road commuters (65 out of 311 workers) have reached their saturation point, with an average level of toll saturation amongst toll road commuters around 60 percent. Thus, some commuters can still sustain increasing toll costs; but a substantial proportion appear to be no longer prepared 'to pay to save'.

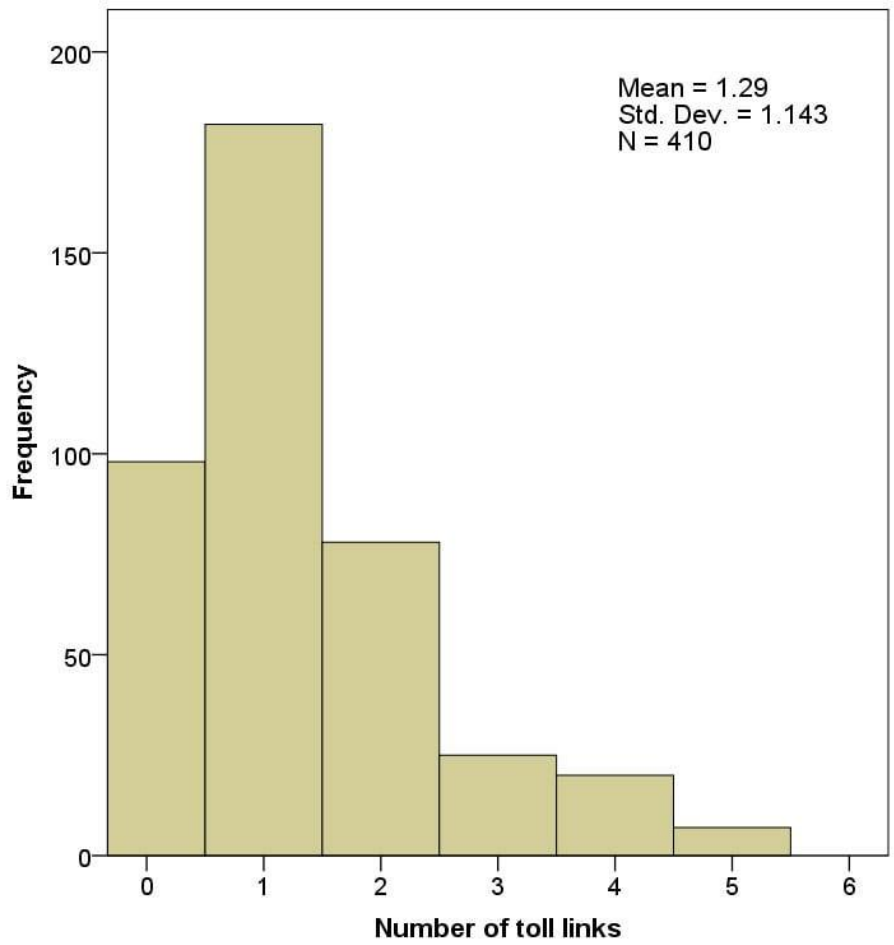

Figure 6. Number of toll roads involved on journey to work

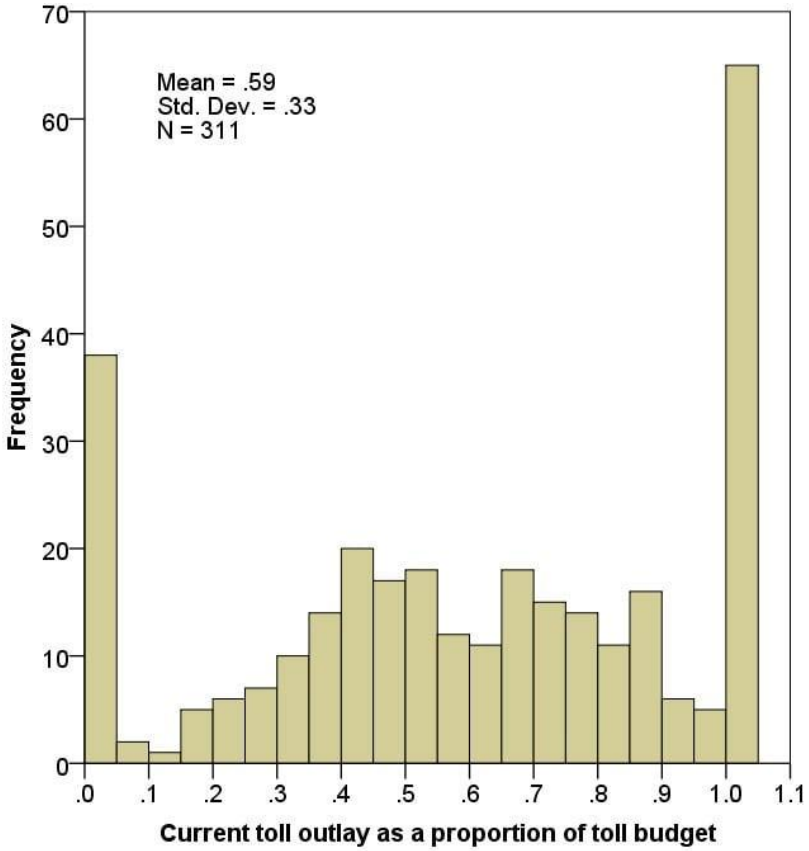

Figure 7. Current level of toll saturation amongst toll roads commuters

On average, the JTW or JFW of a sampled car commuter takes close to an hour, with one-third of the commuting time being on toll roads. Over the last two weeks, commuters have outlaid, on average, $50 on toll roads with the maximum amount of toll outlay of $374. The toll outlay is currently smaller than the budget commuters have for commuting on toll roads, with an average gap between toll outlay and toll budget of $37 ($87 – $50 = $37) for 2-week commuting or $3.70 per day if commuters travel to and from work five days per week. The average age of sampled workers is 43 years and a vast majority (80%) work fulltime. Five percent of the workers have their commuting tolls covered by employers, and another 4% of workers pay commuting tolls through their own business. In terms of gender and occupation, the sampled workers spread quite evenly across both sexes and cover all occupations.

Footnotes

1. Excluding Stamp duty and other charges such as vehicle transfer administration fees (paid on change of ownership) and number plate fees (paid on first vehicle registration).

2. A number of commuters live in the Central Coast, which is over 90 kilometres from the CBD. In addition, commuters coming from the far Outer West spent significant time on connected toll roads (i.e., M7, M2, Lane Cove Tunnel and Harbour Bridge).

11. Toll Review Public Hearing Presentation

6 November 2023

This is the presentation given to the NSW Toll Review Public Hearing on 11 July 2023 by Professor Martin Locke. In preparation the discussion paper, summary of work completed and the submissions from TfNSW, Transurban and IPA to last year's inquiry, were reviewed.

