



WORKING PAPER

ITLS-WP-20-09

**Insights into the Impact of Covid-19 on
Household Travel, Working, Activities
And Shopping in Australia
– the early days under Restrictions**

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TITLE: **Insights into the Impact of Covid-19 on Household Travel, Working, Activities and Shopping in Australia – the early days under restrictions**

ABSTRACT: When 2020 began, we had no idea what was to unfold globally as we learnt about the Novel-Coronavirus in Wuhan, in the Hubei province of China. As this virus spread rapidly, it became a matter of time before many countries began to implement measures to try and contain the spread of the disease. Covid-19 as it is referred to, resulted in two main approaches to fighting the viral pandemic, either through a progressive set of measures to slow down the number of identified cases designed to ‘flatten the curve’ over time (anticipated to be at least six months), or to attack it by the severest of measures including a total lock-down and/or herding exposure to fast track ‘immunisation’ while we await a vaccine. The paper reports the findings from the first phase of an ongoing survey designed to identify the changing patterns in travel activity of Australian residents as a result of the stage 2 restrictions imposed by the Australian government. The main restrictions, in addition to social distancing of at least 1.5 metres, are closure of entry to Australia (except residents returning), and closure of non-essential venues such as night clubs, restaurants, mass attendee sporting events, churches, weddings, and all social gatherings in any circumstance. With some employers encouraging working from home and others requiring it, in addition to job losses, and many children attending school online from home, the implications on travel activity is extreme. We identify the initial impacts associated with the first month of stricter social distancing measures introduced in Australia.

KEY WORDS: *Coronavirus, Covid-19, travel activity, working, working from home, air travel, shopping, attitudes, survey, Australia*

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1. Introduction

The coronavirus disease 2019 (Covid-19) has created disruption to travel and activities unlike anything seen since perhaps the Second World War. The first outbreak occurring in late 2019 in Wuhan, the capital of the Hubei Province in China, quickly spread to become a global pandemic. While China was emerging from their peak of the curve in mid to late March, the rest of the world was starting to feel the exponential growth of infection and the resulting pressure on public health systems, and countries like Italy and the United States of America (particularly New York City) experienced devastating loss of life.

In the early half of March, discussion in many countries focused on the most effective forms of intervention to slow the spread of Covid-19 while grappling with the consequence of many measures to respective economies, civil liberties and social impacts that such measures would have. However, by March 31st there were over three-quarter of a million reported Covid-19 cases (754,933) and 36,522 deaths¹, by this time governments had no choice but to act.

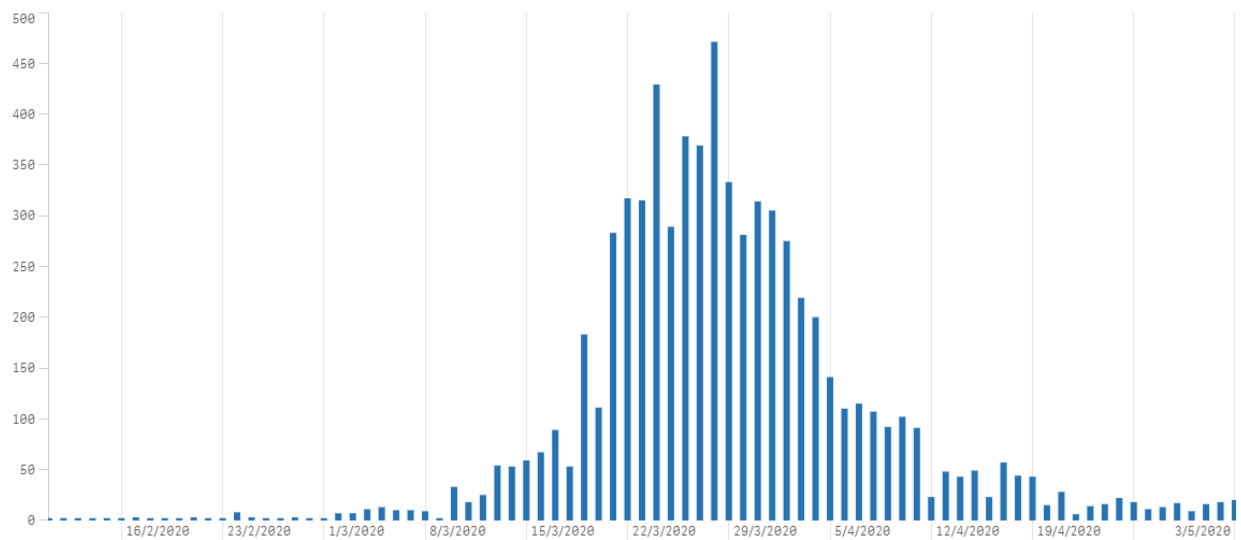
Some countries like the United Kingdom initially opted for a herd immunity approach, while others such as New Zealand opted for a full-scale shutdown of social and economic activity. Australia initially approached Covid-19 in a relatively controlled way:

- On the 19th of March following the disembarkation of the Ruby Princess cruise ship, Australian borders were closed to non-citizens and residents. Australians were urged to return home as soon as possible.
- On the 20th of March, restrictions were placed on the size of public gatherings with outdoor gatherings of more than 500 and indoor gatherings of more than 100 banned, with indoor gatherings requiring enough space for one person every 4m².
- On the 23rd of March, following mass gatherings at places like Bondi Beach, restrictions were further tightened to include the closure of all bars, restaurants, clubs, gyms, casinos, cinemas, beaches, indoor sports and entertainment venues, and places of worship.
- On March 29th these restrictions were tightened once more, with public gatherings limited to no more than two people, those with chronic illness or over the age of 70 urged to stay home and the outlining of only four acceptable reasons for Australians to leave their houses: shopping for essentials; for medical or compassionate needs; exercise in compliance with the public gathering restriction of two people; and for work or education purposes. Violation of the restrictions carried fines of \$1,000 per person and \$5,000 per business².

The evidence is that these measures, and the willingness of the Australian public to adopt the recommended behaviours, have been successful in turning around the growth of Covid-19 transmission. Following the highest recorded number of 469 new cases on the 29th of March, the number of new cases has fallen, indicating that that curve has initially flattened in Australia. As of the 3rd of May, Australia has had a total of 6,801 reported cases (see Figure 1) of Covid-19, and 95 deaths.

¹ <https://covid19.who.int/>

² The amount varied by State, with NSW introducing the fines in the text.



<https://www.health.gov.au/resources/daily-number-of-reported-covid-19-cases-in-australia>

Figure 1: Daily Number of Reported Cases

While Australia has, to this stage, been relatively successful in battling the health risk presented by Covid-19, the impact on the economy has been just as large. Based on a recent survey conducted by the Australian Bureau of Statistics³, the number of people who were working paid hours fell from 64% prior to the restrictions, to 56% in the first week of April, with a total possible increase in unemployment of 1.5 to 2 million people as a result of Covid-19 and associated measures.

In response to the economic shocks, governments at all levels have announced unprecedented levels of support. On the 22nd of March the Federal Government announced the \$550 JobSeeker supplement for those on unemployment benefits, to remain in place for up to six months. This was followed by the \$130 billion JobKeeper initiative announced on the 30th of March designed to keep employees attached to their place of employment, with \$1500 per week being made available for eligible employees and paid via their employer. Along with a range of other measures designed to support the economy, the Federal government has committed to approximately \$320 billion in stimulus spending (16.4% of annual GDP)⁴. Similarly state governments have also injected money into the economy, for example NSW announced \$2.3 billion in spending on the 17th of March, followed by a further raft of measures on the 27th of March⁵.

The impact of Covid-19 mitigation policies on the movement of people has also been significant. For example, Figure 2 displays the Citymapper Mobility Index⁶, an aggregate measure of use of public transport, walking and cycling, over the last three months, and demonstrates a large change in both Sydney and Melbourne.

³ <https://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4940.0Main+Features11-6%20Apr%202020?OpenDocument>

⁴ <https://treasury.gov.au/coronavirus>

⁵ <https://www.treasury.nsw.gov.au/index.php/Covid-19Stimulus>

⁶ Citymapper.com/CMI

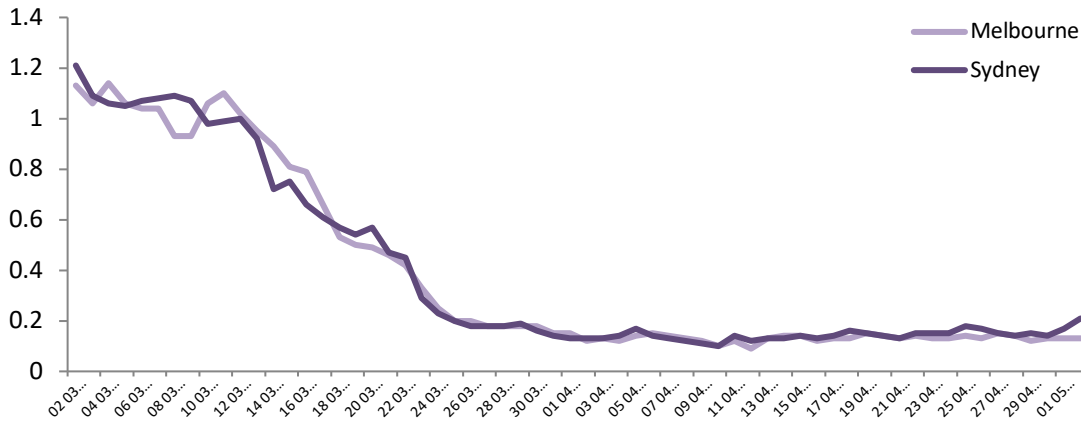


Figure 2: Citymapper Mobility Index

The Google Community Mobility Report⁷ uses location data from mobile phones to highlight the percent change in visits to places like grocery stores and parks within a geographic area, relative to baseline travel (Figure 3). As can be seen in this aggregate data, the amount of time spent at home has increased, while that spent at workplaces, retail and recreation, and transit locations has fallen dramatically since mid-March.

