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What have we learned about long term structural change brought about by COVID-19 and working from home?

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TITLE: What have we learned about long term structural change brought about by COVID-19 and working from home?

ABSTRACT: March 2020 will forever be etched in our minds as the beginning of what has become the most concerning health pandemic faced by all generations of the living population. Almost two-and-three quarter years on, we are starting to see a number of signs for what the future might evolve into through structural change brought about by many events, and no more so than the burgeoning growth in working from home (WFH). No longer associated with negative stigma, working from home, or remote working more generally, has become almost folklore with all elements of society slowly recognising that it is to some extent here to stay, and we should start rethinking how this non-marginal change in the way we live, and work will be used to restructure the fabric of society. In this paper, we draw on the research undertaken as part of an ongoing project on WFH and its relationship to travel and work, since March 2020 to summarise the main evidence that we use to speculate on what we think are likely to be the big changes in the land transport sector that would not have been considered, at least to the same extent, pre-COVID-19.

KEY WORDS: *COVID-19; strategic responses; working from home; flexible working, hybrid working, suburbanisation; long term impacts*

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Introduction

The world has changed in ways we would not have expected prior to early 2020. While the interest continues unabated with themes such as integrated transport and land use, the promotion of sustainable transport (public transport and active transport modes in particular), and a refocus on place and movement linked to ‘vision and validate’ in contrast to ‘predict and provide’, the context has changed in a non-marginal way as a result of mitigation strategies in response to the COVID-19 pandemic. Whereas initial strategies were often immediate and short term in focus, we now see evidence of some strategies developing into more permanent and long-term structural responses that have deepened a commitment to a number of new experiences that we often describe as the positive unintended consequences of COVID-19.

At the centre of this structural response is working from home (WFH), which to the surprise of most has received significant support from both employees and employers in many countries, largely linked to evidence of increased productivity, whether perceived or economic (Barrero et al. 2021, Beck and Hensher 2021b). WFH to some extent is here to stay and looks like ‘stabilising’ at one to two days a week depending on employee occupation and the essential nature of in-office or customer-facing requirements. The Productivity Commission in Australia says that “workers may be more productive at home because they have better control over their time and enjoy better work–life balance. Firms will be able to tap into a larger pool of (more productive) labour. And while not strictly a productivity impact, workers have been shown to work longer hours when working from home during the pandemic”¹. The mounting evidence from numerous surveys and interviews with employers and employees reinforces both non-marginal WFH changes as well as significant reassessment of the needs of organisations for office space capacity pre-COVID-19 including refitting reduced office space to make it a more attractive work environment in place (see Beck and Hensher 2021a, 2021b).

Overall, these almost revolutionary changes (in terms of the short time it took to react and adjust), have resulted in a scurrying to rethink what the landscape will look like going forward for the planning of transport systems and place and space making. Some of the evolving themes are significant revisions, in many ways, of the pre-COVID-19 landscape and include reduced use of regular public transport, the suburbanisation of movement (especially throughout the week days and not just during peak periods) referred to as ‘living locally’, the redistribution of trip lengths aligning with a growing possibility of achieving a 15 minute city with a renewed focus on the local precinct, downsizing of the main office space and the growth in satellite offices with teleconferencing facilities, and most importantly a greater commitment to the realisation of a work-life balance with the employees values and interests becoming more accepted by employers.

This paper aims to synthesis what we have learnt over the last two and one-half years that offers signals for long-term structural changes to the way we live and work, and especially how we will be reallocating our time to place and movement, and what this means for policy settings designed to deliver on the high agenda topics such as de-carbonisation in the land passenger sector and promoting sustainable mobility.

¹ <https://www.pc.gov.au/research/completed/working-from-home>

The paper is organised as follows. The next section provides a perspective on the context in which we should be assessing how long-term structural changes that look like becoming permanent might relate to the de-carbonisation agenda, especially changes in preferences for the use of modes of transport. The following sections delve deeper into the main structural changes as a way of highlighting the arguments to justify why we believe that such changes are substantial and unlikely to be reversed. This has important implications for future developments in revised strategic transport model systems (Hensher et al. 2022c), leading us to suggest that we have delivered, through the pandemic, the greatest transport policy lever since the internal combustion engine, which we must use to better society, and not to try and plan for a return to the pre-COVID-19 state.

Contextualising long term structural change

Whatever travel behavioural response we identify since the pandemic began in early 2020, there is now a stronger reference to climate change and what these responses mean in terms of CO₂ emissions attributable to the land transport sector. This underpins the call by Budd and Ison (2020) for the idea of a ‘Responsible Transport’ policy agenda to help shape responses to COVID-19 which is built around environmental considerations and greater attention to individual and community health and wellbeing. As a consequence of the pandemic, there are changes associated with passenger and freight movements, the latter linked to the growing demand for online shopping and the replacement of some passenger trips by a freight trip (usually a light commercial vehicle), although click-and-collect means the retention of a passenger trip.

Most noticeable is the decline in the use of public transport in metropolitan areas, typically 65%-70% of pre-COVID-19 levels in many developed economies. The behavioural response is linked to two key factors, increased WFH and enduring bio-security concerns associated with using modes that require sharing (mainly with strangers), where the latter has resulted in increased use of the private car when commuting in particular. With reduced commuting activity per week for a non-marginal quantum of trips, the convenience of the car and reduced sensitivity to costs such as parking and delays due to congestion (where it exists), this makes the car an even more attractive mode of transport. To cite one of many studies with similar findings, the Conti-mobility survey² in May 2022 of 1,000 German citizens aged between 18 and 70, showed that a majority of people consider the cars as “an essential part” of their mobility and their personal living space. 54% percent of respondents see their car as a place of personal refuge. Cars continue to gain in importance as a result of the pandemic and have become an integral part of many people’s travel and leisure-time habits.

Given plans to transition to electric cars that have zero emissions at the tailpipe, the growth in car use by electric cars may be of little concern for de-carbonisation targets; however, we anticipate increased car use adding to congestion as the transition opens up relatively attractive purchase prices and significantly lower use costs compared to the petrol car (typically 25% lower usage costs and maintenance costs) (Hensher 2020). Despite the talk of introducing a distance-based charging regime when a sufficient number of cars are electric, the proposed 2.5c/km in Australia for electric cars only is, on our calculations, too low to maintain car kilometres at the levels experienced pre-COVID-19 in Australian cities, and any higher cost is almost certainly to be rejected by the political process.

²<https://www.european-rubber-journal.com/article/2091625/conti-mobility-study-shows-cars-remain-preferred-travel-option-post-covid>

Although rarely discussed in the transport debate at government levels, there are still significant emission outcomes when we factor in the energy generation source, the manufacturing process for cars and the replacement and disposal of batteries (i.e., the circular economy); this is something that should be communicated to the consumer. Embedded carbon is embedded cost, and we need to implement circular economy principles to reduce the carbon that is embodied in all facets of mobility.