The need for toll reform is widely accepted and the current structure of tolls and toll road contracts is not sustainable. Toll relief is a short-term band-aid solution. This review has the potential to come up with a meaningful and long-lasting reform plan.

A lot of useful discussion has already taken place on the arguments for introducing simpler standard motorway network pricing across the entire motorway network to fix our current patchwork approach. This also needs to address escalation and bi-directional tolling on all roads.

My presentation only covers one aspect of the debate, namely whether tolls should be subject to regulation by IPART. I believe the logical solution to fixing our toll road contracts is to adopt the regulated utility model.

Changes in tolls and escalation will require discussion with concessionaires and we are told by IPA that concessionaires are willing to consider reform including a single network policy.

Transurban has stated that it welcomes the opportunity to consider changes to tolling regimes including the shift to network wide tolling and road user charges.

Transurban has highlighted the risk of social licence to its investors and that negative public sentiment may result in political measures that adversely impact its operations.

So the time is right to move to a regulated model with mutual interest and support from concessionaires.

So what needs to happen? The history of our toll road contracts is anchored in the project finance model. When a toll road contract is negotiated, a base case financial model becomes the foundation of the agreement. In simple terms, the financial model projects costs and revenues over the term of the concession with return on equity as the key output.

The concessionaire forecasts revenue based on patronage assumptions and the prescribed toll and escalation provisions. If the government changes the toll provisions, the concessionaire would normally be entitled to compensation for any net adverse financial impact determined by the financial model; the test is the level of the equity return.