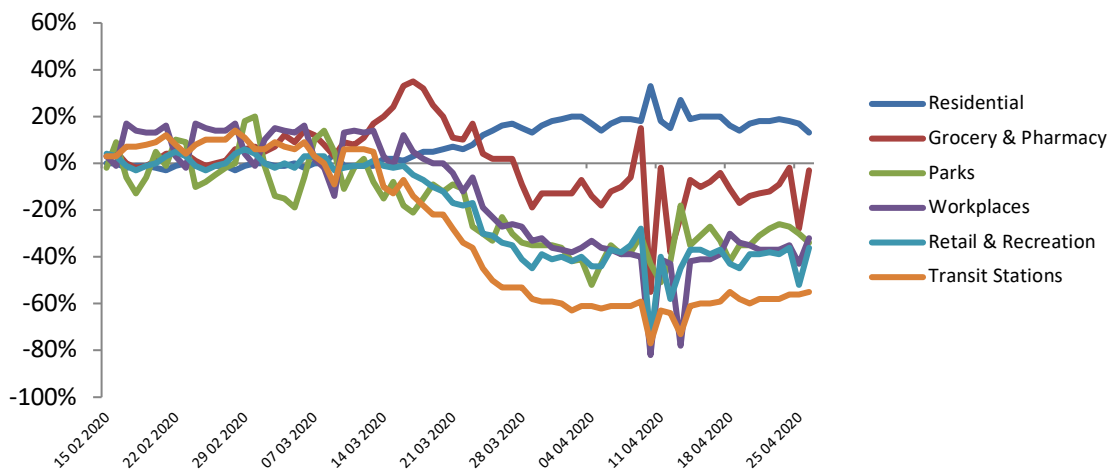


Figure 3: Google Mobility Report

In order to gain insight at a more disaggregate level, we deployed a survey examining household travel and activity patterns, employment and working from home, aviation travel, experiences in grocery shopping and general attitudes towards Covid-19. In the next section we give an overview of the survey and discuss the sample, followed by a presentation of preliminary findings, then ending with a discussion of the results and concluding remarks. This survey is the first of a series we are undertaking to

⁷ <https://www.google.com/covid19/mobility/>

track responses over time to the Covid-19 pandemic and how to monitor how Australia is responding as we move out of the most severe restrictions to the ‘new normal’.

2. Survey and Data Collection

The survey was designed in the last week of March, and asked respondents to provide information on their level of employment prior to the Covid-19 outbreak as well as after, including their ability and instances of working from home. Respondents were then asked to think about weekly travel activity of the household in the early part of March, prior to the emergence of Covid-19 as a significant public health threat, and to complete a short travel activity survey asking them to recall what trips the household made by different modes of transport and for different purposes. They were then asked if the household had changed their travel activity as a result of Covid-19 and if the answer was yes, they completed a second set of travel questions outlining the changed travel. For those that had not changed but had plans to do so, and those who had changed and planned even more, they also completed a travel diary asking what their planned change might look like.

Outside of travel activity, questions were also asked about the level of car use of the household, their level of comfort with using public transport given new biosecurity concerns, behaviours with respect to potential air travel and the nature of disruption to that activity, experiences with grocery shopping and a series of attitudinal questions about the threat of Covid-19 and the response of governments, businesses and people in general.

The online panel survey company PureProfile was used to sample respondents, and the survey was available across Australia in order to examine the widespread impact of Covid-19. The survey went into the field on the 30th of March and a sample of 1073 usable responses was collected by the 15th of April, 2020. A summary of the final sample is provided in Table 1.

Table 1: Overview of Survey Sample

		NSW/ACT	VIC	QLD	Other	TOTAL
Female	18-34	34	52	25	91	202
	35-54	38	27	57	34	156
	55 or older	41	42	44	72	199
	Total	113	121	126	197	557
Male	18-34	44	35	26	15	120
	35-54	56	64	41	29	190
	55 or older	55	85	43	28	211
	Total	155	184	110	72	521

For the purposes of preliminary analysis, socio-demographics differences are explored based on gender, age (younger (18 to 34, n=322); middle-age (35 to 54, n=352); older (55 or older, n=410)), and household income (lower income (less than \$100,000, n=617); middle income (\$100,000 to \$200,000, n=276) and high income (more than \$200,000, n= 121).

3. Results

3.1. Impact of Covid-19 on Travel

The survey went into field on the 30th of March, when the most extreme of the Australian social distancing measures came into effect. At this point in time, 78% of respondent households had already made many changes to their weekly household travel (females more likely to report that changes had already been made), 15% had not made changes nor were they planning any (lower income households more likely to not have changed) and 7% were planning to change (men more likely to report changes being planned). Of those households who had already changed, 32% were planning further changes moving forward (with younger households more likely to be planning further change).

The following sections report reductions in overall travel, travel by modes and travel for different purposes. Similar work is being completed globally, and one such of interest is a project of IVT, ETH Zurich and WWZ, University of Basel, the MOBIS-Covid19 study⁸. This study uses mobile phone GPS tracking data from 3,700 participants who completed a prior mobility study in between September 2019 and January 2020, to examine the impact of Covid-19 on the French and German speaking part of Switzerland. Our results, using a household travel survey, are consistent with those found via the MOBIS GPS tracking, as well as those found by aggregate location data in Australia such as Google and CityMapper.

3.1.1. Overall Travel

Consistent with information provided by more aggregate sources such as Google Maps and CityMapper, we find that reported trips have reduced significantly from an average of 23.9 trips per week (for different purposes using different modes) down to 11.0, a reduction of over 50% in weekly household trips (Figure 4). Moving forward, planned further changes were marginally different to those that had already occurred, averaging 9.4 per week.

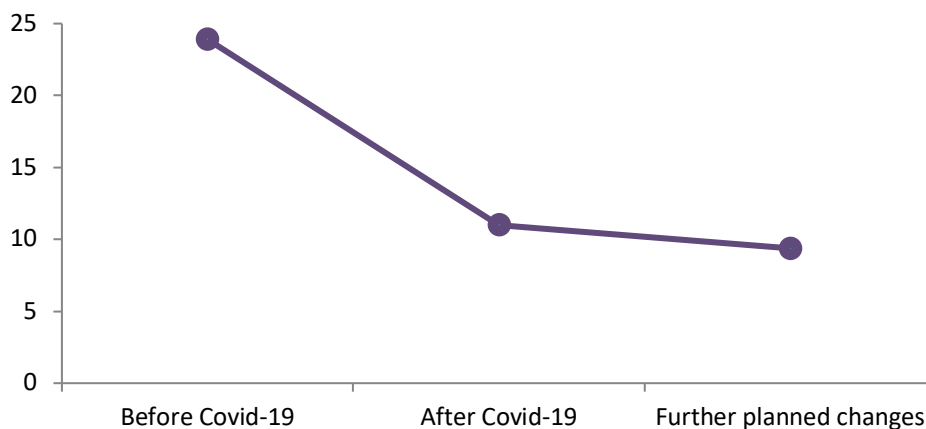


Figure 4: Impact of Covid-19 on Reported Household Weekly Trips

Before the Covid-19 outbreak, younger households made significantly more trips than middle and older aged households, and middle aged households in turn made significantly more than older households. After Covid-19, the number of trips made per week by middle and older households were no longer different; however younger households while making less trips, still reported making significantly more

⁸ <https://ivtmobis.ethz.ch/mobis/covid19>. Using MOBIS and GPS tracking, they found ~50% reduction in tracked trips, more or less mirroring the Australian findings in this paper.

than middle and older households. With regards to further changes planned, younger households still planned more weekly trips on average than older households, but planned to revise the number of trips down to similar levels to middle aged households.

Lower income households made significantly less trips per week than middle or higher income households prior to Covid-19; however after Covid-19 this difference largely disappeared as households of all incomes reduced the number of trips made.

3.1.2. Travel by Mode

In terms of how different modes of transport are affected by changing travel behaviours (Figure 5), the biggest reduction in aggregate trips was via the private car, falling from an average of 17 trips a week down to eight. Similarly, the use of public transport has also fallen, with significant reductions in train and bus usage.

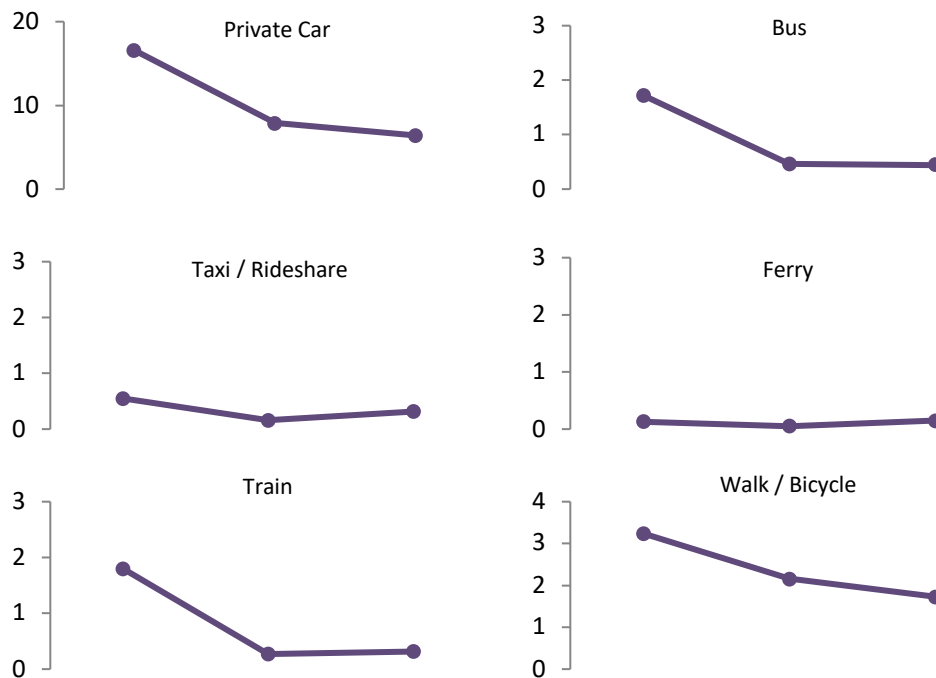


Figure 5: Reported Weekly Household Trips by Mode

Interestingly, as a proportion of overall household trips, the private vehicle remains relatively stable at around 70% before or after Covid-19, or for any planned future changes, but the use of public transport falls from around 15% of trips on average down to 7%. Active transport, while lower in absolute terms, increases from 14% of household weekly trips prior, to accounting for one in five (20%) of trips after Covid-19.