Enhanced mobility through electric private car use is unlikely to align well with sustainability objectives, especially in metropolitan settings with growing congestion³. This results in a real dilemma, described brilliantly by Anable and Goodwin (2021) where they describe de-carbonising transport like shot silk. The warp (blue) relates to still being able to use our cars, because they will be electric; we will still be able to fly away on holiday, using non-carbon fuel, and technology will give us a timely transition. The weft (green) is the potential for significant traffic reduction including a substantial mode shift to walking, cycling and public transport, increasing car occupancy overall, and embedding transport de-carbonisation principles in spatial planning to ensure that new development promotes sustainable travel choices. The challenge, however, is that only one colour is typically seen, depending on where the viewer is standing.

Key influences driving long-term structural response

Non-stigmatised WFH linked to a new perspective of employers about employees is a real game changer. This has been driven, in large part, by very little (albeit slightly positive) change in productivity of employees working from home during the course of the pandemic. Figure 1 shows that from mid-2020 to the end of 2022, employees have felt that they have been just as productive, if not slightly more overall, working from home as compared to their regular non-home place of work. We should note that when we refer to working from home, we do not mean this is an all or nothing proposition. Rather, that working from home will form part of a normalised mix of where work is done, with each individual who is able to WFH being able to adopt some mix of such work that best suits them; allowing each individual to capture the benefits of both WFH and working from the “regular” work location.

³ The role of the car in a rural setting is likely to be quite different since public transport is often inadequate and unable to serve the spatially diverse needs of residents. Ride share as a car share service is likely to be too expensive unless government subsidises at the local bus fare, which is often not the case, and community transport services are typically very limited and available to a specific segment of the population. Hensher (2022) has proposed the idea of ‘Private Car as a Service (PCaaS)’ or more generally “Private Assets as a Service (PAaaS)”, given 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. 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)³. 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.

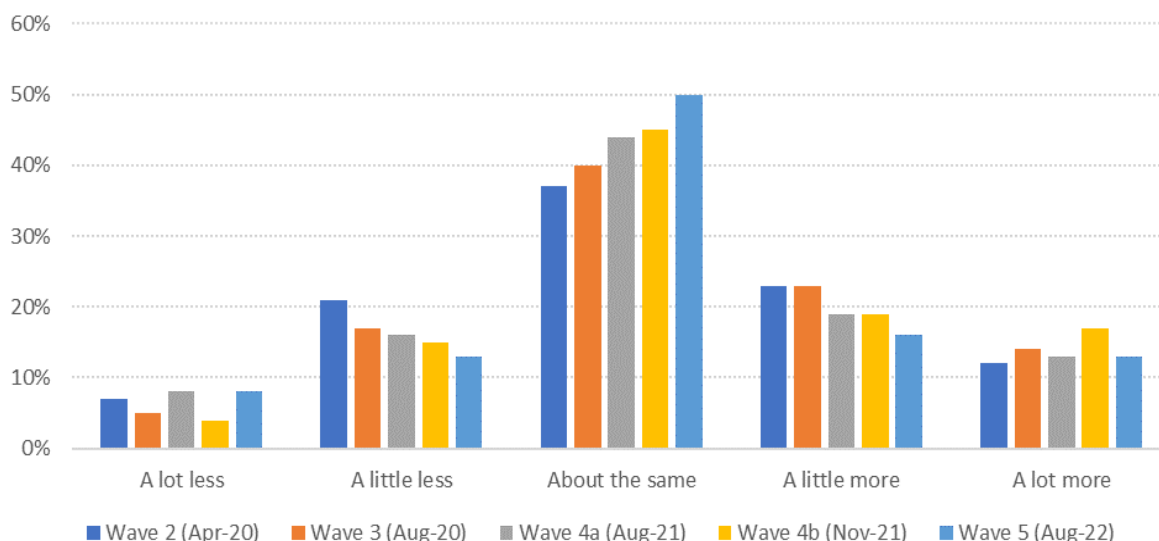


Figure 1. Reported Productivity while Working from Home

The evidence of ongoing WFH is indisputable in respect to the desire by employees, with support from employers, to WFH to some extent. The often-suggested metric of 1 to 2 days a week on average, seems to be reinforced by almost all studies. As hybrid working becomes more structured, and technologies and work patterns better support the mix between WFH and work “on-site”, we can expect productivity gains to be enforced as workers and workplaces gain the benefits of better flexibility, but also better face-to-face contact. As long as productivity is seen as a positive outcome of working from home, especially by employers, who also recognise the lifestyle and well-being benefits to their employees (something that will inevitably be built into employment contracts going forward), and that a preference of workers to continue to work from home remains, given the many benefits on balance that have been recognised, the ‘next normal’ will almost certainly be linked to the delivery of structural change centred around a hybrid working model.

Figure 2 shows, for South-East Queensland (SEQ) and the Greater Sydney Metropolitan Area (GSMA) since the beginning of COVID-19 (March 2020), the average number of days WFH (over a 7-day week) a continuing decline, on average, of the number of days WFH and hence the growth in the return to the office. It is not clear, however, whether we are not at a point yet where we could conclude that it has stabilised as the new normal hybrid model and further surveys for a few more years might be desirable. These estimates vary by occupation as shown in Figure 3. Figure 4 provides another perspective on the change in the probability of WFH for each SA2⁴ location in the SEQ and GSMA between data collected in September 2020, June 2021 and August-September 2022. There is clear evidence over this 28-month period of a reduction in the average number of days WFH, with the reduction being greater between September 2020 and June 2021 than between June 2021 and

⁴ Statistical Areas Level 2 (SA2s) are medium-sized general-purpose areas to represent a community that interacts together socially and economically. See <https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/main-structure-and-greater-capital-city-statistical-areas/statistical-area-level-2>

September 2022, suggesting a convergence to a level of WFH which we might describe as a stabilised hybrid working.