So if for example, the government is assessing the reasonableness of the unsolicited proposal to widen the M7, the concessionaire will prepare an updated financial model with updated cost and revenue assumptions. Government will assess the reasonableness of the cost and revenue assumptions and the financing assumptions, particularly the equity return. This is regulation by contract.

The problem with this model is the rigidity introduced by the base case financial model, the costly process of agreeing changes and the absence of competitive tension in negotiating with an incumbent. There are also concerns around lack of transparency and loss of social legitimacy.

Interestingly, the UK provides a precedent with a shift away from the traditional economic infrastructure PPP to the regulated enterprise model used on the Thames Tideway project.

The regulator would undertake a periodic review of the contract, review the reasonableness of the cost assumptions and the Regulated Asset Base and the reasonableness of the equity return using the Capital Asset Pricing Model. The regulator can then assess the toll price and revenue assumptions.

In all honesty this sounds not too dissimilar than the current ad hoc arrangements. But there are four key differences; (i) the equity return is determined by the regulator rather than being anchored in the base case equity return, (ii) there is a periodic regulatory reset, (iii) the regulatory determination is binding and (iv) everything is made public.

I found the comments last year from TfNSW somewhat dismissive about the potential benefits of a regulator.

TfNSW said that IPART regulation of toll roads was not consistent with its core function and area of expertise.

TfNSW said introducing regulation could change the risk profile for private finance and make it more difficult to secure funding with decreased competition in the market; regulation would have extremely negative impacts on existing concession agreements, risk ongoing viability, insufficient revenues to repay financiers and trigger claims for compensation.

I disagree with this gloomy interpretation. Regulation done properly could avoid all of these concerns. Indeed, regulation can provide greater certainty to financiers and improve competition.

Infrastructure financiers generally regard regulated utilities as having a lower risk/return profile than natural monopolies like toll roads and airports. Moreover, the regulated model provides greater flexibility for changing tolls over time and supporting social legitimacy; infrastructure financiers reportedly prioritise sustainability and doing something worthwhile over myopic financial returns; here is the opportunity to put that into practice.

How could regulation happen and what are the key issues?

We would need to agree on the period of the regulatory reset. A shorter period would help deal with the changing pricing dimensions.

The regulator can then determine what is base level of permitted toll revenue over that period considering the capital base and the return. Any excess revenue could be shared on a 50:50 basis like the treatment of refinancing gains. Note this is much more balanced than the lop-sided upside sharing provisions in standard toll contracts.

The proposed regulatory principles could be set out by the regulator and agreed with the concessionaires.

If we consider the WCX concession, for example, was it sensible to fix tolls for 40 years with tolls escalating at the higher of CPI and 4% for the first 20 years. Isn't that inflexible? And why was it necessary to opt for a 40 year term?

Changes can be negotiated but only in the context of the contracted terms and the base case financial model; compensation claims protect the equity investors for loss. A shift to a regulated utility model sounds much more pragmatic.

Moreover, it is highly likely that further changes to tolling beyond the shift to standard network pricing will be required. Future changes could include wider use of time-of-day tolling and more

widespread adoption of road user pricing; such changes could be easily accommodated under a regulated utility model.

Have a look at the reasons why the Victorian Government adopted a State Tolling Company model rather than outsourcing toll revenues under a typical concession contract. Its review noted that network pricing and development and road user charging was more within the control of government and competition was limited because of existing toll road operator incumbency.

And whilst the ACCC has required Transurban to publish quarterly traffic data, Transurban will be in a unique position to leverage its existing network to support future expansions; NCX is a good example as no other party could provide a competing proposal due to Transurban's ownership of the adjoining M7/M2 tollroads.

Moreover, TfNSW noted that operators with investments in multiple roads can realise synergistic benefits and economies of scale; this implies that it will be increasingly difficult to compete with Transurban. Regulation is the most appropriate tool to manage natural monopolies.

The question was asked how it can be ensured that the benefit from toll relief obtained by operators is passed back to the community. Interlink Roads has benefitted from M5 Cashback boosting patronage. The regulated model would have passed this back to the community.