Looking at perceptions of different modes in a little more detail, Figure 6 shows that the private vehicle is clearly dominant in terms of which mode a respondent would feel most comfortable using if they were required to travel. The perception of the train and bus are quite negative in the context of Covid-19 with 33% and 42% of respondents rating these modes as their least comfortable respectively. These

perceptions are largely invariant to socio-demographics, with only middle age respondents displaying a greater propensity to rate taxi or ride-sharing as their most comfortable option.

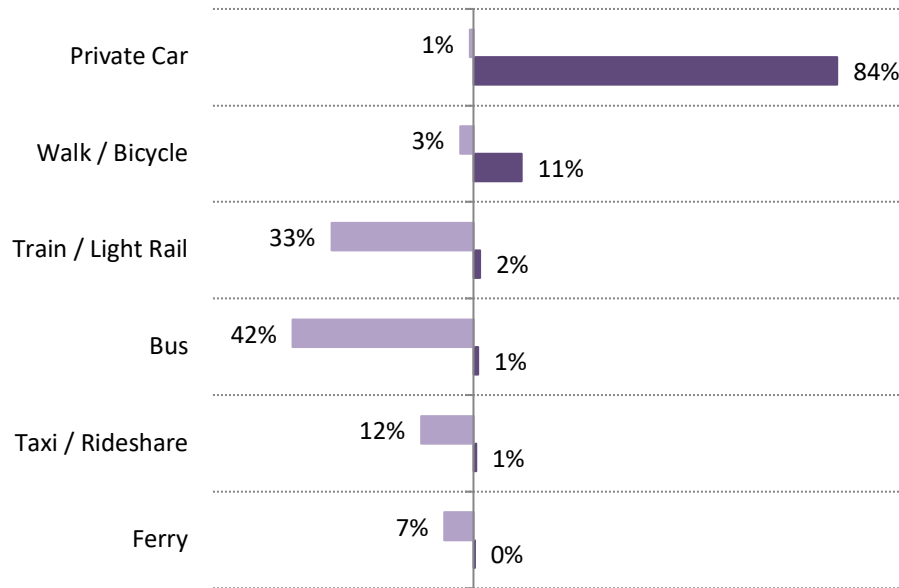


Figure 6: Most and Least Comfortable Mode of Transport

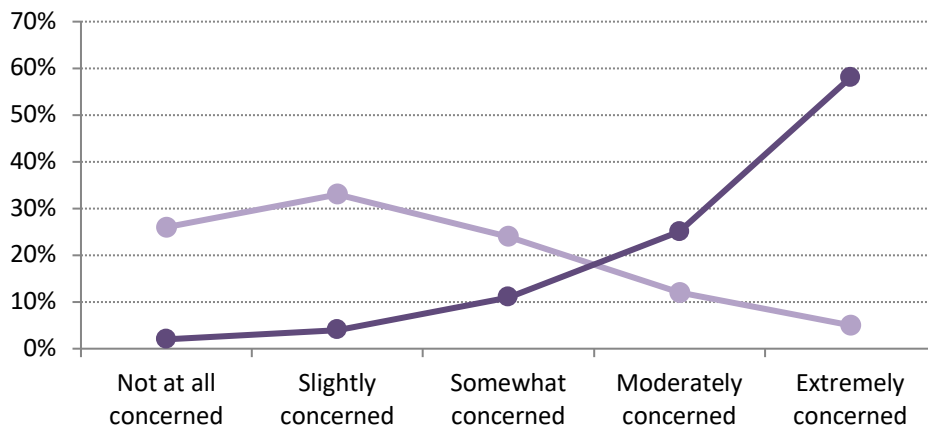


Figure 7: Level of Concern about Hygiene on Public Transport

The impact of Covid-19 on public transport is further demonstrated when looking at how concerned respondents were about the level of hygiene on public transportation prior to the Covid-19 and after (Figure 7). Over half of respondents (58%) are now extremely concerned about levels of hygiene on public transport, up from just 5% prior to Covid-19. Again, these attitudes are largely invariant across the sample, with females being more concerned both before and after Covid-19, and older people who were significantly less concerned than others prior to Covid-19, but are after restrictions hold the same concern as other age groups.

3.1.3. Travel by Purpose

As seen in Figure 8, trips for all purposes examined have fallen, the biggest fall unsurprisingly being in commuting trips, from an average of seven per week down to three. In aggregate, significant falls are also observed for the purposes of childcare and education, social and recreation, general shopping, personal business and for purposes of caring for the sick or elderly. Interestingly, there is no significant reduction in the number of trips for food shopping. Again, as a proportion of household trips, commuting remains relatively constant at approximately 30% of all household trips, with falls in childcare and education (from 10% to 4%) and social and recreation (18% to 13%), but food shopping now accounts for 29% of trips (up from 17%).

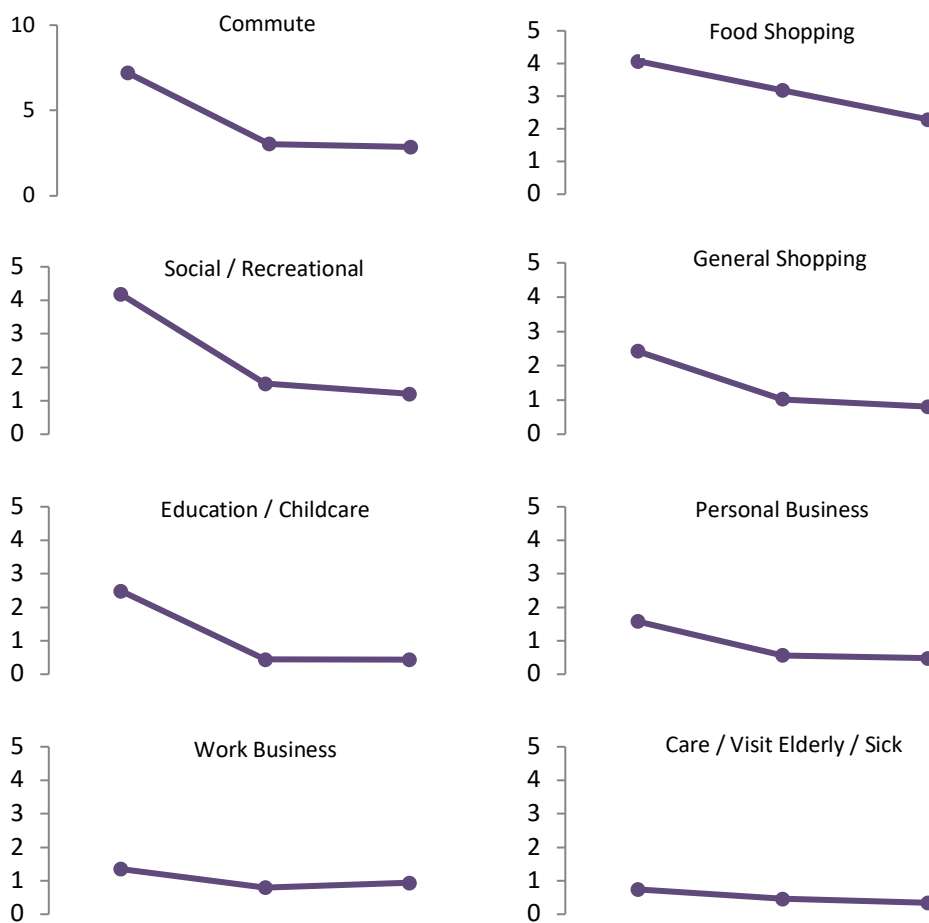


Figure 8: Reported Weekly Household Trips by Purpose

Again, as a proportion of household trips, commuting remains relatively constant at approximately 30% of all household trips, with falls in childcare and education (from 10% to 4%) and social and recreation (18% to 13%), but food shopping now accounts for 29% of trips (up from 17%).

3.2. Impact of Covid-19 on Work

3.2.1. Employment

A large driver of travel activity is employment, and there is no doubt that Covid-19 has had a large impact on the availability of work and the way in which work is done. With changes to retail and shopping behaviour already occurring due to Covid-19, the restrictions on trading announced by the Federal government, coming into effect on the 30th of March, had further impacts on the economy.

Figure 9 highlights just how widespread these impacts were, with only one-third of respondents being unaffected or perhaps more impactful, 70% were impacted by the regulations or knew someone who was. Females were more likely to either be impacted or know someone who was, and respondents from high income households were more likely to have someone in the household affected (and low income less likely).

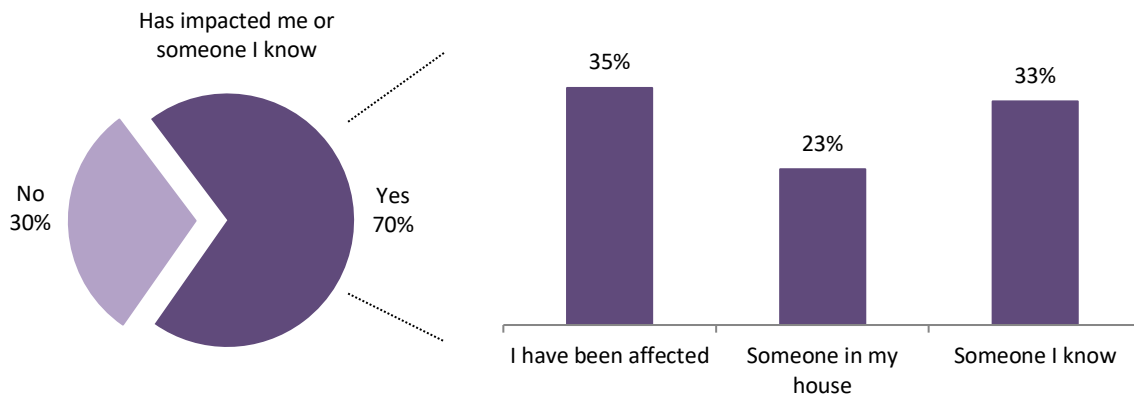


Figure 9: Impact of Government Regulations on Availability of Work

In this sample, 33% of respondents were not working prior to Covid-19 (either retired, or a stay at home parent, or unemployed); but looking at only those who work at least one day a week, prior to Covid-19 more than half of respondents worked 5 days per week (57%), with the average among those working being 4.5 days a week. However, after Covid-19, over a quarter of respondents (26%) are no longer employed and the number who work 5 days per week has fallen dramatically to 39%, as can be seen in Figure 10. Younger households and those on lower incomes are impacted more heavily as a result of Covid-19, with these two groups now working significantly less days per week on average than other respective age and income groups.