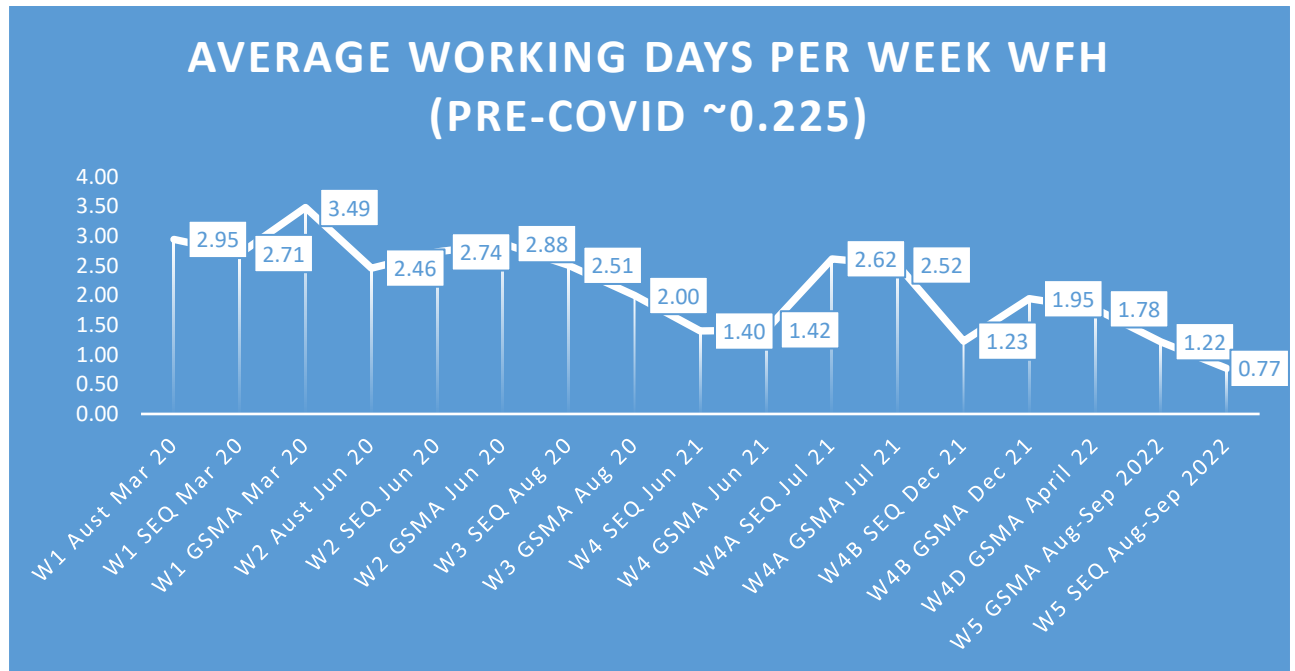


Figure 2. Changing incidence of the average number of days working from home between March 2020 and September 2022.

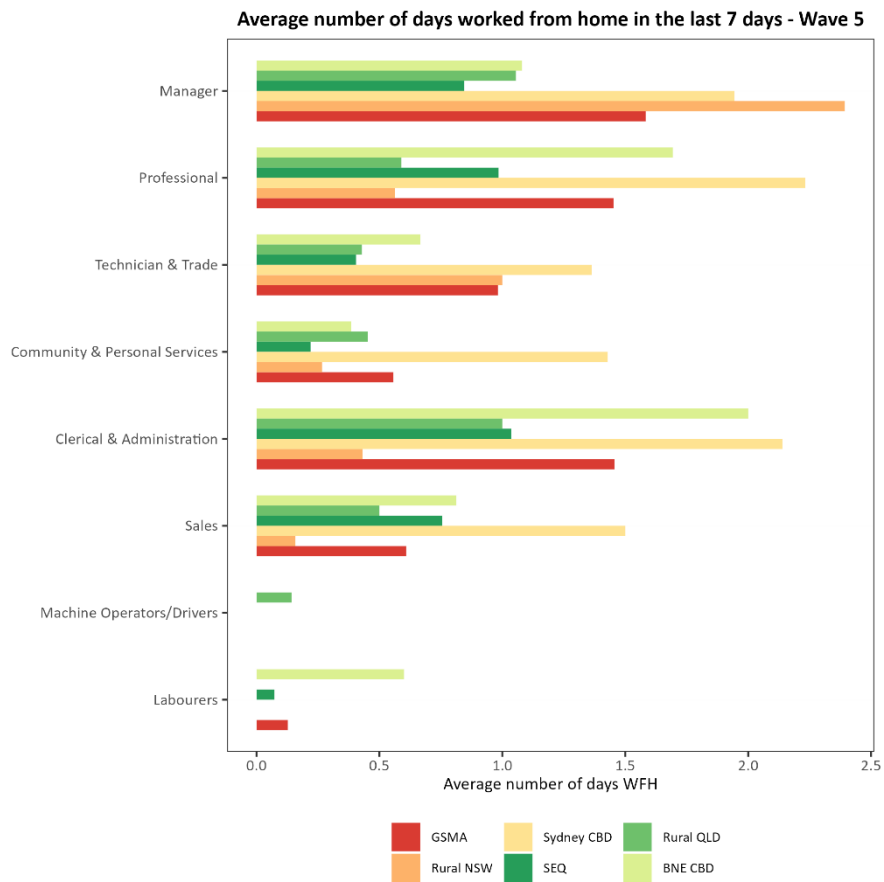


Figure 3. WFH by occupation and six locations in Australia, August-September 2022