Finally, the Western Harbour Tunnel provides a unique opportunity to both reform tolls and strengthen the State's fiscal position.

We need to be imaginative about exploring potential securitisation of the aggregated toll revenue of the three harbour crossings. Bi-directional tolling makes sense. The aggregated revenue provides a low-risk investment opportunity. Adopting the regulated model would safeguard community interest and broaden competition.

12. Managing peak period rail travel: How fares should be constructed to spread commuter loads in the post-Covid working environment

4 December 2023

Christopher Day looks at how the extension of the peak time period hasn't flattened the peak and suggests returning to the previous peak time period would have benefits in terms of reducing the transport network's maximum peak utilisation and corresponding capacity requirement.

The capacity of Sydney's metropolitan railway system has been designed to meet the City's dominant mono-directional passenger flows in the morning and evening peaks which are in and out of the central business district (CBD). Achieving this is extremely costly given that the additional rolling stock, human resources and physical infrastructure necessary to satisfy pre COVID-19 peak demand is only required for a few hours on five days of the week.

As such, policies which can smooth demand across the day and week have the potential to save on costly capital expenditure by enabling public transport operators to squeeze more out of their existing resources.

COVID-19 has significantly altered travel patterns, but the effect is variable across different days of the week. Total peak period commuter travel has not only fallen but concentrated in the middle of the week. This has resulted in significant spare capacity on Mondays and Fridays. Further, hybrid working arrangements give individuals far more flexibility regarding the hours they spend in the office, enabling a potential spreading of the peak on any given day.

Regrettably, Sydney's opal system was adjusted in June 2020 to enlarge the number of hours customers are charged the peak fare.[1] Whilst the publicly proclaimed intention of the policy was to spread patronage across the day during the pandemic, by halving off-peak fares, this was constrained, in practice, by extending the peak time period. In the post pandemic environment this is likely to lead to the opposite of the avowed intention of spreading peak period patronage, particularly given that half price off peak fares have since been removed. The tables below illustrate the current and pre-June 2020 morning and afternoon peak periods for the Sydney railway network.

Current	Morning Peak	Afternoon Peak
Sydney Suburban	6:30am-10am	3pm-7pm
InterCity	6:00am-10am	3pm-7pm

Prior to changes	Morning Peak	Afternoon Peak
Sydney Suburban	7am-9am	4pm-6:30pm

Lengthening the peak may enlarge farebox collection and offset some of the revenue losses caused by declining ridership, but the net effect is that it has become extremely difficult for commuters to avoid peak travel times. Increasing the peak fare window by three hours removes the incentive for workers to adjust their schedule and flatten the peak. Adjusting one's schedule by 30mins to an hour off the classic arrive at 9am and leave at 5pm schedule was quite achievable under the former peak period definition. For instance, someone travelling an hour to work tapping on before 7am to get to work and leaving work just before 4pm. Likewise, one could leave just after 9am and leave work after 6:30pm. Scope for making these adjustments has been made easier by flexible working arrangements introduced since 2020.

However, under the current peak pricing window, it is extremely difficult to avoid the peak without a very early start and/or late finish. Accordingly, many commuters will simply give up attempts to make deliberate adjustments and simply schedule travel once more in the high peak period. This places an unnecessary pressure on Sydney's public transport network for a busy half hour period in the morning and evening on only three days per week!

Whilst farebox revenue will fall if the peak window is returned to its pre-June 2020 setting, I make the case for this change on the premise that flattening the peak has much larger benefits in terms of reducing the transport network's maximum peak utilisation and corresponding capacity requirement. If this can be achieved, government will be able to avoid costly new transport infrastructure that provides minimal benefits. Instead, the focus can be directed towards operation of a reliable seven day per week public transport system that provides efficient and frequent services during the off-peak and on weekends.

Further changes could be made in light of the clustering of commuter demand on Tuesday, Wednesday and Thursday. To spread the peak load across all five workdays, a discount could be implemented for peak travel on Mondays and Fridays. Overall, constructing fare structures to smooth peak time travel has significant benefits to government in the form of reduced capital expenditure. By having an extended peak window, the present fare structure disincentivises commuters from making minor shifts to their travel plans to flatten the peak.

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