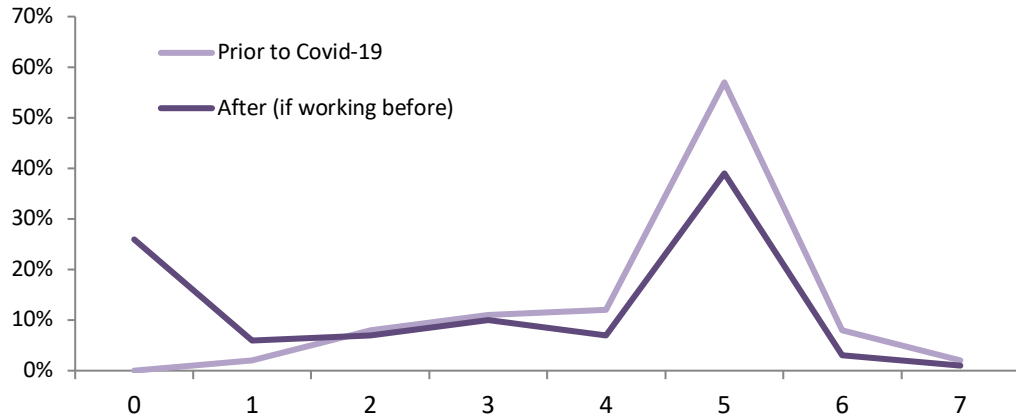


Figure 10: Days Worked per Week (if employed prior to Covid-19)

3.2.2. Working from Home

For those who still have employment, many have been able to shift their work such that they are now working from home. As shown in Figure 11, almost half of those employed have stated that their work can be done from home (47%), with those from higher incomes or from middle aged households being more likely to be able to complete their work from home.

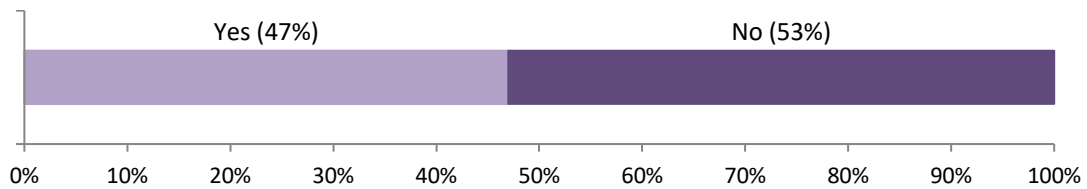


Figure 11: Ability to Complete Work from Home

In terms of the policy of the workplace in which respondents are employed (Figure 12), 41% are in workplaces that either direct employees to work from home, or give them the choice to do so; half either cannot work from home given the nature of the job or their workplace does not support it, while 9% unfortunately work for a business that has now closed as a result of Covid-19. Many of the latter businesses are restaurants, pubs, clubs, gyms, tattoo parlours and shops.

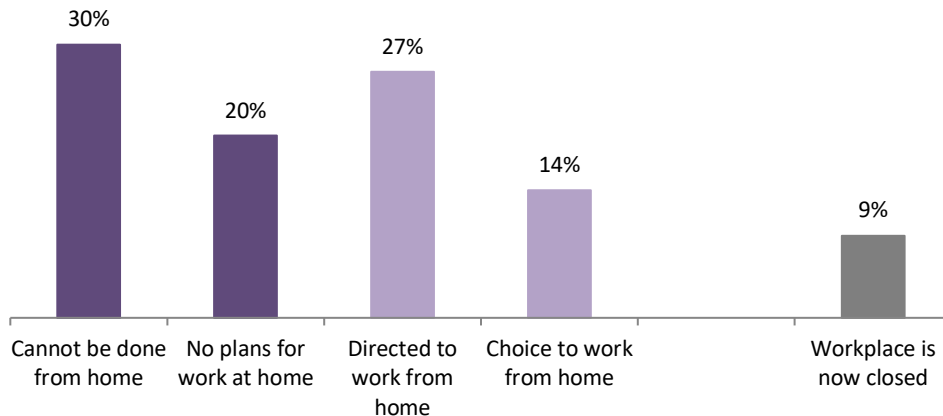


Figure 12: Workplace Policy to Working from Home

In terms of differences based on socio-demographics, females are more likely to have worked in places that have closed, those in lower income households or respondents who are younger are more likely to be in workplaces that have no plans to allow working from home or in jobs where work cannot be done from home, and higher income households are more likely to either be given the choice or directed to work from homes.

Prior to Covid-19, of those who were employed, the vast majority did not work from home (71%); however following the Covid-19 restrictions, that number almost halved (down to 39%), with a quarter of respondents now working from home five days a week, see Figure 13. As a result the overall average number of days worked from home per week swelled to 2.5, up from 0.8 days prior. While middle aged respondents work more from home on average (both prior to and after Covid-19), the number of days worked from home is generally independent of age, gender or income.

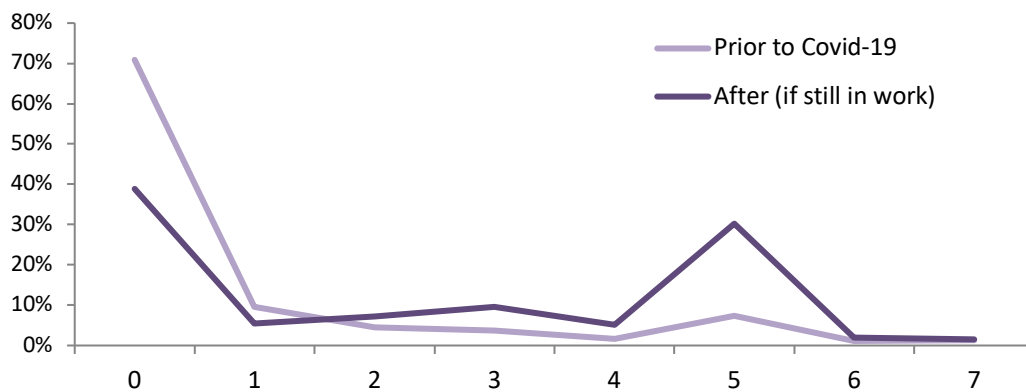


Figure 13: Number of Days Working from Home

3.3. Impact on Activities

The impact of Covid-19 on regular activities outside of work has been just as profound (Figure 14), with large numbers of respondents reporting interruptions to meeting with friends (80%), visiting restaurants (76%), and going to the shops (76%). Interestingly, only 34% of the sample stated that watching professional sport was a regular activity that had been interrupted, possibly because many do not watch these events.

There are many differences in the impact based on socio-demographics. Females are more likely to state that meeting with friends, going to the shops, and doctor’s appointments had been interrupted; males that watching professional sport or playing organised sport had been interrupted. Younger respondents were more likely to report interruptions to going to the shops, going to movies, going to pubs or bars, gyms and exercise, and attending music events; middle-aged respondents are more likely to experience disruption to schooling or childcare; and generally older respondents report less disruption overall, with the exception of doctor’s appointments where they are more likely than other age groups to have this activity disrupted⁹. With respect to income, lower income households are less likely to report disruption to visiting restaurants, going to pubs or bars, gyms or exercise, watching professional sport, playing organised sport, or work functions; middle income households were more likely to find that going to restaurants and pubs or bars has been interrupted; and higher income households were more likely to report disruption to gyms and exercise, watching professional sport and work functions.

⁹ The Federal government introduced free tele-health to enable appointment with a GP to be made from home.

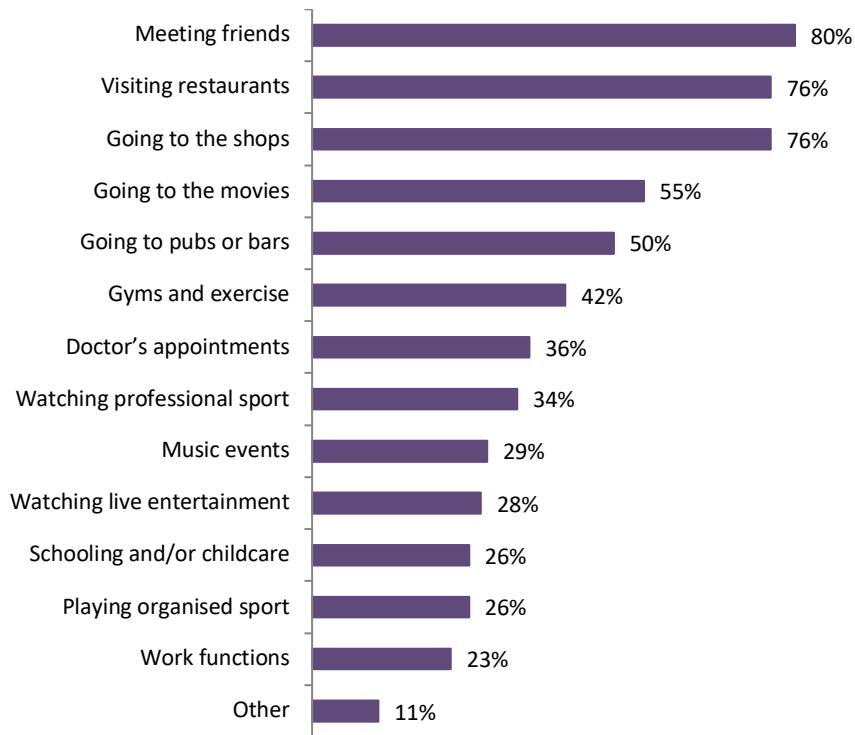


Figure 14: Interruption to Normal Activities due to Covid-19

3.4. Impact on Air Travel

Another point of interest in this survey was the impact on the aviation industry. As at the end of the first week of April, only 2% of the survey was still planning on making a flight of some kind, with 52% delaying travel voluntarily and 46% doing so because of government regulations. For those who still intended on travelling, 63% were going to do so domestically, while 54% were still intending to make international travel during the Covid-19 pandemic (selecting both was possible). The majority of intended travel was personal travel (79%) as compared to business (29%).