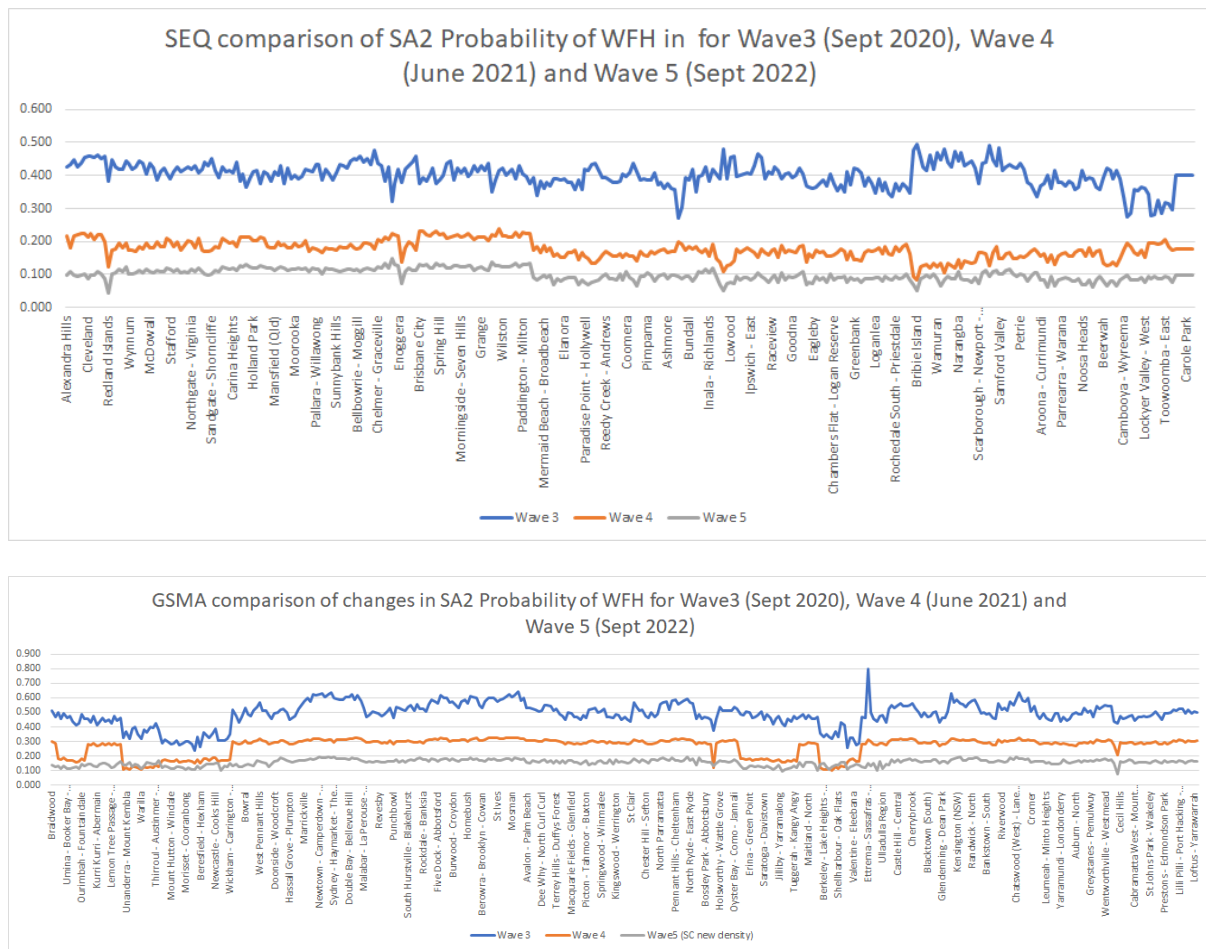


Figure 4. The changing incidence of working from home over time for SEQ and GSMA.

In Mar/Apr of 2021 we first examined how respondents were reallocating time that would otherwise have been used on commuting, which we followed up in more detail in Aug/Sep of 2022. We can see from Table 1 that a large percentage of time that would have been spent commuting is reallocated towards individual or household leisure time (and tasks). Given that within our most recent data the average time saved per week is around eight hours, this is not an insignificant amount of time that a person could spend in ways that offer themselves, or their family, higher levels of utility. There are also benefits that accrue to business, with the remaining time being allocated to work, which presumably leads to additional outputs that otherwise would have been foregone.

Table 1. Reallocating of Commuting Time Saved while WFH.

	Wave 4	Wave 5	
Additional paid work	29%	9%	Paid work for main job (WFH)
		6%	Paid work for main job (outside home)
		3%	Paid work for another org. (WFH)
		1%	Paid work for another org. (outside home)

Additional unpaid work	23%	23%	Unpaid work for main job (WFH)
		6%	Unpaid work for main job (outside home)
Leisure time	47%	25%	Household tasks
		21%	Home-based leisure activities
		10%	Leisure/Volunteer (outside home)

Flexibility and work-life balance now has new meaning in the sense that it is actionable without stigma. It has non-marginal spin offs linked to suburbanisation and the 15-minute city. These quotes are symbolic of a changed future.

‘Flexibility is here to stay’ and ‘employers who offer a balance of WFH and in office will attract more high-quality employees’ (The Future of Office Space Summit, 17 Feb 2021)

‘Employees demand a different approach to the workplace, one flexible to their needs and better equipped to address work-life balance. Getting them “back to work” entails more than just insisting that it happen as you’d like.’

<https://www.smartenspaces.com/blog/struggling-get-employees-back-work>

WFH has resulted in more travel through the day, typically by car, and some flattening out of the traditional peaks and growth in off-peak travel, especially more shopping trips, and personal business/social recreation trips (Balbontin et al. 2022) which are relatively closer to home than the traditional office location. This position is reinforced by staggered working hours as offices reduce capacity leading to an increase in single-occupant car use, although it is recognised that staggered hours will not necessarily be appropriate for some types of work. Additionally, there can be effort made to ensure that the distribution of WFH is efficiently allocated over all days in the typical Monday to Friday working week, and that any staggering of commuting times across each day is similarly organised/coordinated in a smart fashion, to help provide the greatest smoothing effect on peak hour travel. Hensher et al (2022b) show, for each metropolitan area and wave of data, the distribution is remarkably flat across the weekdays, with a range in the latest period being 26% to 30% for the GSMA and 15% to 19% for SEQ. What this suggests is that the WFH impact has spread evenly through the weekdays, which is a very encouraging sign for peak period planning; however, it is necessary to look at the evidence at an origin-destination level in order to see the extent to which this flatness is spatially widespread or not.

Hensher et al. (2022a) identified how working from home and a growing interest in the use of satellite offices (linked to working near home (WNH)) impacts on the amount of primary office space likely to be required (or preferred) in the near future in the Greater Sydney Metropolitan Area as we seek out evidence on what the ‘next normal’ may look like in the office property market. They predict a reduction in the percentage of office space compared to pre-COVID-19 of 79.6% for an average of one day WFH and 72.1% for an average of two days WFH. The decline of 20% to 28% in 2023 relates reasonably well to an occupancy rate in February 2022 of 18% for the Sydney metropolitan area

(Williams 2022). This is accompanied by an average 14.34% of staff in the future working in a satellite office or, on average, one in 6.7 employees⁵.

Using data from the US Postal Service Zillow, Ramani and Bloom (2021) quantified the effect of COVID-19 on migration patterns and real estate markets within and across US cities. They find that within large US cities, households, businesses, and real estate demand have moved from dense central business districts towards lower density suburban zip-codes, and they label this the “Donut Effect” reflecting the movement of activity out of city centres to the suburban ring. While this observed reallocation occurs within cities, they did not see major reallocation across cities, suggesting less evidence for large-scale movement of activity from large US cities to smaller regional cities or towns. They rationalised these findings by noting that working patterns post pandemic will frequently be hybrid, with workers commuting to their business premises typically three days per week. This level of commuting is less than pre-pandemic, making suburbs relatively more popular, but too frequent to allow employees to leave the cities containing their employer.

These findings are significant in assessing policy settings that government needs to consider with respect to initiatives designed to manage changing demands on servicing various locations, especially infrastructure and ways to support businesses in delivering benefits to society as a whole. With WFH being seen as one of, if not the most, impactful transport policy instrument available for many years, the policy settings that flow from this WFH and WNH ‘next normal’ are expected to include infrastructure investments that align more with suburban investments to benefit walking and cycling and the broader agenda of the 20-minute city where reduced commuting distances become a greater priority⁶. Importantly, the changed profile of commuting may look more like reduced frequency over a week while preserving much of the longer distance commute over fewer days while either avoiding commuting at all on some days or commuting to a close by satellite office.