Figure 15 highlights the bigger impact on planned air travel that has been disrupted by Covid-19, with over a third (37%) of respondents experiencing some kind of disruption to their planned travel. Unlike travel that was still intended, interrupted travel was primarily international (63%) compared to domestic (55%), and almost all personal travel (94%) rather than for business (12%). Almost half of respondents cancelled travel (49%), a large number returned the ticket for a voucher or credit with the airline, with 11% having rebooked their flights for a later date. Females are more likely to have returned their ticket for a voucher or credit.

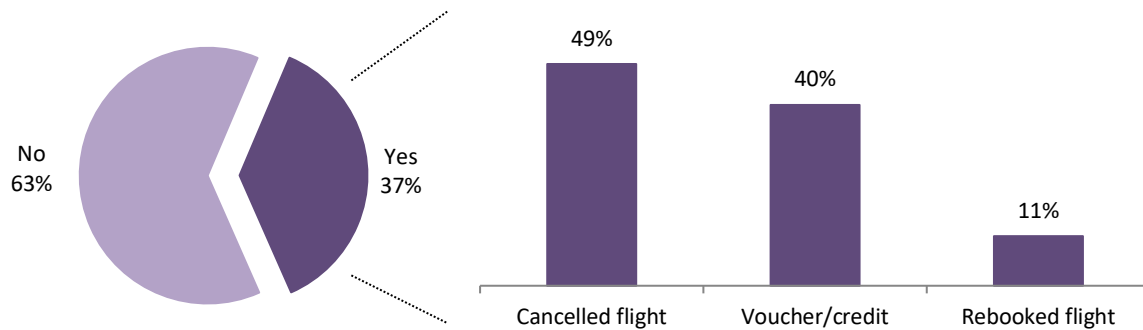


Figure 15: Air Travel Interrupted by Covid-19

3.5. Impact on Shopping

The Covid-19 outbreak resulted in widespread instances of panic shopping, particularly for toilet paper, sanitisers, and staple foods such as pasta, rice and minced meats. The survey asked respondents if they encountered difficulty shopping for a number of key items, and Figure 16 shows that 80% of respondents experienced problems shopping for toilet papers, along with food (73%) and tissues (63%). Females were more likely to report difficulty in shopping for toilet paper, food and non-prescription medicine, and males more likely to report shopping for sanitary products. Interestingly, older respondents were less likely to report difficulty in shopping for food, sanitary products and non-prescription medicine. Almost a quarter of respondents were using online grocery shopping prior to the 1st of March, and a further 18% reported using online grocery shopping as a result of the Covid-19 outbreak; though older households were less likely to use it both before and after the pandemic.

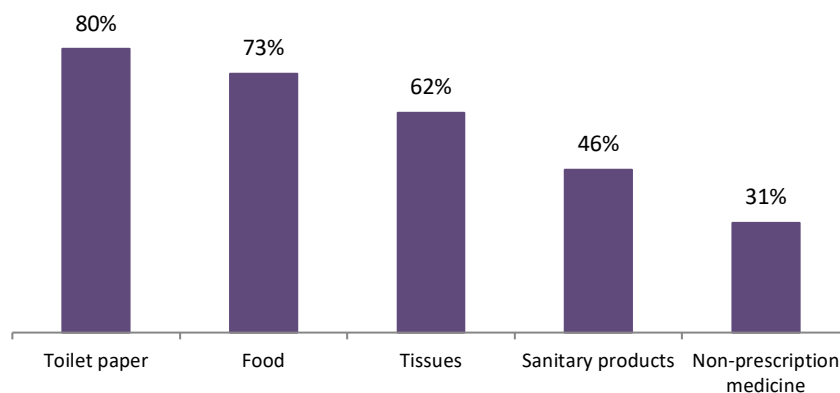


Figure 16: Difficulties Shopping for Items

The survey also explored if respondents engaged in any “stocking up” behaviour themselves (Figure 17), and almost half the sample (47%) reported doing so for food, and one-third for toilet paper. Older

respondents were less likely to have stocked up on food or sanitary items, and lower income households less likely to have stocked up on toilet paper.

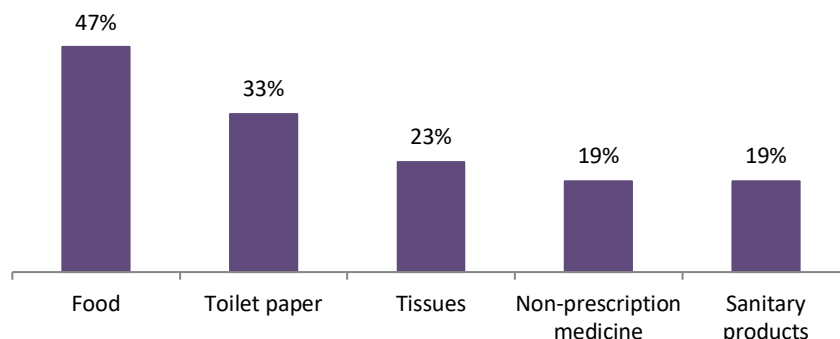


Figure 17: Stocking Up on Selected Items

In terms of the number of days of stock for each of these items, there was a great degree of variability in the data (as indicated by the error bars in Figure 18), but households held an average of approximately three weeks of stock for toilet paper, tissues and non-prescription medicines. Stock of food was the most consistent among responding households, estimated to be at a week and a half of supplies. Females reported a higher average number of stocked sanitary items; older people a higher average stock of food and less sanitary products, and higher income households holding a higher average stock of non-prescription medicine.

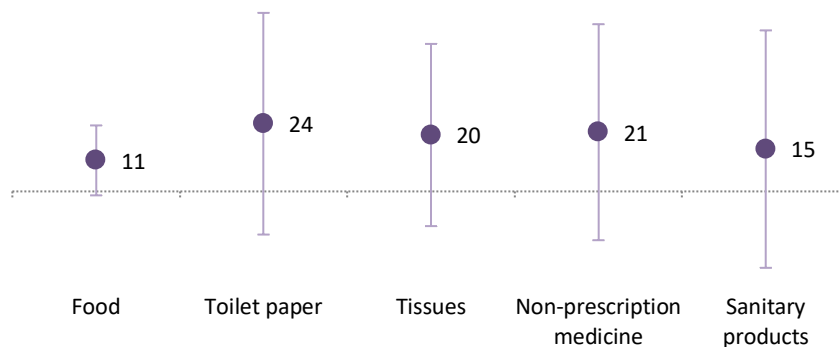


Figure 18: Average Days Stock of Selected Items

Interestingly, when looking at the variation in household supplies, 7% of households reported having only one day of food in stock, whereas 2% reported having two months or more. With respect to toilet paper, 10% felt they only had enough stock to last a day compared to 11% who felt they held two months or more worth of supplies. Twenty-percent of households reported only having one day of tissues and 9% having two months or more; 27% one day of non-prescription medicines and 9% two or more months; and lastly 32% report one day of sanitary products compared to 5% feeling they hold two or more months of supply.

3.6. Attitudinal Analysis

The survey also explored the attitudes held towards various aspects of the Covid-19 outbreak with respondents asked to state their level of agreement with a number of statements (Figure 19). Across all

statements, respondents exhibit significant levels of agreement, however the thought that Covid-19 is a serious public health concern, requires drastic measure and will affect the way people travel is significantly higher than other statements. On the other hand, agreement with the statement that I will go to work to avoid social isolation is significantly lower than all other statements. Interestingly, there is significantly lower agreement with the trust in other people to respond in the future, the appropriate self-isolating and social distancing of others and the response of the wider community, as compared to the response of the governments and business and their actions moving forward¹⁰.

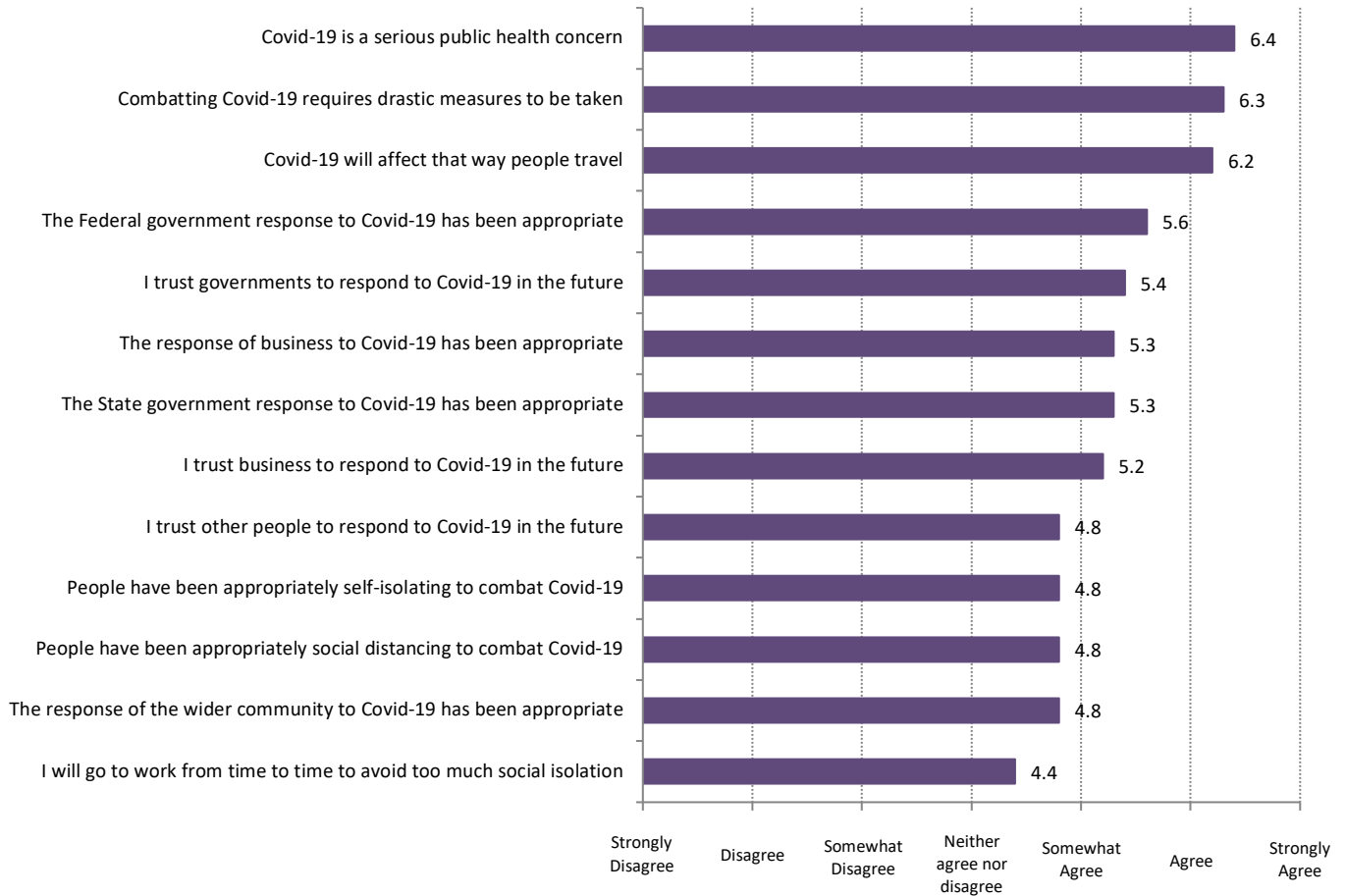


Figure 19: Level of Agreement with Statements regarding Covid-19

In terms of sociodemographic differences, older respondents reported significantly higher levels of agreement with all statements; females higher average agreement with Covid-19 being a serious public health concern, requiring drastic measures, that it will affect how people travel, that the response of business has been appropriate and that the response of the state government has been appropriate. Males and middle income respondents exhibit significantly higher average agreement with the statement that they will go to work from time to time to avoid social isolation.

¹⁰ The perceived appropriateness of state government responses will need to be examined on a state-by-state basis, particularly to see if there is any impact of the Ruby Princess disembarkation in NSW. NSW instigated an inquiry in mid-April which is likely to run for at least 6 months.

With respect to the risk that Covid-19 presents (on a scale from 1 = extremely low risk to 10 = extremely high risk – Figure 20), the risk of Covid-19 to the health of the economy is viewed to be significantly higher than the risk to someone known to the respondent, the general public, or the health of the respondent themselves. However, Covid-19 is still thought to be a very high risk to someone known to the respondent or themselves; indeed while respondents do view Covid-19 as a risk to themselves, on average their own health is at the lowest perceived risk.

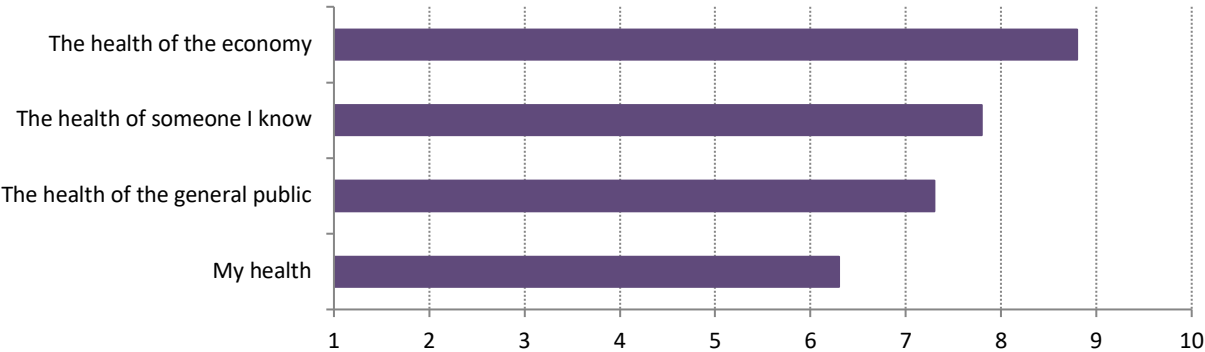


Figure 20: Risk of Covid-19 to Human and Economic Health

3.7. A Closer Look at Car Travel

While Figure 5 shows a fall in the number of trips made by car to be approximately 50%, Figure 21 below shows that two-thirds of respondents (66%) report a reduction in household car use, 15% having car use that is about the same, and 8% of households report using their car more. Females are more likely to report a decrease in household car use, along with older respondents. Low income or younger households, however, are more likely to not own a car or less likely to report decreased car use.

Overall, car use as a percentage of kilometres driven has decreased by 35% in aggregate (standard deviation = 42%). Among those households to have decreased their car use, the estimated reduction is 60% on average (median = 60%, standard deviation = 27%); lower income households report a significantly lower average reduction, with high income households reducing car use the most. In terms of the small number of households who have increased car use, the average increase is 44% (median = 35%, standard deviation = 30%).

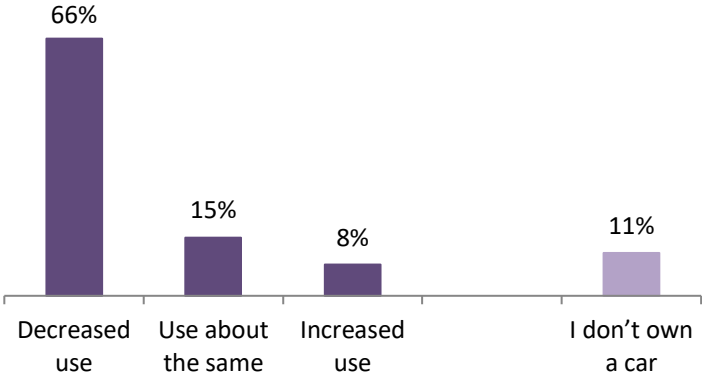


Figure 21: Changes in Car Use over Previous Week

To explain these broad changes in use of the car, a series of ordered logit models (Greene and Hensher 2010) were estimated, where the ordered choice were based on the response to a question that indicated whether a respondent would be more or less likely to decrease car use (0), keep car use constant (1), or increase their use of the motor vehicle (2). Many covariates were tested, and the best model is presented in Table 2. In explaining a broad change in car use, we found statistical significance associated with being able to do work from home, being directed to work from home by the employer, and where the car was the main mode of transport to work prior to the outbreak of Covid-19.

Table 2: Ordered Logit Model Explaining Changes to Car Use

LL _{Base}	-864.17
LL _{Model}	-896.30
Pseudo R ²	0.04
χ^2	64.25
AIC	1742.30
n _{obs}	1073

Variable	Coefficient	Std. Err	Z value
<i>Constant</i>	0.20	1.27	0.20
Directed to work from home	-1.08	0.20	-5.30
Work can be completed from home	0.001	0.0002	4.69
Commute by driving car (prior)	-0.84	0.18	-4.67
Resides in Western Australia	-0.40	0.22	-1.82
Commute by bus (prior)	0.44	0.27	1.57
Threshold Parameter μ_1	1.90	0.11	17.53

The mean direct elasticities presented in Table 3 provide insights into the impact of the variables on car use. If someone is directed to work from home by their employer, on average there is a 34% increase in the probability of a household decreasing their use of the car. Similarly, if someone's work can be completed from home, or if they mainly used the car to commute prior to Covid-19 or if they live in Western Australia, the probability of the household decreasing the use of their car also rises (and conversely for these variables, the probability of car use staying the same or increasing is lower for these households). Though the effect is relatively weak, if a bus was the main mode of commuting prior to Covid-19, the probability of car use staying the same, and particularly increasing car use, is higher. This is likely due to the high level of discomfort attached to bus travel¹¹, and concern over the relative hygiene of that mode; with the preference now being for the hygiene of their own vehicle.

While the number of significant explanatory variables at this aggregate level is small, there are more factors when examining the magnitude of the change. Given that two-thirds of households have decreased the use of their car, we opt to look at this change in detail in this paper as there is preliminary evidence that cars will be relatively more attractive when travel restrictions are eased.

¹¹ This concern also applies to trains and ride share, although they were not found to be statistically significant. We suspect this is because bus is the dominant mode in most cities and outside of the major metropolitan areas.

Table 3: Elasticities from Ordered Logit Explaining Changes to Car Use

Variable	Decrease	Same	Increase
Directed to work from home	0.34	-0.52	-0.63
Work can be completed from home	0.11	-0.16	-0.23
Commute by driving car (prior)	0.14	-0.21	-0.27
Resides in Western Australia	0.30	-0.43	-0.62
Commute by bus (prior)	-0.17	0.23	0.40

Where commuting was undertaken primarily via bus, the probability of increasing car use increases (and conversely the probability of reducing the use of the bus is less). This result, combined with the findings that respondents would be least comfortable travelling on buses (followed by trains), and that 83% of the sample express concern about hygiene on public transport, indicates a likely high aversion to public transport at least in the short term. Additionally, the likely reality is that capacity on public transport will be significantly reduced due to social distancing requirements, creating a further disincentive for these modes. As people return to work, the attractiveness of the private vehicle may create worse congestion than what was seen prior to Covid-19, so understanding why people are decreasing car use is important in being able to develop policies to keep use suppressed as restrictions are eased.