Among these changes, the role of the Central Business District (CBD) needs consideration in many economies. As much as suburbanisation of work can lead society closer to the idea of a 30 (or 20, or 15) minute city, given their size and strategic locations at populations centres, the idea of a central business district will likely need reimagining. As worker density decreases, it affords the opportunity for a change in the nature of the office space itself, with less of a focus on maximising the per square metre (hot)desk space and more as a venue for greater social interaction, facilitated by better common and meeting spaces, along with improved access to outdoor or green working spaces. This aligns well with the popular idea of a mobility or city hub. To further increase the value proposition of the central office, there is perhaps the need to think creatively about other attractors like exercise spaces, in-house restaurants, and potentially employer subsidised (public) transport. Rather than simply returning to work, an organisation will need to systematically re-evaluate what the office brings to the organisation.

⁵ So called Central Business District (CBD) needs to be given new nomenclature as Downtown Activity Precinct (DAP) given an unlikely return to pre-COVID-19 office activity and growing interest in using space for residential accommodation and leisure centres.

⁶ The return to office when encouraged needs to contemplate many issues to make the office attractive. Having a window cf. not, increases productivity by 13% (many homes have a window in a study/office). Offices with light penetration are a concern with many offices (except if open office design). Meeting rooms may be less windows compared to where people sit most of the time.

The cityscape itself will also likely need to change, with improved greenspace and pedestrian amenity, a more diverse and vibrant nightlife, and a greater emphasis on cultural aspects often associated with CBDs such as density of museums, galleries, and performance spaces. As greater work flexibility becomes more normalised, employees are likely to spread out work which in turn has implications for the provision of public transport in non-peak times. A potential spill-over of these changes is that CBD as Downtown Activity Precinct (DAP) locations may become more attractive places to live, rather than just places for work alone. COVID-19 has accelerated the move for commercial real estate to become more adaptable, allowing industries to be reborn and rethink their place in their evolving surroundings. With appropriate vision and support, CBDs/DAPs can be restructured in ways that are more inclusive and affordable. As a final note, we also observe that many governments need to reconcile their paradoxical messaging brought about by the duality of a desire for the 20-minute city contrasted with public messaging about the role of the CBD/DAP as an economic powerhouse and the posturing that must return else economic ruin.

Changing perspective on corporate mobility

The changing perspective on corporate mobility is an important influence on the long-term structural responses being observed and is consistent with employers recognising the benefits of a balanced approach towards WFH; indeed, it has long been a recognised (but only lightly implemented) demand management tool. The idea of Corporate (or Company) Mobility Management (CMM) is not new and has been defined by the International Transport Forum (2010) as strategies which “seek to promote sustainable commuter, business and customer travel”. Findings from the OECD International Transport Forum study on CMM revealed that, for most businesses, mobility initiatives targeting customers and visitors are very similar to those aimed at the employee journey-to-work, in terms of end-of-trip infrastructure, incentivisation and information provision (International Transport Forum, 2010). Their study showed that the magnitude of change brought about by CMM initiatives can be quite large (15-20% reduction in drive-alone travel is not unusual) and cost-effective since many interventions can be relatively low-cost.

As businesses reset their activities and priorities in the light of the pandemic experience, it is logical to call for a renewed focus on travel demand management (TDM) in the workplace. This could include the introduction of the well-known travel hierarchy approach which prioritises access by active modes and public transport over personal motorised modes with the use of a company vehicle as the last option. In refreshing this hierarchy, one might now place WFH / WNH at the top (Figure 5). Such measures are relatively straightforward to introduce, and it is well established that the inclusion of TDM initiatives in travel plans via the workplace can give employers the unique ability to influence travel behaviour of large numbers of commuters (Cairns et al., 2010) by providing customised information to aid more sustainable travel choices. Furthermore, CMM cannot be separated from the continuing challenges around transport decarbonisation which are discussed below.

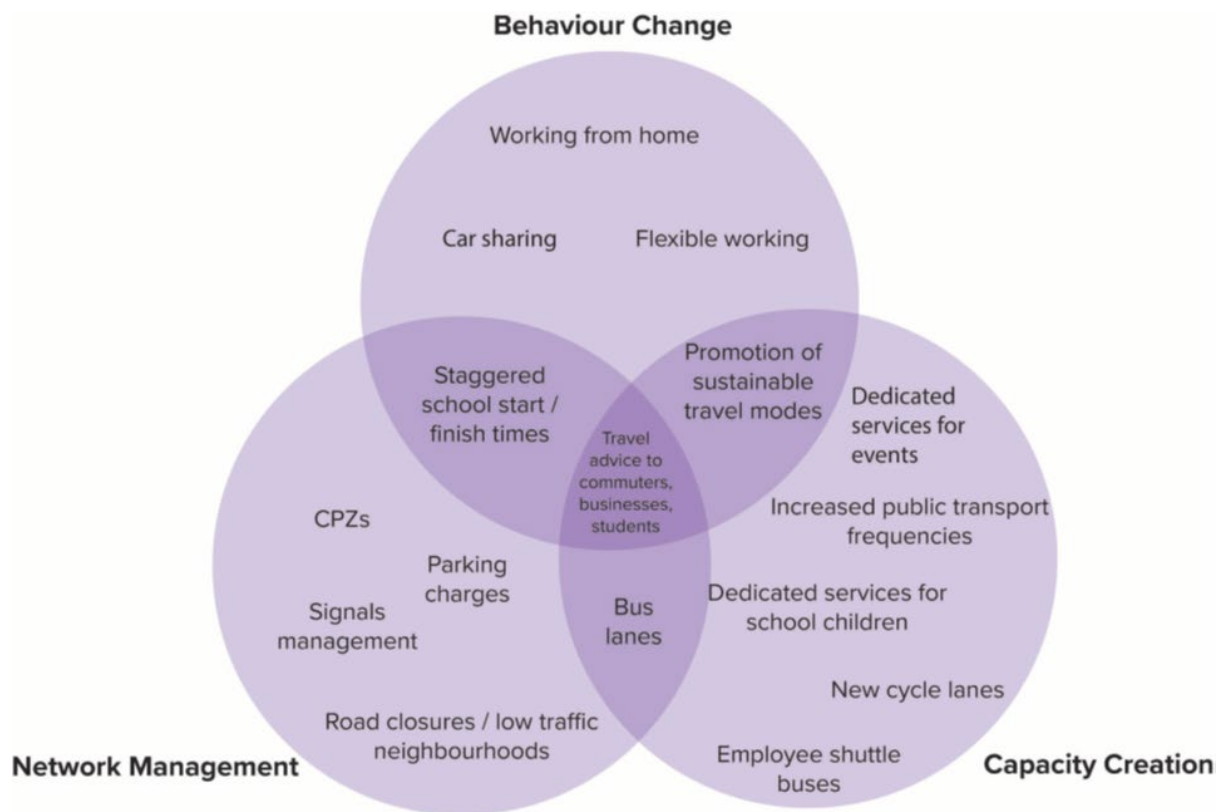


Figure 5. WFH as a behavioural change mechanism for travel demand management.