Table 4: Explaining the Magnitude of Decreased Car Use

	R ²	0.101
	Adj. R ²	0.091
	F _(8,689)	9.700
	F _{sig}	0.000
	Std. Err. Est.	25.905

Variable	Coefficient	Std. Err	t value
<i>Constant</i>	-34.27	3.90	-8.79
Difference in days of employment (Prior vs After)	-3.08	0.50	-6.13
Difference in days worked from home (Prior vs After)	3.07	0.50	6.13
Shopping affected by Covid-19 outbreak	-7.52	2.42	-3.11
Meeting friends affected by Covid-19 outbreak	-6.93	2.78	-2.49
Work cannot be done from home	7.02	2.68	2.62
Drive car as main mode (prior)	-7.51	2.77	-2.71
Covid-19 is a threat to public health	1.24	0.52	2.40
Covid-19 is a threat to economic health	-1.23	0.52	-2.38

Table 4 presents the results of a regression modelling examining drivers of decreased car use. Again we see that the large drivers of reduced usage are changes to work and important life activities, which is expected. Those who did more days working prior to Covid-19 (compared to after) report a higher percentage decrease in the overall number of trips after the outbreak (the dependent variable is negative to represent a percentage drop). Those who worked more days from home after the outbreak

than before, have a higher percentage decrease than those who work from home the same amount or less. Respondents who reported that shopping activities and meeting with friends were usual activities that had been interrupted by Covid-19 reported significantly decreased car use relative to others, as did those who felt that the outbreak was a significant threat to the health of the economy (possibly supporting this view through decreased car use). Individuals who could not work from home had significantly less reduction but still a decrease, in car usage (recall that these people were also more likely to keep car use the same or increase it), and those who agreed more strongly that Covid-19 is a significant public health threat reduce car use by a lesser percentage.

These findings align well with what we are seeing in the grey press and media about the challenges in making public transport attractive again. In Australia, service levels and schedules were unchanged during Covid-19 with resultant movement of almost empty carriages and buses. Public transport Authorities are already planning new strategies to support public transport which include regular deep cleaning and enforcing the wearing of masks while on board, on platforms and at public transport terminals. Social distancing will mean that seats adjacent to passengers must remain unfilled, dropping passenger capacity to around 30 percent for most public transport modes. The latter may indeed be acceptably achievable if working from home continues at a rate that might not be as high as at present but substantially higher than prior to Covid-19. With offices obliged to comply with social distancing rules as restrictions are lifted, the staggering of working hours is likely to provide some support in achieving a public transport system that is no longer typified for the high peaks (the camel effect), but rather becomes like the horse (flat throughout the day).

4. Discussion and Broad Policy Implications

The changes brought by the Covid-19 outbreak are widespread and unparalleled. Following the restrictions announced by National Cabinet implemented on the 30th of March, we can see that travel activity has significantly decreased, as a function of a reduction in travel via every mode, and for every purpose. The government's request to 'stay at home' has had the desired impact on reducing the risk of exposure and transmission of Covid-19. Our analysis indicates that as a whole, Australian's view Covid-19 as a significant health risk to themselves, to the general public and people that they know in particular, and especially the health of the economy.

Understanding that Covid-19 required drastic action and change to the way people travel, and perhaps altruistically motivated by the threat to the general public and the economy, Australian residents took the social distancing measures in their stride, adapting their life by changing the way they visited with friends, went to restaurants and shops, or to the movies and pubs or bars, with a significant increase in deliveries of all manner to the home. They did so, largely in support of the Federal and State responses, trusting the actions of both levels of government, as well as agreeing that the response of business has been largely appropriate thus far.

Early modelling indicated that a compliance of below 70% would be unlikely to succeed, whereas compliance with social distancing measures at a 90% level would likely control the disease within 13–14 weeks, when coupled with effective case isolation and international travel restrictions (Chang et al. 2020). National Covid-19 statistics provide tentative evidence that this changed behaviour has been effective thus far in "flattening the curve" of Covid-19 infection rates, indicating that compliance has been strongly embraced in Australia. Interestingly, this outcome has been despite significantly lower levels of agreement, though agreement nonetheless, that the wider community and people in general have been self-isolating and social-distancing appropriately. The Covid-19 outbreak has seemingly

produced a rare instance where people trust the government and business more so than those around them.

Significant disruption was also witnessed in grocery shopping, with large numbers experiencing difficulty shopping for toilet paper and food, with many stocking up on both. Analysis seems to indicate that, on average, households have enough stock of necessities to cope with disruption, though stock levels are variable and food stocks are relatively lower at an average of 11 days¹². The supply chain operations of supermarkets and producers have seemingly caught up with rapidly changing demand, but should remain prepared for future disruptions which might occur, particularly that to the food supply. Future work currently being undertaken will examine wider experiences with the retail industry and online shopping during the Covid-19 pandemic.

Similarly, the aviation industry has experienced dramatic upheaval. At the time of sampling, only 2% of people still intended to make a flight and over a third of people had air travel disrupted by Covid-19, with the majority of this group cancelling flights for a refund, or suspending bookings in return for a 12 month credit with the airline. How good that credit might be could be questionable, for example Virgin Australia has gone into voluntary administration as a result of Covid-19. Most of the interrupted travel was personal travel, and more was for international travel than domestic. International borders were closed by mid-March and in some cases in Australia (i.e., entry in and out of Queensland and Western Australia).

Moving forward, this behaviour is likely to change significantly, perhaps the most definitive trigger for relaxation of global travel restrictions will be the advent of a vaccine but that is at least 12-18 months away, ignoring the further time it would take to mass produce a vaccine on the scale that would be required. There is very little indication as to how individuals will react. While some may be less inclined to travel, growth in international travel continued unabated under previous shocks like the Oil Crisis, Gulf Crisis, 9/11 attacks, and SARS (IATA 2020). Previous research has shown that travellers react to external threats in the short-term, but over time those preferences have so far reverted back to pre-existing thresholds.

The recent growth in air travel, however, has been predicated on the fact that international travel was becoming more affordable, thanks to new technology and fiercer competition in the industry. Yet, with a prolonged global recession there may be less competition in the sector moving forward and what was once affordable may no longer be so, and the number of competing airlines may well be less¹³. While it is likely that preference for international travel may be suppressed, or unaffordable, for some time this will increase the relative attractiveness of domestic travel. Following the bushfires, there were many well received campaigns to travel and buy local, and the sector will need to recapture that momentum and sense of 'Australian-ness'.

While the disruption to travel is widespread, the unfortunate reality is that a large part of that disruption is because of changes to work and employment. More than two-thirds of household's surveyed (70%) have been impacted, or know of someone whose availability of work was impacted, by the government regulations introduced to combat the spread of Covid-19. The impact can be seen most

¹² As of May 6, the supermarkets have advised that there is no shortage of stock, and in some cases they overstocked since people have started hoarding, with soup the most popular purchase.

¹³ Qantas announced on May 5 that it is considering offering very low airfares domestically to get people back to travelling within Australia.

dramatically in the findings that the number of people working five days a week has fallen from 57% to 39%; and 27% of the sample who were working at least one day prior to Covid-19 are no longer working. While this impact should not, and cannot, be ignored, it is again worth highlighting that our evidence is that Australians support the government and have embraced this disruption, thus far displaying the important trait of resilience as a nation.

The way in which work is undertaken has changed; the number of people working zero days from home has fallen from 71% to 39%, and the number working five days a week from home has increased from 7% to 30%. Almost half of the sample has the ability to complete their work from home, and have either been given the choice or told to do so. There are challenges to working from home, and future research will explore those challenges along with potential benefits. It is important to note, however, that these results also indicate the emergence of a “two-speed economy” wherein there are those who have the ability to work from home and are successfully doing so, and those who cannot. We have data from a separate convenience sample, largely comprised of individuals whose jobs can be done from home, that highlights this differential impact, and current research is examining the different experiences between these two groups of people.

Interestingly, there are important implications for the future of work that may emerge from the Covid-19 experience. Our preliminary evidence is that those who have experienced the largest disruption to the availability or safety of their work have been those involved in human facing industries: personal service and retail; restaurants, cafés and bars; the arts and creativity. These industries have been long argued to be the bastion of future employment, where interpersonal and creative skills will be central to the future of work, as they are jobs which are the hardest to automate. We have now flirted with the concept of a universal basic income, with the lifting of the unemployment benefit (JobSeeker) and the government subsidisation of wages (JobKeeper) (Australian Government 2020).

Associated with all of this change, and in particular the change to work, is the way in which we travel, or not, as the data currently reveals. Car use is down by over a third (35%), and for the majority of respondents who are able to decrease car use, that reduction is even larger at 60% less than before Covid-19. The benefits of that reduction can be seen by all, with improved air quality and visibility in our capital cities, and in less congestion on the roads for those essential workers who need to travel in order to work.

However, our analysis indicates that it is likely that as Covid-19 restrictions ease, the car will return in a dominant way and could cause congestion at levels not seen prior to the outbreak. The private vehicle is shown to be the mode of transport that the vast majority of people would be most comfortable using in the current climate (particularly those who feel that Covid-19 is a larger public health concern than others), with the key public transport options of bus and the train being easily viewed as the least comfortable. Concern about hygiene on public transport has also become extreme in the aftermath of Covid-19. With there already being crowding on public transport, particularly in capital cities like Sydney (Infrastructure Australia 2019); adherence to social distancing requirements will reduce that already strained capacity even further. Additionally, another by-product of Covid-19 that favours the car is the significant reduction in fuel prices and the growing global stockpile of oil. Preliminary evidence in the Swiss MOBIS study shows the start of slow recovery in kilometres travelled by car (and a large increase in bicycle use) while public transport modes stay comparatively flat (Mobis 2020).

The key factors suppressing car use¹⁴ are reduced employment, increased amounts of working from home, prior use of the car as the main mode of transport, and interruptions to meeting with friends and shopping. Clearly as restrictions ease, the very last thing we want to do is constrain employment, but perhaps governments can ask Australians to still be patient with regards to meeting friends and engaging in widespread discretionary shopping particularly during the week, as people do hopefully start to return to work, at a staggered time of day rate.

Public Transport will face some of the greatest challenges if we are to make it attractive again as we emerge slowly out of the Covid-19 pandemic. In Australia, service levels and schedules were unchanged during Covid-19 with resultant movement of almost empty carriages and buses. Public transport Authorities are already discussing new strategies to support public transport which include regular deep cleaning and enforcing the wearing of masks while on board, on platforms and at public transport terminals. Social distancing, a concern of the respondents in this survey as well as society in general, will mean, at least in the short to medium term, that seats adjacent to passengers must remain unfilled, dropping passenger capacity to around 30 percent for most public transport modes. The latter may indeed be acceptably achievable if working from home continues at a rate that might not be as high as at present but substantially higher than prior to Covid-19. It is likely that we will see service created where public transport users can receive alerts about when a good time to travel is or when is a bad time, via a simple “green” or “red” indicator in a phone app¹⁵. Much like lunch time in schools with the “no hat, no play policy”, there may need to be a no mask, no ride approach to public transportation.

With offices also obliged to comply with social distancing rules as restrictions are lifted, the staggering of working hours is likely to provide some support in achieving a public transport system that is no longer typified for the high peaks (the camel effect), but rather becomes like the horse (flat throughout the day). On the other side, we will have the reinforced popularity of the private car to deal with as biosecurity becomes a new attribute of modal choice. Indeed this risks significant increases in traffic congestion unless the staggering of work hours is achievable which can also flatten the camel. There are unintended consequences of Covid-19 but if they are managed appropriately, society can reap a benefit in reduced traffic congestion and less crowding on public transport, something that had eluded government in the pre-Covid-19 era. There is, however, the challenge to government of lost revenue from public transport use and consequence escalating subsidy from the public purse. From a societal benefit-cost analysis point of view this additional cost to government can be justified as delivering a huge benefit to society in reduced travel times and crowding. The claimed \$30billion plus of lost time benefits due to congestion (BITRE 2015) can now be recouped!

In the longer term, there are architectural and urban design issues that will arise from the different way in which work is done; office spaces previously designed for hot-desking and open plan face a redesign, and homes might also need to be rethought with a dedicated space for work. Ultimately, this may have impact on the need to be close to places of work, and as that evaporates there may even be a move towards less dense living, reversing the densification seen over the course of the last decade.

Additionally, governments might have to give thought to pausing large infrastructure projects in the public transport space (and potentially even those like the second Sydney Airport), perhaps thinking laterally about increased infrastructure for active transport such as improved bicycle lanes and

¹⁴ We must separate this out for utility vehicles and panel vans used by tradespersons, who have obtained a huge increase in work and travel as a result of Covid-19.

¹⁵ Skedgo has recently developed this capability in their TripGo App.

accessibility. For example, as the WestConnex project continues, maybe some space can be provided for a bicycle super-highway next to the orbital, or bicycle lanes could be developed alongside heavy rail infrastructure and away from roads. Nascent modes such as e-bikes and e-scooters (which are currently illegal in NSW) could also receive policy and regulatory support for shorter trips, or perhaps with increased spacing between passengers on public transport, commuters could take these modes more easily onto public transport to improve access and egress at stops or stations. Governments might also look to divert spending to improvements in freight distribution capacity as the use of online shopping grows and the distribution sector increasingly starts to show strain.

To help stave off increased rates of congestion (potentially above those experienced prior to Covid-19), older perhaps impossible policies such as car-pooling should also be revisited. With the likely increase in popularity of the car, there may be mechanisms that can be designed to better coordinate car-pooling between known/trusted persons, for both work and recreational purposes. More generally this aligns well with how Mobility as a Service (MaaS) (Hensher et al. 2020) might evolve to better accommodate sharing of modes and reduce reliance on the private car under a post-Covid-19 where bio-security becomes a new attribute in mode choice decisions. It is clear that Australia has adopted an “in it together” mentality and now the MaaS subscription model might encourage people to plan and conduct joint trips with those in the local neighbourhood, as we see a potential rise in a new local community spirit .

It might potentially be the case (certainly through anecdotal sources like television and radio discussions), that many of those living in capital cities are currently enjoying the clean air and visibility associated with the reduction in car use. Perhaps authorities can leverage the current enjoyment of better amenity, combined with significant improvement to health as a result of less tailpipe emissions, to encourage lower levels of car use to be ongoing. Should demand for private car travel return in a significant way, it may also be worthwhile to accelerate the adoption of electric vehicles as a means of reducing tail-pipe pollution, as well as the evolution of connected and intelligent vehicles with differing degrees of autonomy to create smarter and more efficient traffic flows. Ultimately, governments may finally be forced to strongly consider road-pricing as a mechanism to reducing traffic congestion, especially where electric cars will become less expensive to purchase and use as they scale up (Hensher 2020). Research has shown that it is possible to develop such a scheme that achieves this outcome, while also ensuring that road investment and ongoing maintenance is secured, without an additional impost to users above current outlays (Hensher and Bliemer 2014, Hensher and Mulley 2014).

Clearly though, the biggest lever available to policy makers is the ability of people to work from home, with the support of the employer to do so. As children slowly return to school, working from home for many may become easier, and while there is mild agreement that people would like to go to work to avoid social isolation, that feeling of social isolation may be less of a concern as people are slowly allowed to visit friends and family again. Governments will need to sit down with representatives of employer and employee organisations and look at what incentives and investment is required to make working from home a viable long-term proposition for more Australians. The survey suggests a high incidence of choosing to work from home.

The government may need to mandate some form of work from home arrangement where business is required to allow staff to work from home one or two days a week on a rotating basis. Alongside these discussions, there should also be robust debate about another long held transport objective; peak-spreading. In both instances it may be that governments allocate road-space to drivers using a similar system to that in Singapore, where the ability to drive based on the registration number of your car

(though systems will be needed to stop those with financial means to circumvent the system from doing so). These two policies will be crucially important strategies for reducing both crowding and congestion, and of course community transmission from close contact, allowing us to flatten the two curves that occur in the peak – something we can do successfully.

5. Conclusion and Future Research

In support of the actions taken by Federal and State governments, Australians have significantly changed their travel and work habits. This resilience and adaptability has thus far resulted in the desired flattening of the Covid-19 curve, and suggests that the careful mix of change that has been legislated and change which has been given over to the Australian public to own, has been successful thus far. While some of the success may be attributable to the appearance of Covid-19 in the warmer part of the year, the hot summer and a history of bushfires with the immediacy of an experience that was more extreme than ever has perhaps steeled Australia for the behavioural response needed in disaster mitigation. Additionally, by giving Australians co-ownership of the problem, jurisdictions have created individual investment in the solution.

While there are significant differences between travel before and after the Covid-19 outbreak, there are no differences between what is now occurring and the changes which are planned from those who are yet to do so, or from those who have already changed but still planning more. This suggests that the reduction in travel has reached equilibrium. As restrictions ease, Australia should rightfully be wary of increased cases of Covid-19, but governments and business should also be aware of other side-effects of the Covid-19 pandemic that might also interrupt work and travel, both of which have been shown to be important to our wellbeing (Stanley et al. 2011, 2011a, 2019; Ettema et al. 2010). There is previous evidence that the car can play only a minor role for satisfaction with daily travel and its effect on wellbeing (Bergstad et al. 2011).

While this paper presents the headline results examining the change brought by Covid-19 on a number of fronts, further work is ongoing to understand the change at further at this disaggregated level, and on a state by state basis. Our ongoing research, including a second survey one month after the initial survey discussed in the current paper, will also aim to examine the emergence of the dyadic impact of Covid-19 restrictions on those who can work from home and those who cannot, as well as the impediments and experiences of working from home by those who have been able to do so. We hypothesise that the support from employers will be pivotal in ensuring that congested traffic levels and crowding on public transport does not return to pre-Covid 19 levels, which we investigate in a follow up survey.

Something that would help in any post-action review for authorities is a better understanding of examples from around the world comparing different approaches in calibrating the provision of public transport services during a lockdown period, and also in the subsequent recovery phase. For example, many buses in Singapore today are running almost empty, supporting under 20% of the normal workforce with about 90% of services, yet are hesitant about degrading service provision further. How do we know if the Australian approach is appropriate for the situation, or whether Australia is being excessively conservative?

We also have a suspicion that post-COVID, work from home arrangements will likely become a bigger part of the 'new normal' and unlike pre-COVID, where peak PT demand is relatively inelastic, we may have to start to more seriously rethink the role of fixed route, fixed scheduled services in our transport

landscape. Various governments have alluded to the possibility of having to update their financing framework if there is a drastic impact to travel demand. We will also likely need to find ways to make on-demand/shared services more acceptable and financially viable, within or outside of Maas. Given the amount of subsidies that have been poured into traditional public transport services, perhaps some of the monies could be better spent seeding more on-demand/shared services in the private sector. A natural follow on question if we more aggressively pursue this route, is in the governance and regulatory controls for such services.

Finally, in summary, Covid-19 may have broken the resistance of many employers to working from home. The idea that working from home through telecommuting or a nine day fortnight, referred to as distributed work practices, has been suggested for many years (see Brewer and Hensher 1998). Indeed earlier research on finding ways to reduce enhanced greenhouse emissions, essentially CO₂ in the transport sector, suggested that the two main ways of achieving this, in the absence of road pricing reform, was to improve the fuel efficiency of cars (reduced emissions per kilometre) and to introduce distributed work practices (Hensher and Ton 2002). Efforts to improve public transport within the financial constraints of government have not proven to be a panacea in making a significant difference to traffic congestion. We now have first-hand evidence - a real market test, admittedly under severe restrictions - that working from home works much more than many employers, and indeed many employees, had thought. So the evidence is in, and although we do not expect such a high incidence of working from home when restrictions are lifted, we now have a real opportunity to promote an increased amount of working from home to achieve progress on a number of other societal challenges.

One of the greatest impacts has been on traffic congestion, although we recognise that it has resulted in a significant drop in public transport use and some trips normally by public transport are undertaken by car given the growing importance of bio security on one's health risk. When the restrictions are fully relaxed, if we could obtain at least one day a week working from home, spread equally over the five working days (or reasonably equally to avoid a dominance of Friday or Monday to give long weekends), then we can improve the travel times on the roads significantly, and this will have a greater impact on traffic congestion, especially in the peak periods, than simply construction of new roads or changing the physical capacity of existing roads through transport management interventions. We suggest that this may be politically more palatable than road pricing reform, which remains a challenge.

There is no reason now to not take advantage of this 'new normal' to contain congestion growth, and indeed, if we can reduce car traffic each day by about 10 percent, we should eliminate the worst of congestion, returning all times of the day to levels of traffic experienced in school holidays which is usually very acceptable to the travelling public. We could even do better than 10 percent. This is an opportunity not to be foregone by industry and government, offering a real opportunity for employers to show a commitment to sustainable goals, something many aspire to and very few ever get close to achieving. With the field test complete, let us use this to benefit climate change, wellbeing and infrastructure priority funding, enabling a greater amount of funding directed to essential services such as health services and care support.

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