Source: Mott Macdonald (2021 - Figure 10).

There are potentially profound changes in the business travel market with the evidence that many meetings can be held effectively online. Hensher et al. (2022d) observe that we should also reflect on the implications for long distance domestic travel. Although there is evidence that business travel is rebounding strongly⁷ with Australian corporate travel more broadly tracking at 75 - 80% of pre-pandemic volumes, this is likely fuelled in part by a renewed enthusiasm for face-to-face events and networking. In the longer-term, given the overwhelming evidence that many meetings can be held effectively online, it may be deemed desirable to replace a day return flight (typically 4 hours out of the day) to attend a one-hour meeting with an online meeting. Committing to ensuring a reasonable balance between online and face-to-face meetings could be part of an employer's corporate social responsibility policies.

Greater focus on transport decarbonisation and the critical role of public transport

The positive impact of significantly reduced mobility on the environment (such as improvements in air quality) was widely observed in the early stages of the pandemic. This has been associated with calls to exploit opportunities for the development of a greener, more resilient mobility (e.g., Budd and Ison, 2020). Fundamentally, a strong public transport sector is vital in the pursuit of decarbonisation goals. This requirement has assumed greater urgency given the weakened public transport base as a consequence of the pandemic.

⁷ The Australian Financial Review reports that business travel is back to 90% of pre-COVID levels (29/08/22). <https://www.afr.com/life-and-luxury/travel/australian-business-travellers-take-to-the-skies-20220826-p5bd1h>

Beck et al (2022d) observe that the long-term implications of the pandemic on public transport seem to have so far been less investigated in the literature (a notable exception is Jenelius, 2022 who observes that the longer-term perspective is inevitably influenced by the fact that the pandemic has been more persistent than anticipated at its beginning). The significant drop in public transport patronage and the relatively slow build back to 65%-70% of pre-pandemic levels in many metropolitan areas (which may prove to be a ceiling) is contributing to concern about the impact that this will have not only on decarbonisation but also social equity.

A more positive perspective is to consider the opportunities for public transport created by the pandemic. The Transforming Public Transport Forum held in October 2021 in Victoria (PTAANZ and Aurecon, 2022) identified four challenges for future of the public transport industry, namely: the transition to zero emissions, rebuilding customer confidence post-COVID-19, embedding new mobility solutions into the broader public transport ecosystem, and optimising data to drive evidence-based planning and decision making.

Other than the need to rebuild customer confidence which has been widely documented (see for example, Beck et al., 2022c) these are not new challenges. Preston (2020), for example, notes that public transport is continually evolving; for example, the influence of disruptive events such as the market entry of rideshare providers and the anticipation of greater automation and autonomy have in the past led some to speculate that the end of public transport as we know it might be in sight. There is however, particularly in the light of the pandemic, a more widespread realisation that a strong public transport sector is essential to the pursuit of transport decarbonisation which will not be realized by technical solutions or “fixes” (such as the move to electric or hydrogen as a fuel) alone. Additionally, government actions and economic incentives “post-COVID-19” to encourage decarbonization will likely influence the CO₂ emission pathway for decades through a ‘new normal’, but the decrease in emission levels experienced early in the pandemic (recalling the clear skies experienced in cities like Delhi and the growth in popularity of active modes) will only be temporary (Logan et al., 2022). Since Net Zero targets will not be met without mode shift towards public transport the need to implement strategies to recover public transport patronage while decarbonising all forms of transport has a new imperative. These arguments are relevant both to local and longer-distance travel with the latter including implications for inter-city modal competition with a shift away from short haul flights to High-Speed Rail (in Europe at least).

Beck et al (2022c) note that since public transport use lags significantly behind the rebound in private vehicle use in many jurisdictions, authorities should do everything within their power to avoid the further entrenchment of the motor vehicle as the dominant mode of transport, as this would be the fastest way to erode any gains in sustainability.

If the will to tackle urban road pricing is lacking, then targeting growth in urban road traffic volumes is a second-best way to achieve more efficient travel choices. A land-use response would include substantial density increases achieved primarily through Transit Oriented Development (TOD). A transport response would include substantially improved public transport, walking and cycling opportunities, ideally as part of a package of TDM measures which can be used to reduce vehicle travel in ways that minimise costs and maximise benefits to consumers and society. Although TDM has been

typically applied in large event scenarios, it is now integrated into urban transport strategies, infrastructure projects within a movement and place framework and is currently integral in the response to the COVID-19 pandemic.

The regional and rural context

It is striking to note that amongst the growing literature on the reported impact of COVID-19 on travel behaviour, there is relatively little documented experience of how rural travel behaviour has been impacted and yet the longer-term impacts of COVID-19 on mobility in rural areas should also be considered (Nelson and Caulfield, 2022, Mulley et al. 2023). Underlying issues of social exclusion are likely to be exacerbated by policies which place strong emphasis on digital interventions unless they are accompanied by the necessary investment in digital infrastructure (it is harder to work from home in many rural areas on account of inadequate internet bandwidth). Such investment would need to include programmes to combat digital literacy and lack of confidence amongst certain segments of the population when using the Internet and Apps (e.g., the elderly). OECD (2020) identify a number of opportunities for rural areas emerging from the COVID-19 crisis. Several of these are strongly dependent on a sufficiently robust digital infrastructure to support (for example) remote and distributed work and greater accessibility to services such as e-health and e-education.

Other policies that could be promoted include a switch to consuming habits that favour local products and destinations (also relevant in the context of tourism) and a greater focus on strengthening local networks which will also build in resilience to the threat of future shocks. Nelson and Caulfield (2022) discuss some of the responses that public transport operators and shared transport providers have implemented during the pandemic and highlight the role that Demand Responsive Transport (DRT) and community transport (CT) has played a strategic role in sustaining rural communities. More attention should be given to flexible and responsive forms of transport and to MaaS-type solutions in rural environments which also recognise the role of the private car.

Potentially, if WFH becomes an even stronger feature of the workplace, we could see the rise of digital nomads in a non-trivial fashion. These workers can be thought of as those whose jobs are largely digital and unconstrained by locational factors (Hardy and Robards, 2015). Given the lack of constraints placed by geography, regional areas have the opportunity to attract these knowledge/high-skill workers, if appropriate infrastructure is available. In particular, regional centres within striking distance of major urban locations are especially well-placed to grow as these workers prioritise cheaper housing, weather, and quality of life (Gretzel and Hardy, 2019, Hall et al. 2019). Even though in the short-term there is limited evidence for inter-city relocation, this is a possibility worth monitoring, particularly as more employment becomes digitised.

Retail and Supply Chain Impacts

Throughout the pandemic, many consumers trialled online shopping substantively for the first time. It is likely that this behaviour will stick. According to Australia Post (2022) 9.2 million Australian households shopped online in 2021, spending \$62 billion dollars; representing a 23.4% year on year growth (compared to 4.3% year on year growth for overall retail spend). Online now accounts for one out of every five dollars spent in Australia. In the first half of 2020 in the US, the increase in e-

commerce equivalent to that of the previous ten years. This has placed inordinate strain on supply chains globally, and just as pressingly, 60% of businesses feel they are only moderately prepared to capture e-commerce-growth opportunities (McKinsey 2020).

The Institute of Transport and Logistics Studies September 2022 Transport Opinion Survey (TOPS)⁸ found more Australians have shopped online compared to March 2022. More than three-quarters (76.4%) of Australians shopped online, spending an average of \$375 per month. Online shoppers in Queensland, South Australia and NSW spent the most, ranging between \$400 and \$420 per month. Groceries and fashion were the top purchases, accounting for 27 percent and 20 percent of online spending respectively, followed by hobbies (13 percent) and health & beauty products (10 percent). The preferred delivery method for online shopping varied by products, with over 70 percent of online shoppers choosing home delivery for fashion and hobby products, while up to 45 percent of shoppers chose click-n-collect for groceries, specialty food, liquors, variety stores, and home and garden products. Online shopping has moved many passenger trips towards a goods delivery trip, increasing the number of light commercial vehicles on our roads. The greatest impact is being felt at the suburban levels as delivery vehicles compete with cars, resulting in increased traffic despite the reduction in commuting trips.

The role of the supply chain, and the infrastructure that underpins the movement of goods, is placed in sharp focus by this rapid growth. COVID-19 revealed vulnerabilities in the widespread globalised supply chains of many companies. When the supply chain was disrupted in even one location, often times this created a lack of critical components that shutdown production. A sharper focus may also need to be placed on communication and data sharing within the supply chain, where smaller companies upstream may play critical roles, but where there is little visibility from companies downstream. Given narrowing differences in costs of production between global locations and the realisation that disruptions are increasingly more frequent, we could potentially see a trend of moving production back within the borders of major consumer markets, but more likely a diversification of supply networks (particular in critical industries such as healthcare manufacturing and microelectronics), with a greater focus on security and resilience than “just-in-time”. This may be exacerbated by the recent energy price shocks.

Implications for Infrastructure

As discussed, investment digital infrastructure is paramount. Given the pandemic experience, it is likely that many companies will now seek to accelerate digital transformation to ensure business continuity, improve productivity and launch new business models to remain competitive. COVID-19 has already had a disruptive impact on labour markets. OECD data indicates that declining household incomes coupled with tax reforms linked to the pandemic led to widespread decline in effective taxes on wages (OECD 2021). Border closures in many countries has resulted in skill shortages, and industries particularly disrupted by COVID-19 restrictions have lost large percentages of their workforce as employees left the sector in pursuit of other work. To avoid future adverse social and economic outcomes, reskilling and upskilling of the workforce will be a priority. The education and

⁸ <https://www.sydney.edu.au/business/our-research/institute-of-transport-and-logistics-studies/transport-opinion-survey.html>

training systems will need to adapt to help the workforce quickly reskill and upskill, with investment in virtual solutions and human-centric technology to drive communication, and knowledge and skill transfer.

Given that digital flexibility can reduce crowding and congestion on the transport network, investment in such digital infrastructure can be viewed as a substitute for investment in physical transport alternatives. As more people move and work in their local areas, the role of suburban amenity and how investment in local infrastructure is supported will need to be reconsidered. Active local transport planning and facilities will become increasingly important, especially cycling and pedestrian infrastructure, and even more so as e-bicycle and e-scooter technology becomes more diffused.

Better modelling of more localised travel patterns will also be needed. Most jurisdictions employ a strategic transport model to evaluate the impacts of alternative transportation and land use investments as well as presenting any changes in travel demand in response to different input assumptions. We have been working on embedding the impact of WFH into these models (e.g., Hensher et al. 2022c), but more detail on the impacts such behaviour on suburban land use, particularly with reference to shared office space in these localised areas, is needed. Beyond the strategic models, the funding models themselves also need to be reassessed. As social and work interaction becomes more local so will the use of public spaces, other social infrastructure, and transport networks. We will likely see increased demand for national parks and green spaces, particularly amongst those living in high density areas. Most local amenity investment is made by local governments, however moving forward these local assets may require more substantive funding from “revenue richer” governments at a State or Federal level. There is perhaps the need to restructure and formalise local amenity investment at these higher levels, to promote better working near home experiences. A positive of these localised investments is that they have shorter lead times, are less expensive, and as smaller projects have a much lower risk of going significantly over time or over budget. The dividend to the public is also achieved much more quickly.

The resilience of infrastructure, both physical and digital, has been brought into sharp focus by the pandemic, but also in the face of a changing and increasing chaotic climate. In Australia, late 2019/early 2020 was marred by extensive and unprecedented bushfires where a total of 24.3 million hectares was burnt (the size of the United Kingdom is 24.5 million ha). In 2022, Australia experienced one of the nation's worst recorded flood disasters with property damage last estimated at AU\$4.8 billion (as at June 2022). Sydney received 1290mm of rain in total in 2021; by the start of November 2022 the city had recorded 2585mm. The pandemic experience and embedded WFH has shown that with appropriate infrastructure, negative impacts of economic productivity from disaster events can be mitigated. Invest in climate-resilient infrastructure to withstand or to adapt to the detrimental impacts of climate change is even more essential moving forward. We note highlight that the Wave 5 data collection was significantly delayed due to ongoing flooding in QLD and NSW (the primary states for data collection), along with industrial disrupts that further disrupted transport networks. We anticipate that disruption will only become increasingly more prevalent.

This sharper focus on sustainability is also being driven by business, as the costs of pollution and the benefits of environmental sustainability are increasingly recognised and as they respond to the sustainability concerns of investors. In some respects, the pandemic, as a global, systematic, fast-

moving phenomenon, has shown what an extreme climate crisis could look. To avoid such disruption from climate change, there is the need to take action to limit climate risks with more climate resistant capital investments, or by diversifying supply chains. Perhaps more directly, there is a direct financial motive to invest in sustainable infrastructure such as green energy, efficient batteries, sustainable mobility, carbon-capture, and agriculture innovations could well be the next boom in investment returns, much like digital-economy companies have powered recent stock-market returns. These investments don't need to be macro-economic infrastructure, there is also the scope for micro improvements such as introducing better insulation requirements, developing energy-efficient appliances and equipment, and designing cities to be more resilient to climate change events such as flooding and heatwaves. Following the Global Financial Crisis, infrastructure investments were used to boost economic activity, but very few had a sustainable focus. While many economies are currently trying to cool economic activity given rising inflation, should infrastructure be used as a stimulus moving forward, such investment should also come with a green focus.

Finally, the pandemic may deliver some insight into the nature of contractual models or investment frameworks were able to withstand volatilities in markets, including demand, and also how systems, assets and projects were able to manage risks or shocks and absorb losses. There are likely going to be exemplars of how finance and capital, along with regulatory flexibility, can impact on credit risk and access to financing, along with the role of insurance.

Reflecting on Initial Perspectives

As we seek to synthesise the stream of research that we have conducted (and still continue to conduct), we revisit our initial thoughts published in the first paper wrote on the impact of COVID-19 following analysis of data collected in the initial stages of the pandemic in March 2020 (Beck and Hensher 2020). In seeking to contextualise the policy implications of those early experiences and results following are the key themes that evolved:

- Australians supported the governments early response to the pandemic, which had early dividends in terms of flattening the curve of COVID-19 infections. Largely, the support for action remained high over the last two years and, if anything, our data indicates that the governments have been felt to move too slowly on implementing restrictions when needed, and a too quickly when removing restrictions as case numbers ease.
- We identified that supermarkets and essential consumer goods providers would need to remain prepared for disruption, the role of rationing and better cooperation between manufacturers, suppliers, and transport and logistics providers at the time of such panic. We also highlighted how widespread COVID-19 infection in the workplace might create further disruption that would need to be accounted for. Supply chains (of consumer staples) have mostly caught up (impacts of natural disasters excluded) but many supply chains remain affected by COVID-19 outbreaks within manufacturing centres, along with variable government policy.
- We recognised that while international travel may be suppressed, or unaffordable, the relative attractiveness of domestic travel would be increased and that Australian-based airlines likely needed to investigate strategies to encourage air travel within Australia. Driven

by a strong desire to connect and explore, there has been a resurgence in air travel in Australia, but reductions in staff numbers during the pandemic, along with surging demand post-restrictions have meant that on-time running statistics have been significantly worse throughout 2022.

- Early in the pandemic, we argued that public transport would face some of the greatest challenges, and that overt and regular cleaning would be required. At least anecdotally, this is most apparent now on services provided by Sydney Trains. We argued that innovation could see the development of a simple “green” or “red” indicator in a phone app as a method to communicate when a good time was to travel versus when was a bad time. This idea is still current, particularly in the context of work flexibility and the potentially for the better staggering of peak-hour commuting.
- It was suggested very early in the pandemic that the reduction in private motor vehicle use during restrictions had benefits such as improved air quality and visibility in the capital cities, and in less congestion on the roads for those essential workers who need to travel. We noted, however, that it would be likely that as COVID-19 restrictions ease, the car will return in a dominant way (given continuing bios-security concerns in shared spaces) and could cause congestion at levels not seen prior to the outbreak should appropriate measures not be introduced. In many respects, this is what has occurred, with the private vehicle being further entrenched as the predominant form of transport when a journey is made. This gives rise to the spectre of road pricing as the effective instrument to curb the dominance of the car.
- We reflected early on the important role of active travel in local areas, but also as a substitute for car use. It was argued that with careful thought, strategic “pop-up” bicycle lanes could be created and if successful, could become permanent infrastructure. Unfortunately, the role of NIMBYism (perhaps driven by the dominance of the car), six pop-up cycleways in Sydney installed by the government under emergency COVID-19 powers have been argued as being unlawful by residents who want them removed. Thankfully the government has thus far rejected these claims and have stated that they are permanent. Indeed, the most recent State Government budget included provisions for active transport that have not previously been seen on that scale.
- Finally, the impact of the pandemic on infrastructure investment and funding was discussed. Infrastructure investment in transport projects is typically used as a stimulus measures, but in the context of the structural impact of COVID-19, authorities should think very carefully about any future infrastructure investment. In 2022, several governments in Australia (including Federally) placed billion dollars of projects on hold citing volatility in cost of materials, equipment, and the shortages in skilled labour. Further echoing our calls from two years prior, Infrastructure NSW encouraged the government to focus instead on small and medium-sized activities (with particular focus on water security and sustainability).

Overall, many of the earlier recommendations we set out have proved to be robust almost three years after the outbreak of COVID-19. Early on, we identified that flexible working arrangements were perhaps the greatest policy lever available to governments to minimise the risk of the spread of

COVID-19, but also as a systematic approach to help reduce congestion during the peak. In light of what would be a structural change to the nature of work, earlier papers posited that future research would be required to understand architectural and urban design issues that will arise from the different way in which work is done (admittedly we also speculated that there might be a trend towards less dense living, reversing the densification seen over the course of the last decade). We similarly speculated that better levels of congestion witnessed in the early stages, combined with significantly lower levels of pollution as a result, authorities could potentially encourage lower levels of car use to be ongoing. This is something that has not been successfully achieved. Finally, it was noted that future research should also continue to monitor what was, at the time, largely uniform support of and compliance with government restrictions, and it was unclear if the behaviour was motivated by altruism given the threat of COVID-19 to others, or egoism given the risk posed by COVID-19 to the economy. This widespread response remains a social phenomenon that still requires investigation.

Conclusions

The unintended positive consequences of COVID-19 have cushioned the severity of the pandemic to some degree, and this should be recognised as an immediate benefit. More importantly, however, is the potential for longer term gain in well-being and lifestyle that may not have been offered up if life had continued along the journey associated with the pre-COVID-19 state of travel, commuting and associated pressures on work-home balance. Given that it is likely that working from home and/or working near home will continue to feature as a greater proportion of where work is completed, it is crucial to develop and implement best practices for WFH and WNH⁹ to maintain a good level of productivity, achieve the right level of work and life balance, and maintain a good level for physical and mental health. There currently exists limited evidence on the impact of COVID-19 on rural and regional communities; hence the focus on change in urban environments must not lose focus on the changes that may also be required in these places, to ensure equity and inclusion among these communities.

While we would have preferred that the virus had not taken hold, we must look forward to using this extreme event experience to obtain positive benefits to individuals, households, businesses, and society more broadly. This position must recognise that mental health and well-being, including social exclusion has not gone away and that it remains a high priority for governments as well as for business more generally; however, let us recognise that some good has come out of the pandemic to provide some directions to better support well-being that was not on offer before COVID-19. The policy implication is very clear; namely, to continue to ensure that people can work from home successfully, and know they are making a positive contribution while doing so. Meaningful work provides meaning to life.

These structural changes are evolving to become a permanent fixture of the mobility land use scape. The new catch phrase may might be best stated as “Let’s give everybody access – democratise the office place and given them better choices – so it is about giving people better access to choices.” We

⁹ One initiative with great appeal is the construction of a floor of an apartment block dedicated to shared working space that is available through booking to all tenants. This enables social interaction as well as relieving pressure on small apartments where the design of a separate office space may be unattainable.

should caution overestimating the impact of the short run; there is no ‘normal’ – we will not return to the past and why would we want to? However, long term structural reform as elicited in this paper appears to be a welcomed feature on the ‘next normal’.

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